A NURSING HOME IN SWEDEN

MA4 ARCH 49 - 2012
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Aalborg University
Architecture. Design & Media Technology
4th Semester Master 2012, Architecture

Project period:
1st of February 2012 - 23rd of May 2012

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Pages:
141

Print run:
6

Abstract

Dette projekt behandler arkitektonisk design af et plejehjem til naturområdet Majelden i Linköping, Sverige. Projektets hovedfokus er at skabe et hjemligt miljø, der relaterer sig til sine omgivelser og udnytter nærheden til naturen. Der er ydermere lagt fokus på værdier, som har konsekvens for plejehjemsbeboernes hjemlighedsfølelse og på at skabe et arkitektonisk miljø, der kan tilpasse sig beboernes fysiske og psykiske tilstande også over tid. Således er der udviklet et plejehjemskompleks, som er egnet til både kognitivt velfungerende ældre og ældre med demens. Skitseringsprocessen baserer sig på Den Integrerede Designproces og de førnævnte trivselsværdier er undersøgt på basis af evidens. Teknisk fokus er på dagslys og indeklima.

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Introduction

Getting old entails changes in the way life works. Family relations change, social networks slowly decrease, and maybe the mobility is not anymore what it once was. Such changes require new settings, which provide for the special needs that slowly appear.

'Nursing homes take care of seniors suffering from chronic problems that prevent them from caring for themselves and for whom there is no adequate alternative source of care.' (Marcus & Barnes, 1999)

Despite the obvious associations emerging from the word home, this is not always what nursing homes are about. Very often they are perceived as mere institutions - by society as well as the future residents. Nevertheless residents in a nursing home are likely to spend the majority of hours in the same settings – day after day. How do we make these many hours a little better?

This project tries to combine knowledge found in the literature with special attention to the effects of the most changeable and affective phenomenon known, namely the daylight.

Daylight is of indescribable importance in regard to human health, physically as well as psychologically.

When building today, considerations regarding perceived architectural quality, come along hand in hand with demands to how the outcome responds to its environment, how it acts sustainably in the long run and how the indoor climate affects human health, well-being and thus the will to live.

This project emerges in the cross-field between perceived living quality and environmental awareness. It seeks to find a way to combine the perceived, architectural and technical aspects of light as a weighted influent on the process of designing a nursing home in the north, respecting its settings, its users and the environment.

'How do we create a nursing home in a Nordic context with focus on the impact of daylight on human health and psyche, which combines perceived residential quality with functionality and fulfills the 2015 requirements to energy consumption?'

ill. 1.1.1 Majelden

Preface

Methods

This chapter will clarify the methodical approach applied to the project. Overall two main methods – the Integrated Design Process (IDP) and Evidence Based Design (EBD) - are incorporated as they are both considered essential in regard to the architectural challenge of designing a nursing home. In the following text the two methods will be introduced separately. They are applied simultaneously in the project however, thus supporting each other.

Integrated Design Process

The Integrated Design Process (IDP) was originally developed with the purpose of being taught at Architecture and Design (AOD) at Aalborg University (AAU).
The aim of the branch of study is to teach students how to design good architecture by means of integrating a wide range of both architectural and engineering aspects. In such the IDP presents a structural approach dividing the project into 5 phases (see ill. 1.2.2). It stresses however, that the actual design process is a rather complex matter calling for loops both between and within the phases. Following is a summary of the five phases:

1. Problem / Idea
In this phase the problem statement or problem idea is derived.

2. Analysis
During this phase preliminary information gathering and analyses are conducted. These include a thorough context analysis, plans and requirements, user profile, necessary theoretical knowledge etc. Toward the end of this phase a recapitulation is completed presenting a vision and a room book.

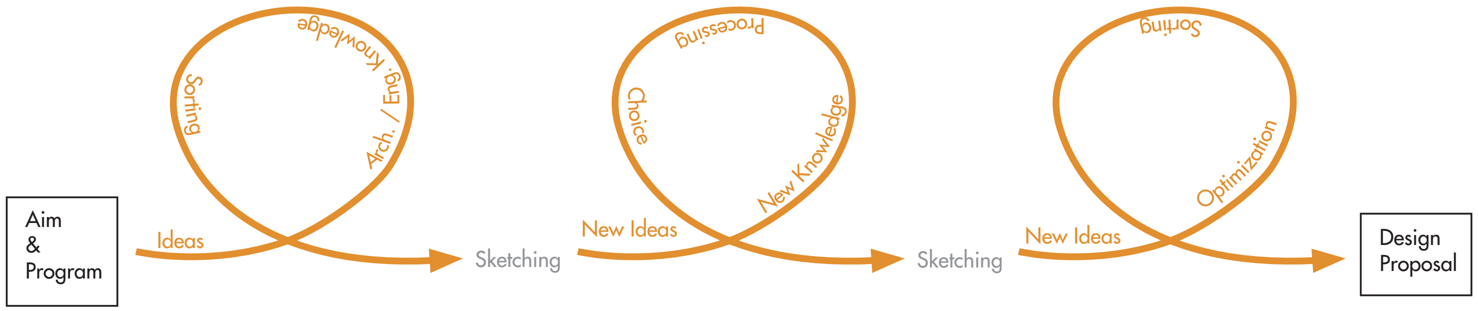
3. Sketching
During this phase conceptual ideas are generated through sketches and models. Here the integration between the architectural and engineering fields of knowledge is essential as it forms the basis of both the ideas and the evaluation of them. Hence the sketching process is a matter of generating ideas, evaluating them, generating new and improved ideas etc. working towards a design proposal covering all the architectural, functional and technical aspects of the project (see. ill. 1.2.1).

4. Synthesis
The synthesis phase is where the design proposal is optimized and detailed to fulfill the vision and the requirements put forward in the analysis phase.

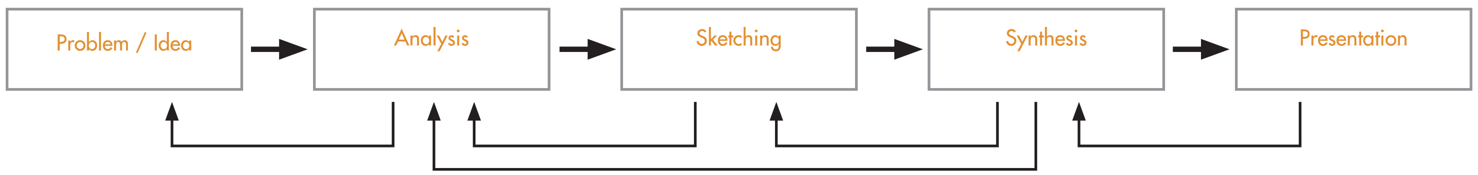
"The Project finds its final form and its final expression and a new building with – hopefully good – architectural, aesthetic, spatial experiences, functional and technical solutions and qualities is created." (Knudstrup in Botin & Pihl, p.20, 2005)

5. Presentation
The final phase of the project is the presentation phase. Here the focus is on communicating the final design proposal through text, visualizations, illustrations, presentation models etc.

(Knudstrup in Botin & Pihl 2005)



Ill. 1.2.1 The Sketching Process (Knudstrup in Botin & Pihl p. 19 2005)



ill. 1.2.2 The Design Process (Knudstrup in Botin & Phil p. 17 2005)

Evidence Based Design

Evidence Based Design (EDB) suggests that - in order to achieve the best possible outcome - decisions regarding the built environment should be based on research findings or other credible evidence.
(McCullough in McCullough et. al. 2009)

In the case of designing a nursing home, parallels to the physical and psychological conditions connected with hospitalized patients are found. There is much literature in this field, the respected researcher Roger S. Ulrich states:

"The evidence indicates that well-designed physical settings play an important role in making hospitals safer and more healing for patients and better places for staff to work." (Ulrich et al. p. 1 2008)

Hence, these design strategies along with additional credible literature presented in the program will form the basis of the EBD approach to this project. In such, decisions will be based on evidence-rooted argumentation throughout the design process.

To summarize the essence of this chapter, the project will be structured according to the Integrated Design Process while basing decisions on evidence-based knowledge to the extent of which it is possible and considered relevant.

ill. 2.1

2. THEORETICAL BACKGROUND

Program

The Nursing Home

This chapter shortly explains the characteristics of a nursing home as a building.
Although a nursing home is an institution it is important not to think of it as such. Instead it should be regarded a home, a community and a workplace.

Conponents
A nursing home consists of the following core elements (see ill. 2.1.1):

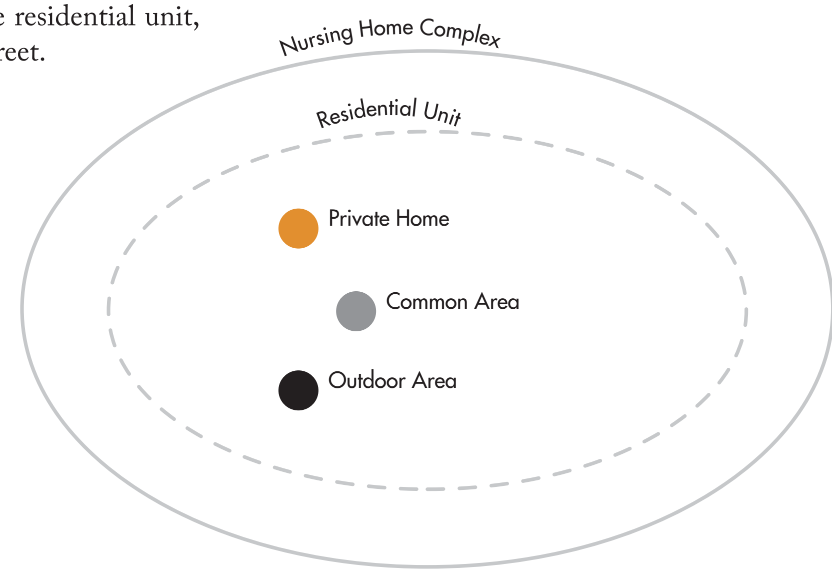
- The nursing home
- The residential unit
- The private home

(Møller & Knudstrup 2 2008)

The Nursing Home Complex
A nursing home complex consists of a range of characteristic functions. A nursing home is subdivided into residential units. The nursing home complex typically includes some functions shared among all its residents. The characteristics of a nursing home complex could be seen as a small town-community.

Residential Unit
The residential unit includes a number of residents and common facilities such as common kitchen and living room. In such the residential unit is the close community comparable to a town street.

Private Home
The private home is naturally included in the residential unit, and is comparable to the private house in a street.



Ill. 2.1.1 Core Elements in the Nursing Home

User Groups

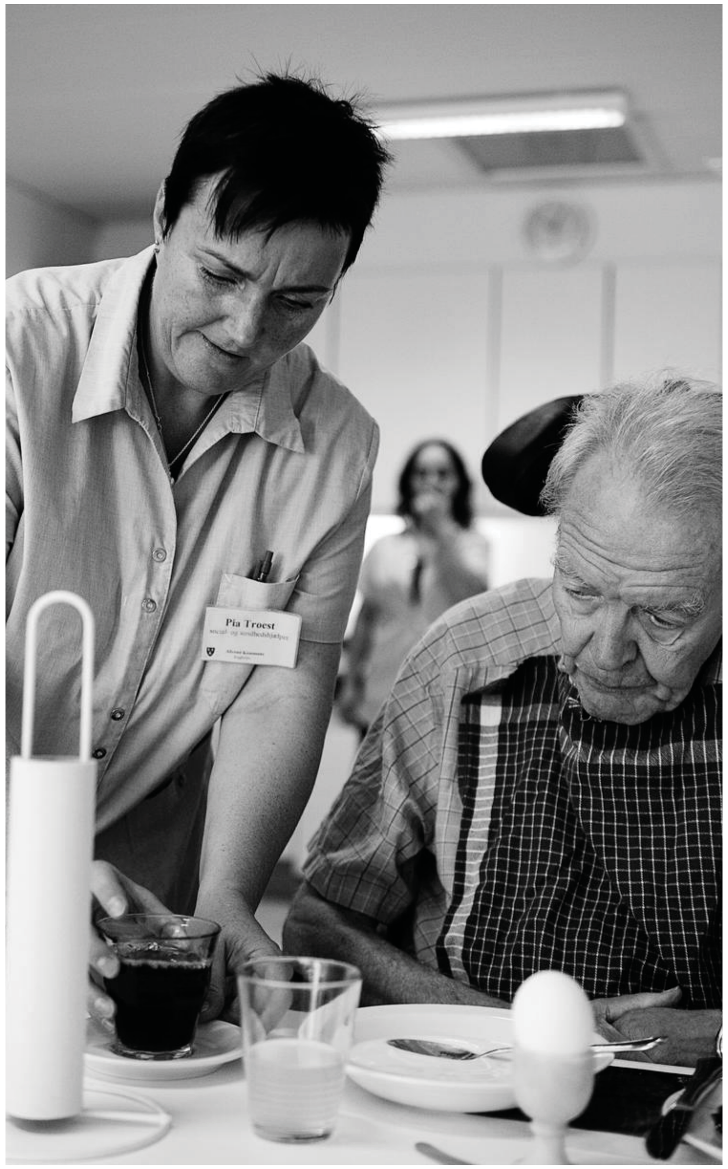
A nursing home is naturally first and foremost a home to its residents, but it is just as much a workplace for the nursing staff.
The text below will be a short description of the characteristics and needs of each user group.

The Residents
Elderly living in nursing homes are people with stories and memories. The reason for moving to a nursing home can vary extensively from person to person. Some nursing home residents are quite independent, some need support to get through daily routines, some are bedbound and some again suffer from dementia. Drawing the line among the different user groups can be difficult, and the physical or mental state of nursing home residents can change drastically over time. This project mainly differs among cognitively healthy residents and residents suffering from dementia, as the differences among these resident groups entail important decisions regarding the building design.

The Nursing Staff
The staff in a nursing home has a very important position, and their care is of prime importance for the well-being of the residents. Securing a good working environment for the nursing staff and enhancing the well-being of this user group by securing an easy workflow and sufficient space for breaks, storage and meetings is thus a central consideration in the future design development.

Coexistence
Conflicts of inflicts can be detected regarding e.g. assistive technologies - they should be easily accessible when favoring the employees, but hidden away when favoring the residents. Consequently, compromises must be made considering the daily routine of both groups. The mixed user group further implies, that two sets of requirements must be incorporated; one for the living conditions and one for the working environment.

(Møller & Knudstrup 2 2008)



Ill. 2.2.1 User Group - Staff (left) and Resident (right)

Program

Well-being in Nursing Homes

When designing a nursing home high priority must be given the well-being of its residents. This chapter therefore treats the concept of well-being among elderly focusing on aspects of architectural relevance.

Well-being and Habitus

'The well-being of elderly people living in assisted living facilities is fundamentally about the interaction between the individual and his surroundings.'
(Møller & Knudstrup 1 p. 9 2008)

A research project in Denmark entitled "Trivsel og Boligform" has developed a model explaining how well-being of elderly in assisted living facilities depends on a series of factors combined with the habitus of the individual (see ill. 2.3.1). Note that the appearance of the model has been altered in the illustration to bring forward design-related factors. In addition habitus represents the characteristics of the individual and should be regarded a filter defining the degree of impact on the experienced well-being from each factor. In such habitus embraces the aspects of personality, mental and physical conditions etc.

The research project concluded a strong relation between well-being of elderly people and design and interior decoration of their assisted living facilities. It however stated that due to different personal preferences caused by differences in habitus, no unique optimal design solution can be defined. Instead the research project put forward a list of general recommendations with the intention of improving the perceived quality of future assisted living facilities.

Homeliness and Privacy

Homeliness is crucial for the well-being of nursing home residents. Most important is the home - preferably individualized with private furniture and other personal effects. The sense of privacy is significant to the felling of homeliness too. In such the home should at all times be a place where the resident can withdraw to and be alone if desired.
An indication of the transition between the home and the common area is highly beneficial and should be distinctive. The presence of assistive technology has a negative impact on the homeliness, but must of course be present if needed. The visual dominance of these equipments should however be as low as possible preventing an unwanted institutional atmosphere. This last recommendation applies not only to the private home but to the entire nursing home as such. Means of preventing an institutional atmosphere include working with colors, personal effects, plants, spatial qualities etc. Note that long naked corridors should be avoided as they can provoke the feeling of living in an institution.

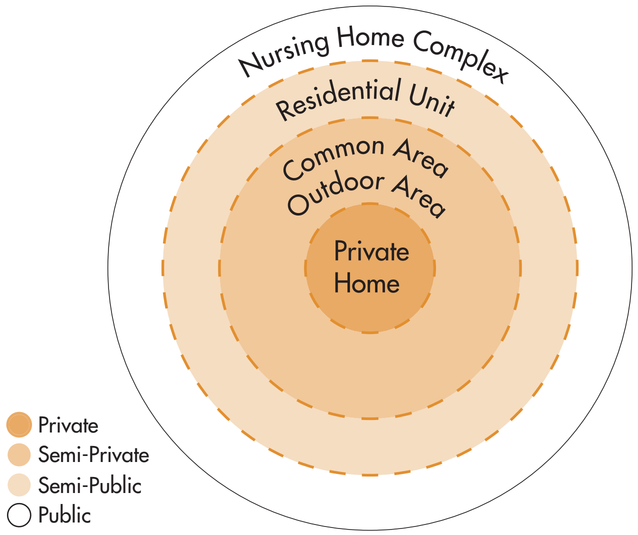
Location

The location of the nursing home has also got to do with the feeling of homeliness. In regard to this, the research project pointed out that a well-known or at least familiar neighborhood will seem safer, evoke reminescence and enhance the overall feeling of well-being.

Flexibility

Flexibility in design and interior decoration is crucial for the well-being of elderly. This is due to the different

Ill. 2.3.1 Well-being Model (Møller & Knudstrup 2 p. 25, 2008)



Ill. 2.3.2 Degree of Privacy (Møller & Knudstrup 2 p. 31, 2008)


Ill. 2.3.3 Expression of Well-Being


Ill. 2.3.4 Nature and Social Relations


Ill. 2.3.5 Privacy

preferences among the residents. In addition another important aspect of flexibility is the possibility of adjusting to mental and physical changes causing alterations to the preferences and needs. Thus, it is recommended to design the private home with only one room which can then be subdivided by partition walls.

Stimulation of Senses
The stimulation of senses should be present in all corners of the nursing home. Especially visual stimulation is important as elderly people spend a lot of time sitting or lying down observing the surroundings. Inside the private home visual connections to the outside should be established. A careful framing of the view focusing on for instance a tree will enable the resident to follow the change of seasons while a framing of a common living area might encourage the resident to go socialize. Other senses should of course be paid attention to as well, such as the sense of touch and smell in regard to the design of outdoor spaces. This will be elaborated in the following chapter 'Gardens'.

Comfort
As elderly people living in nursing homes do tend to spend a great amount of time indoors, the indoor climate is particularly important. Fundamentally indoor climate is a matter of architecture and technology, which will be processed later in this project. Consequently the indoor climate should provide optimal conditions for the activities taking place and the resident should be able to control the indoor climate manually according to indivual needs.

Social Relations
Social relations among nursing home residents are greatly influenced by the organization and shape of the building. Hence, it is proven that the number of residents within a residential unit affects the possibility of developing a well working social network. Thus, an increase in number of residents will naturally increase the chance of finding potential friends with similar habitus. Note that 12 residents are considered maximum as a higher number impacts the homeliness negatively by adding to the institutional atmosphere.
In addition common areas should be located close to the private homes, preferably with visual contact, as long distances can be perceived as a physical barrier. Also common areas should be interiorly decorated with different seating arrangements allowing the resident to choose between sitting alone or together with other people.

Separation of Resident Groups
It is suggested that elderly people suffering from dementia should be separated from the other residents as the two groups neither interact well nor require the same physical environment. The research publication 'Modelprogram for Plejeboliger' lists the following points, strongly underlining the importance of separating the two resident groups:

' ■ Build nursing homes especially suited for people with dementia.

■ Place residential units for demented residents with clear separation to residential units housing other residents.

■ Build the residential units, so the risk of getting or feeling lost is minimized.' (ebst 2010)

To sum up, a lot of different aspects regarding the concept of well-being need to be taken into consideration when designing a nursing home. These include homeliness, privacy, location, flexibility, stimulation of senses, comfort and social relations according to the mental and physical condition of the residents. The investigations above will function as design parameters throughout the design process.

(Møller & Knudstrup 1 2008; Møller & Knudstrup 2 2008; Ebst 2010)

ill. 2.3.6 Social Activities

ill. 2.3.7 Visual Stimulation

Gardens

It is a well-known understanding that being in nature affects the human health positively - physically as well as psychologically. Greenery, smells, sounds and the fresh air soothes the mind and brings along old memories. It doesn't necessarily need to be picturesque sceneries; even 'a single tree in front of a window means one can follow the course of the year from his living room.' (Bahn et al. 2005)
The following text seeks, through credible literature, to find inspiration as to how to create outdoor spaces that contribute with experienced quality to everyday life in a nursing home.

The Benefits of Gardens
In the paper 'Health Benefits of Gardens in Hospitals' (2002), Roger S. Ulrich makes clear that through research from several sides, gardens at hospitals and other treatment facilities have proven highly beneficial. Gardens reduce stress and increase satisfaction with the treatment and facilities, both for the resident regardless age, his visitors and the nursing staff.

'In addition to ameliorating stress and improving mood, gardens and nature in hospitals can significantly heighten satisfaction with the healthcare provider and the overall quality of care.' (Ulrich 2002)

Ulrich suggests that the positive effect of the garden increases if it comprises various natural elements, such as birdsong, flowers, calm water, trees and lawns, while 'starkly built content' such as a concrete building or a wall reduces the positive impact of the garden. (Ulrich 2002)

Besides the stress-reducing features of a garden, the garden also serves as a reminder of the residents' old memories, from their childhood or grown-up experiences. This helps the resident deal with the fact that they find themselves in the autumn of life, as they will experience a feeling of continuation. Reminiscence comes through references found in landscapes and vegetation, smells, visions etc., which the residents recognize from earlier times. Thus locally well-known plants and flowers are a good choice.

'The need to reminisce has been identified as of prime importance in improving the psychological conditions of geropsychiatric patients' (McBride in Marcus & Barnes 1999)

(Marcus & Barnes 1999; Ulrich 2002; Bahn et al 2005)


Ill 2.4.1 Garden

Gardens for Demented Residents
Evaluation shows that gardens improve the quality of life and the abilities significantly for people suffering from dementia. For this user group, Bahn et al (2005) and Hartig et al (2006) suggest a number of special regards:

- For demented residents it is important that the garden is protected, either by a fence, as a roof garden or an enclosed courtyard.
’The garden can, cautiously, be used by others. Demented persons are very vulnerable, and get easily stressed or distracted. They get insecure about using the garden if there are many unknown people around them’. (Grefsrød & Berentsen 2003)

- Activating the senses can help improve cognitive abilities.

- Altered accessible flowerbeds, colors and defined contrasts.

- If the garden has a gate, the path system should not have an end leading to the gate, as it could confuse and stress the demented resident. Instead; if vehicles etc. need to enter into the garden, the underlying grass or similar could be reinforced or otherwise hidden.

The Private Garden
For elderly people not suffering from dementia, unhindered access to a garden or terrace from their own apartment is beneficial. It should be small in scale, easy to keep and create a feeling of privacy. A small seating arrangement and the opportunity of nurturing plants and flowers are desirable. (Bahn et. al., 2005; Marcus & Barnes, 1999)

This chapter reasoned the importance of having nature and gardens integrated in a new nursing home, and the importance of the special requirements for demented residents.

(Marcus & Barnes, 1999; Grefsrød & Berentsen 2003; Bahn et. al., 2005; Hartig et al 2006)


Ill 2.4.2 Smells

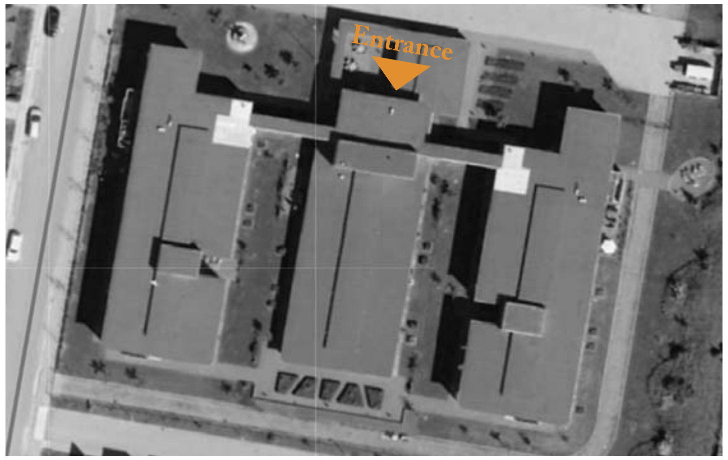

Ill 2.4.3 Tactility


Ill 2.4.4 Altered Flowerbeds

Case Study: Birkebo

This chapter treats a case study of Birkebo nursing home in Aalborg, Denmark. The practical experience of conducting a case study is considered essential in regard to the project as it offers a different – more personal – perspective to the design of a nursing home. In such, this chapter is primarily based on first-hand experiences and impressions. It still, however, considers the knowledge acquired from the previous chapters and discusses the hands-on experience accordingly.

Birkebo was chosen as case study due to its relatively young age, the location within a residential area and the fact that it was designed by a local architectural office. It was built in 2005 and consists of 5 residential units with 8-10 residents each. Note, that this is close to the optimal number of residents within a unit as discussed in a previous chapter. In addition one of the units is dedicated to elderly people with dementia, which means that residents with and without dementia are separated. This matter was similarly discussed previously to be an advantage. The main structure of the building complies with the comb structure, thus creating inward-pointing outdoor areas between the three main blocks. The outer blocks are both two storeys high while the middle block is only one storey high.



Ill. 2.5.1 Top View of Birkebo (Krak.dk, 28.02.12)


Ill. 2.5.2 Facade


Ill. 2.5.3 View from Southwest

Building Facts
Owner:
Boligselskabet Østparken

Year of Construction / size:
2005 / 3850 m2

Architect:
Arkitektfirmaet Nord

Construction Costs:
57 mill.

Address:
Forchhamersvej, Aalborg, Denmark

Number of Dwellings / Residential Units:
48 / 5
(incl. 1 section for demented elderly)

Number of Storeys:
1-2

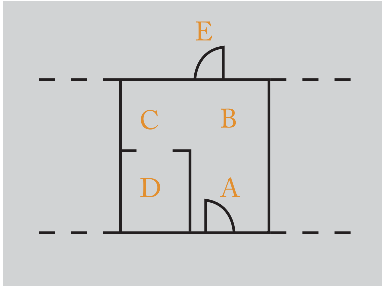
Main Structure:
Comb (E-shaped)

The Private Home

The design and interior decoration of the private units are rather consistent with literature recommendations and thus include the following functions:

A. Entrance with Kitchenette
B. Living Room
C. Bedroom
D. Spacious Bathroom
E. Terrace or French Balcony

First observation is the combination of entrance and kitchenette, which seems to be both functional and space-saving. In addition it was clear how important private furniture was to the homely atmosphere and individualization of the different homes. The staff told that flexible walls, to separate the living room from the bedroom, were stored in the basement and could be mounted if desired. In both the living room and the bedroom it is evident that sunlight conditions have been considered. Thus the window openings are designed to provide views from a lying, sitting and standing position (as specified on p. 66-68). From the living room visual connection is established to the private terrace (ground floor only). These terraces seem rather lifeless however, and could benefit from some individualization, natural features or similar. The visual comfort from the bedroom is not as successful as the living room.



ill. 2.5.4

The Community

Each residential unit has its own common living room with an incorporated kitchen located at one end of the unit. This means that some of the residents have to walk quite a distance compared to if the common area had been placed in the middle of the unit. These common living rooms however seem highly functional and are successfully connected to outdoor terraces or balconies just outside the window. The corridors have been tried broken up into smaller paths by means of e.g. niches. The attempt was less successful as the atmosphere is still perceived rather institutional when looking down the corridor (see ill. D).

The nursing home staff put a lot of effort into arranging activities for the residents, many of which take place in the big assembly hall (see ill. F).

Outdoor Areas

The nursing home is designed with a variety of outdoor spaces. Besides the private terraces and the semi-private terraces and balconies, a garden for the senses is also incorporated (see ill. I). The initiative must be acknowledged but the affect of it during this time of year (winter) is rather poor as the choice of vegetation clearly has not included considerations regarding the winter season.
In relation to the outdoor spaces it was noticed that reinforced grass had been used to disguise the fire access road.

ill. 2.5.5

The Work Place

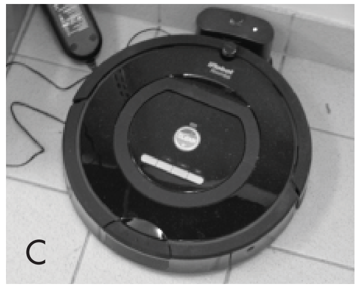
The fact that a nursing home is a working place was indeed evident from the visit. The staff talked a lot about effectivity measures such as the new robot vacuum cleaner, the rolling table and last but certainly not least the ceiling lift. They only had the lift installed in one room but sincerely wished one for all the other rooms as well. They argued that it made a world of difference, not just for them and their safety, but also for the residents, who would then not have to look at the big old manual floor lifts anymore.

Around the nursing home a lot of space was occupied by service-related functions such as laundry room, storage, cleaning room etc. Small offices were however identified as a missing function. This resulted in one staff member actually having to sort pills in the corridor (see ill. E). Her working position was definitely unpleasant and the activity might also have been disturbing to residents walking by.

Overall a lot of useable experiences were made from this case study, both in regard to what to do and what not to do. The tripartition of the private home, the community and the work place is essential to remember as all three aspects need thorough attention.


A


B


C


D


E


F


G


H


I


K

ill. 2.5.6


ill. 2.5.7

Daylight in Nursing Homes

Light is a very influential factor when speaking about architecture and healing environments. Getting old does not necessarily entail illness in the literal sense of the word, but the perceived proximity to the end of this life, reduced mobility and possible need for medication cause needs comparable to those of hospitalized patients. A new nursing home can benefit from knowledge about the impact of light at treatment facilities. In such this chapter is based on credible literature with specific focus on the light in healing environments and nursing homes.

The Nature of Light Sources

The nature of daylight is that of an ever changing phenomenon. Its color and intensity varies substantially over time of day and year. It is unpredictable - one day it presents the most captivating colorful daybreak, the following day the sky is overcast, low and horizontal and the white filtered light makes the shadows vanish completely. The sun's path through the day affects the human circadian rhythm and has the ability to change moods and the appearance of space.

Despite the restless qualities of daylight, given its unpredictability it cannot make it alone. Artificial lighting is far more controllable, and in a nursing home, which must function day and night, well set artificial lighting is an important fellow player.

Daylight through Windows and the Effects on Human Health

Good and sufficient daylight provides positive thoughts and mental well-being. It has been proved that the more daylight an elderly person, with or without dementia, is exposed to through the day, the deeper and less interrupted the sleep is at night. Daylight, especially morning light, has a positive effect on the treatment of depression.

'In several researches, the respondents express pure discomfort when staying in rooms without windows and daylight, and the staff voice worries about their own health conditi-on…' (Frandsen et al 2009)

The quote above substantiates the conception that a room with windows influences positively on human well-being. Research further suggests that also the character of the view in rooms where patients stay for longer periods of time has impact on the recovery time from surgery, the size of medical doses and that it reduces stress and anxiety.

'Views to the outside might be especially important to individuals who have unvarying schedules and spend a great deal of time in the same room'. (Ulrich, 1983)

Roger S. Ulrich in his 1983 paper 'View through a Window may influence Recovery from Surgery' presents research results comparing patients staying in rooms with a view to natural settings as oppose to patients staying in rooms with a view to a brick wall. In both cases the view through the window from the bed was unobstructed, and the research took colors of the room, age, previous hospitalization et cetera into consideration.
The research proved remarkable differences in the recovery time, medical doses and anxiety among the patients. The nurses noted down if the patients showed considerable positive or negative behavior. The negative notes were remarkably less for the patients with a view to nature (1.13 vs. 3.96 per patient). Ulrich concludes that the view and thus the location of the treatment facilities should be strongly considered. He mentions, though, that these results may not apply to all 'built' views or all patient groups, differing between patients staying hospitalized for longer or shorter periods of time.

'Perhaps to a chronically under stimulated patient, a built view such as a lively street might be more stimulating and hence more therapeutic'. (Ulrich, 1983)

Interesting is also that patients and staff in a test described in Helende Arkitektur (Frandsen et al 2009) rated rooms with a window facing a wall or windows set too high to look through just as unpleasant as rooms without windows.

There is strong evidence that sufficient daylight is also important for the wellbeing of staff at work. Ulrich, Zimring et al (2008) state:

'Access to sufficient natural light is one of the few physical environmental attributes that has been linked by research with higher staff satisfaction. This finding suggests that natural light is also needed in staff working areas' (Ulrich, Zimringer et al 2008)

These studies unambigiously conclude that exposure to daylight is of incredible importance for the wellbeing of both residents and staff in a nursing home. Considerations regarding window sizes, heights and views to the outside may not be compromised.

ill. 2.6.1

Program

Daylight Principles

This chapter tries through references found in built works with focus on daylight and roots in the North, to receive an understanding of various ways of using the daylight as a mood definer.

- Diffuse light
- Contrasts
- Atrium - Skylights
- Colors

Diffuse Light
A prominent example of how to create a friendly shadowless space using natural light is Sverre Fehn's Nordic Pavilion for the biennale in Venice1962. Sverre Fehn here creates a system of transversal beams, high but slender. In this way he redirects the strong Venetian sunlight, and the reflected light emerging from the high beams resembles a soft, mythical Nordic light-scape. The beams are penetrated by a couple of leaf-bearing trees, leaving only the trunks inside the exhibition space. Sverre Fehn had a poetic approach to architecture, strongly inspired by Nordic landscapes.
(Lund 2008)

Contrasts
Jørn Utzon built his own house 'Can Lis' on Mallorca in the early 1970's. In this project, the light is a main creator of space.

'In his house on Mallorca, Utzon came close to his original aim - to build simple, well constructed and let the light be the main source of architectural richness.'
(Lund 2008)

Picture of Can Lis speak for themselves, but shortly stated there is a severe use of contrasts of strong light and shadows. The light as it falls along a wall reveals the roughness of the yellow sandstone they consist of.
(Lund 2008)


ill. 2.7.1


ill. 2.7.2

Atrium - Skylights
In his court building in Göteborg (1934-37 Gunnar Asplund has incorporated an atrium. The skylights provide the building with daylight from top to floor.
Besides providing a great deal of natural daylight, the open space contributes to ease orientation within the building.

The material is mainly wooden panels and together with plants and bright white ceilings, they contribute to a friendly character. Gunnar Asplund had a holistic approach to all his buildings - every building is fitted to the specific site until the smallest detail.

(Lund 2008)

Colors
One of daylight's characteristic abilities is perfect rendering of space and color.
Alvar Aalto's Paimio Sanatorium of . Aalto's intention was to let the light-flooded colored spaces play a role in the healing process for people, in this case, suffering from tubercolosis. Light and color are highly dependent on each other, and can accentuate the human mood - cheerful, relaxing, thoughtful. Aalto also used colors to control the light - for example the ceilings in the patient wards where the patients spend many hours, are painted drak grey to avoid glare.

(Schildt 1984)


ill. 2.7.3


ill. 2.7.4

Artificial Lighting Principles

A nursing home must function day and night, and throughout the year. Living on the Northern hemisphere, the daylight aid is not always sufficient. Therefore considerations to the need for and effect of artificial lighting is a crucial basis for the design development.

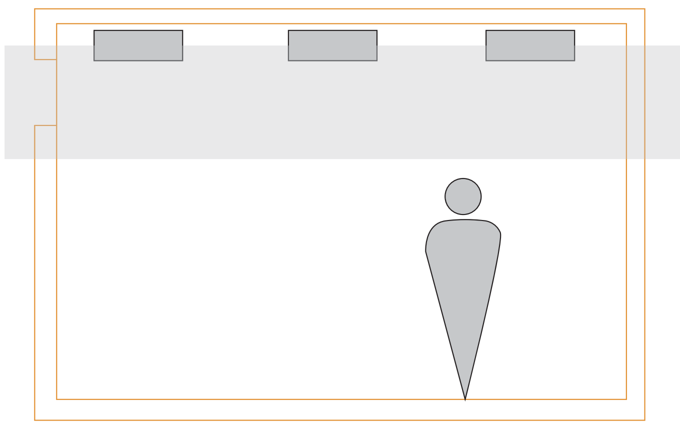
A nursing home apartment needs lighting supporting the inhabitant, the nursing staff and visitors with point of departure in the wellbeing of the inhabitant.

In order to be able to develop a functioning combination of natural and artificial lighting, the characteristic lighting demands of each scenario is divided into three in terms of beneficial light conditions. The division is inspired by (Stidsen et al 2010; Stidsen 2011).

It is important that the main user, the resident, has the control of the lighting type and intensity.

(Stidsen et al 2010; Stidsen 2011)

Light from a high position in the room
When the light source is set high in the room, it supports activities which need good lighting conditions with reduced shadows. It is especially suitable when nursing assistants are present to help the elderly and need good working light, but it also supports the physically or mentally active elderly.
This type of lighting is commonly used in public buildings and institutions. It is a functional type of lighting, and it should not be the dominating unless necessary.



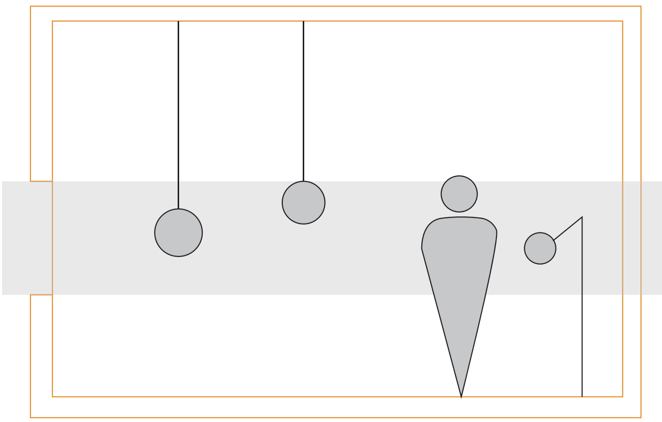
Ill 2.8.1 inspired by (Stidsen et al 2010)

Ill 2.8.2 Danish Hospital

Ill 2.8.3 Danish Home

Light from a middle position in the room
This is the light we usually know from Nordic homes. The lamps hang low, and as they do not distribute light as equally within the room as light from a high position, there will most likely be a number of small independent light sources (see ill. 2.8.3). This also entails a feeling of control with the character of the environment, increased individualization and homeliness.

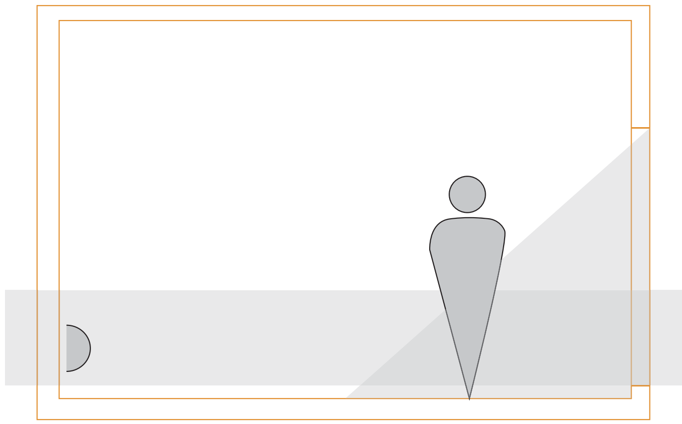
'In the concept of lighting Danish homes it seems like a tendency making it possible to vary the light in the room'
(Stidsen et al 2009)



Ill 2.8.4 inspired by (Stidsen et al 2010)

Light from a low Position in the Room
This way of illuminating a room refers to the characteristics of twilight – the aim is to apply a type of lighting which does not disturb the human circadian rhythm appreciably. When the light source is set low, the shadows get long and the illumination provides for navigation within the room when an elderly needs to go to the bathroom, needs assistance or medication at night, but benefits from not being influenced by light with high intensity. Leading lights at floor level can be compared to the nocturne lighting in e.g. airplanes.

'At nighttime, if possible, the light in patients' rooms should be dimmed long enough to ensure good sleep'
(Ulrich, Zimring et al 2008)



Ill 2.8.5 inspired by (Stidsen et al 2010)

Higher Lighting Intensity Demands
Because of impaired vision, the need for light increases drastically with age.

'A 60-year old needs six times as much light as a 20-year old in order to be able to see equally well'
(Knudstrup & Møller 2008)

Too little light and too few contrasts mean difficulties for the elderly to navigate and orient themselves in the nursing home. As a result, too little light means increased risk of falls and people suffering from dementia getting lost in the complex.

This chapter put focus on conditions specific to artificial lighting in healing environments. Note that this project is not aiming at a full detailing of artificial lighting principles, but that this chapter is used to develop an understanding of the influence of lightsetting on homeliness vs. institutionalism.

(Ulrich 1983; Ulrich, Zimring et al 2008; Knudstrup & Møller 2008; Stidsen et al 2009; Stidsen et al 2010)

Sustainable Architecture

Sustainability is a global issue influencing many professions. Architecture is one of them and due to the fact that buildings account for 40% of Europe's total energy consumption the national building regulations keep tightening (climateminds.dk, 14.02.2012). Sustainability covers more than just the environmental aspect. It includes several other factors as well, which will be emphasized in this chapter presenting first an overall definition of sustainable architecture followed by an outline of different sustainable parameters.

Definition of Sustainable Architecture
In the year 1987 the concept of sustainable development was described by the World Commission on Environment and Development (WCED) in the report "Our Common Future".

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
(iisd.org, 10.02.2012)

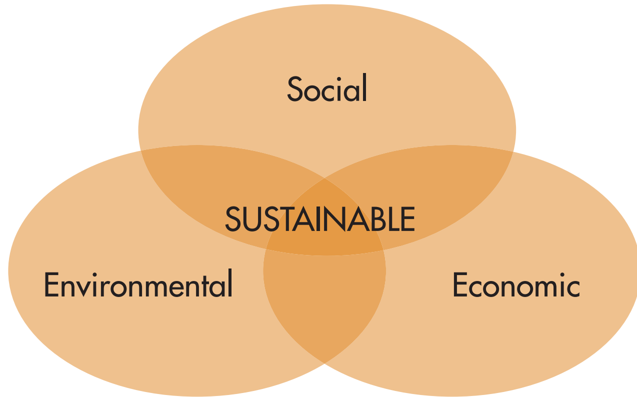
In such sustainability is a holistic way of thinking, caring for the long-termed consequences as well as for the short-termed ones. The report "Our Common Future", also known as the Brundtland Report, further launched a comprehensive set of criteria based on environmental, economic and social aspects of sustainability.
(sustainablecities.dk, 10.02.2012)

Regarding architecture, several Green Building Councils have been founded worldwide, each with the aim of establishing one or more national certification schemes for sustainable architecture. Both a Nordic and an International network have been set up encouraging knowledge sharing between the countries.
The Green Building Council in Denmark defines sustainable architecture according to the tripartition of sustainable dimensions found in the Brundtland Report (see ill. 2.9.1). It encourages an equal distribution of the focus given each category, emphasizing that indoor climate, art and flexibility are significant aspects of sustainability on equal terms with energy consumption.
(dk-gbc.dk2, 10.02.2012)

"Sustainable architecture is aesthetically satisfying, good and healthy buildings with flexibility over time, possibility for reasonable maintenance, quality in terms of usability and very low environmental impact from operation energy and materials." (groenthus.dk, 10.02.2012)

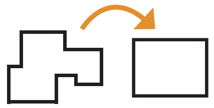
Sustainable Parameters
With the intent of reaching a well prepared final design proposal of high architectural and sustainable quality a wide range of different sustainable initiatives, covering all three of the sustainable dimensions, must be incorporated into the project at an early stage.
(Larsen et. al. 1999).

These parameters will form the basis of an overall sustainable mindset supporting the design process.

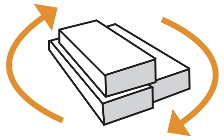


ill. 2.9.1 Sustainable Dimensions (dk-gbc.dk, 10.02.2012)

Compactness
Plan
Shape
Height
Surface
Construction and Material

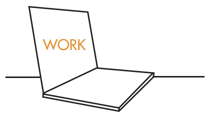


Materials and Components
Minimization of Materials
Prefab Elements
Recycled Material
Recycling and Decomposition
Life Cycle Assessment
Transport of Materials



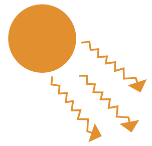
Flexibility
Multi-functional Rooms
Expandability
Interchangeable Installations etc.

Working Environment
Daylight Optimization
Sound Reduction
User Control of Heat and Ventilation



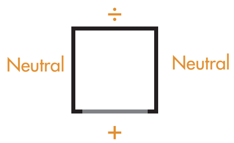
Solar Energy
Passive Solar Heat incl. Zoning
Thermal Collector
Solar Chimney
Solar Walls

Solar Cells
Heat Storage
Optimization of Daylight Supply
Reflectors, Light Schelves etc.
Glare and Overheating
Limited artificial Light
Green Solar Shading
User Control

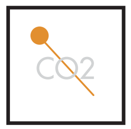


Outdoor Spaces
Protective Planting, Optimal Sun and Lee Conditions
Maintenance without Pesticide Spray
Kitchen Gardens, Greenhouse, Fruit Trees and Bushes
Green Facades
Preservation of Big Trees etc.
Influences on the Micro Climate

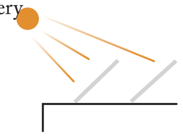
Orientation
Shape
Position of Windows
Overheating
Energy Balance



Indoor Climate
User Controlled Regulation
Increased Room Height
Daylight Conditions
Thermal Comfort
Acoustics
Natural Ventilation in Summer
Mechanical Ventilation in Winter
Atrium, Solar Chimney etc.
Materials without Degassing etc.
Green Products



Energy Saving Measures
Demand Controlled Lightning in Secondary Rooms
Solar Cells
Power Saving Appliances
Heat Supply through Sun Orientated Windows
Passiv Solar Heat e.g. Heat Storage
Active Solar Heat e.g. Thermal Collectors
Evaluation of Insulation Thickness
Ventilation System with Heat Recovery



ill. 2.9.2 Sustainable Parameters (Larsen et. al., 1999)

Low Energy Building Design

As mentioned in the previous chapter building stock accounts for a big portion of the energy consumed in Europe. Consequently the discussion of low energy building design is inevitable and by defining an energy strategy for the project a sustainable awareness is expressed. Hence the chosen energy strategy of the project is to meet the Danish energy frame of low energy buildings 2015. Note that the municipality of Linköping strongly encourages - if not demands - low energy buildings in Majelden (re chapter 3.10). Hence the Danish energy frame 2015 is thought similar to low energy frames in Sweden.
In the following an overall approach to the energy strategy is presented along with a listing of different energy initiatives - both passive and active - which can be applied to the project in order to meet the demand of the energy frame.

BR10 Demands	Energy Frame for Dwellings, hotels etc. (A is the heated floor area)
Standard 2010	(52.5 + 1650/A) kWh/m² year
Standard 2015 (voluntary low E class 2015)	(30 + 1000/A) kWh/m² year
Standard 2020 (voluntary low E class 2020)	20 kWh/m² year
Expected Standard 2025 (ZEB, Zero Energy Buildings)	0 kWh/m² year
(SBI-Anvisning 213)	

ill. 2.10.1

Energy Frames
The concept of energy frames is relatively new as it was first enforced in Denmark in 2006. It defines the energy demand of a building as the sum of energy demands for heating, domestic hot water and building services (ventilation and pumps) while leaving out household electricity (regarding dwellings). Since the introduction of the energy frame, EU demands that the energy regulations tighten every five years aiming at 'Near Energy Zero Buildings' in 2020. (Lehrskov et al 2011)
In the Danish building regulation 4 energy frames are presented - the minimum requirement of today (BR2010) and 3 voluntary low energy classes (see ill. 2.10.1).

Approach to Energy Strategy
In accordance with the overall method of integrated design an awareness of different traditional engineering aspects including energy must be integrated in the mere beginning of the design process. This does not necessarily entail heavy calculations but rather a holistic understanding of different aspects indirectly securing a building proposal with a high level of integrated solutions. Needless to say, the field of architecture contains a rather complex amount of parameters making conflicts unavoidable and compromises thus necessary. For the specific energy strategy the main focus is to limit the energy consumption by integration energy initiatives such as compactness, high insulation and a ventilation system with heat recovery. This e.g. means sketching initial plans with thick external walls and consider where to place ventilations ducts etc. Besides from aiming at limiting the energy consumption of the building another possibility is to produce energy on site, e.g. by means of solar cells. Anticipating this type of situations is an important part of the integrated design process as potential problems can be identified and avoided before they turn problematic.
In the detailing phase of the project energy reflections will be assisted by energy calculations conducted in BR10 in order to both evaluate, optimize and document the building design.

Passive Energy Initiatives
Potential passive energy initiatives include:

- Orientation (utilizing solar energy)
- High Insulation
- Energy Windows (triple glazing)
- Compactness
- Solar Shading (avoid overheat)
- Rational Ventilation System
- Daylight Optimization (limit artificial lighting)
- Thermal Mass (heat storage)
- Natural Summer Ventilation (limit electricity for mechanical ventilation)

Active Energy Initiatives
Potential active energy initiatives include:

- Mechanical Ventilation (heat recovery)
- Heat Pumps
- Solar Cells
- Solar Collectors
- Low Energy Technical Appliances
- Sensory Lighting Control

This chapter provided a short introduction to the chosen energy standard and a strategy on how to achieve it by means of an integrated design process.

Indoor Climate

Indoor climate is an important aspect in any building securing a comfortable and healthy environment. In regard to nursing homes it becomes especially important as elderly are more fragile than other age groups. In such this chapter will introduce the four main areas of indoor climate; thermal environment, indoor air quality, acoustic environment and lighting conditions while discussing their correlation to elderly people when considered relevant.

Thermal Environment

Thermal comfort is a matter of feeling satisfied with the thermal conditions of the surroundings. In such the experienced thermal environment is determined by the individual heat balance, which is influenced by the following parameters:

- Activity level (metabolic rate)
- Clothing (thermal resistance)

} Personal

- Air temperature
- Mean Radiant Temperature
- Air Velocity
- Air Humidity

} Environmental

(CR1752)

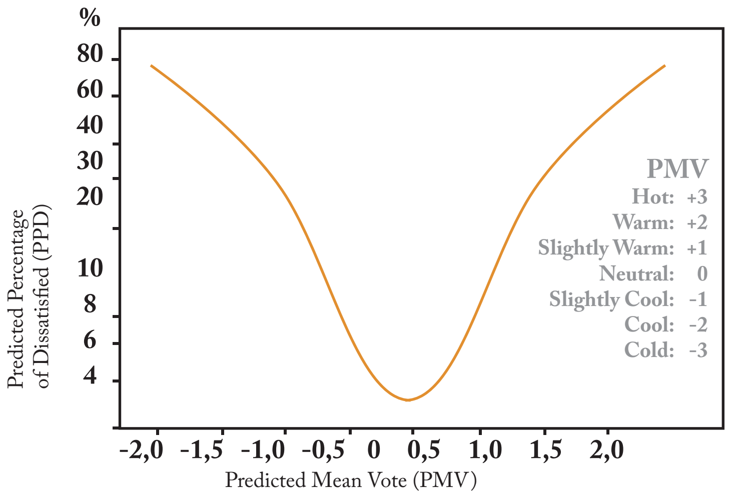
Based on these parameters the CEN report CR1752 presents a categorization of thermal environments ranking quality according to the PMV/PPD index (see. ill.2.11.2). As a design criteria this project aims to fulfill category B, which means that the predicted percentage of dissatisfied (PPD) will be less than 10 % when considering the thermal state of the body as a whole (see ill. 2.11.1). In order to achieve this aim the first step is to determine an operative temperature range, which can be found as a function of the activity level (met) and clothing (clo) of the occupants (see ill. 2.11.3). In nursing homes a conflict of interest occurs as the residents and the nursing staff do not find the same temperature range optimal.

'Elderly people have a lower activity level than younger people. Sedentary life and bad blood circulation entail that elderly people need higher indoor temperatures and are more sensitive to temperature variations and draught.' (Heiselberg in Møller & Knudstrup 2008, p.58)

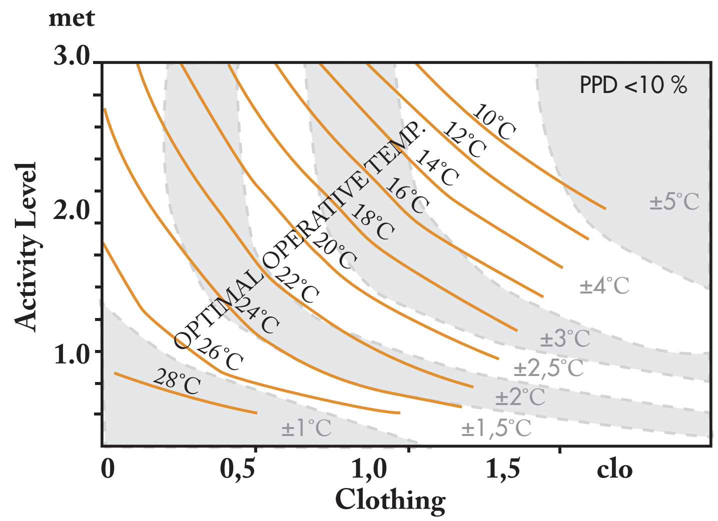
In spite of the fact that nursing assistants ought to work in colder environments it is chosen to follow the needs of the nursing home residents as they must be considered the main priority. An operative temperature between 22-24°C is recommended (Heiselberg in Møller & Knudstrup, 2008). This corresponds to an activity level of around 1 met and a clothing insulation of around 1 clo (see ill. 2.11.4) resulting in an ope-

Category	Thermal state of the body as a whole: Predicted Percentage of Dissatisfied (PPD) %	Thermal state of the body as a whole: Predicted Mean of Vote (PMV) Interval	Local Discomfort: Percentage of Dissatisfied due to Draught (DR) %	Local Discomfort: Percentage of Dissatisfied due to Air Temperature Differences %	Local Discomfort: Percentage of Dissatisfied due to Warm of Cold Floor %	Local Discomfort: Percentage of Dissatisfied due to Radiant Assymmetry %
A	<6	-0,2 to +0,2	<15	<3	<10	<5
B	<10	-0,5 to +0,5	<20	<5	<10	<5
C	<15	-0,7 to +0,7	<25	<10	<15	<10

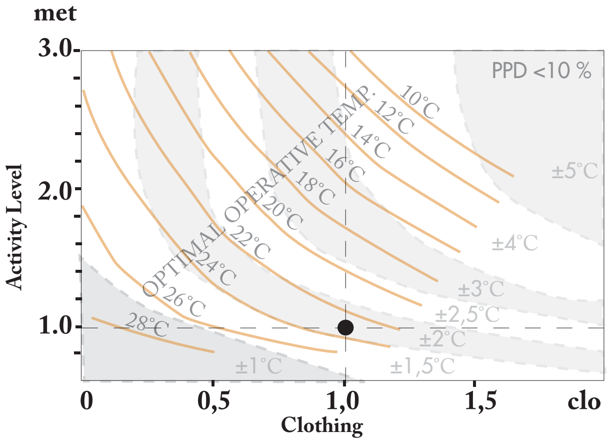
ill. 2.11.1 Categories of Thermal Comfort (CR1752, p.14)



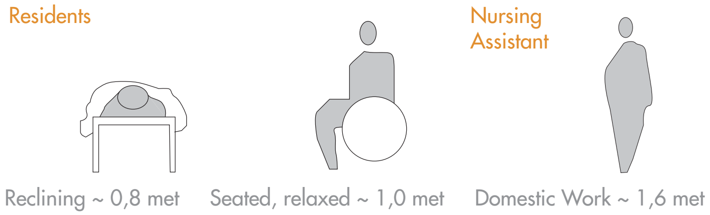
ill. 2.11.2 PMV/PPD (CR1752, p.13)



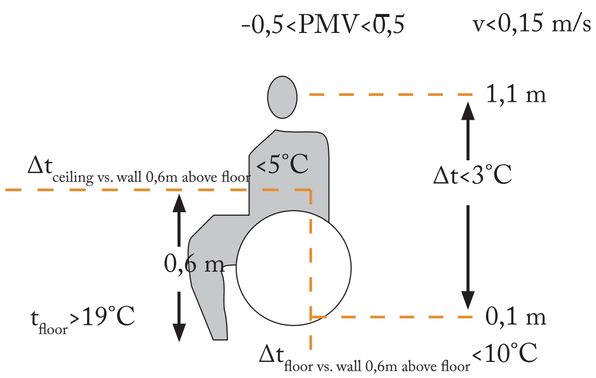
ill. 2.11.3 Optimal Operative Temperature (CR1752, p.16)



ill. 2.11.4 Optimal Temperature of Nursing Residents (CR1752, p.16)



ill. 2.11.5 Activity Levels, Values from (CR1752, p.53)



ill. 2.11.6 Local Discomfort (Madsen, p.16, 1998)

rative temperature range of 21-25°C. During the summer period the operative temperature range might change a bit due to changes in clothing behavior, but not significantly. Note that the nursing staff can adapt to the operative temperatures defined by the needs of the elderly by adjusting their clothing insulation - all year round. Having defined the operative temperature range the resulting criteria of a thermal environment fulfilling category B can be listed:

1. In rooms with only a few people the thermal environment should offer manual control. This applies e.g. to the private home

2. The rate of temperature change should not exceed 2°C/h

3. The indoor temperatures may occasionally exceed the operative temperature range due to extreme outdoor conditions:
tmax,1(t≥26°C) ≤ 100 h, tmax,2(t≥27°C) ≤ 25 h

4. Specific criteria to avoid discomfort due to local influences should be obeyed (see. ill. 2.11.6). Due to the fact that some of these criteria are difficult to calculate they will be incorporated more conceptually in the project.
(DS474)

The mean of ensuring the desired thermal environment in regard to this project includes a detailed processing of the design proposal in regard to choice of materials, window orientation and area, solar shading devices etc. Note, that dynamic simulations of the indoor climate will function as both an optimization tool and a documentation method.

Indoor Air Quality

Good indoor air quality (IAQ) is both a matter of health and comfort. In such the air should be perceived as fresh and the inhalation of it should pose no health risk what so ever. In Cr1752 a categorization method of IAQ is presented. It is quite similar to that of the thermal environment basing the ranking of quality according to the percentage of dissatisfied as well (se ill. 2.11.7). As a design criteria this project will aim to fulfill the category A, which corresponds to less than 15 % being dissatisfied with the perceived air quality. The criteria to fulfill when aiming for category A are:

- The CO2 concentration must not exceed the outdoor level with more than 460 ppm. Hence, the CO2 concentration functions as an indicator of pollution

- The required ventilation rate should be dimensioned according to comfort

- Building materials should be carefully selected to ensure a low-polluting building. Appropriate materials include e.g. natural materials such as bricks, natural stone, glass etc. (CR1752)

In order to ensure the desired indoor air quality attention must be given the cleaning possibilities, the ventilation system and particularly the choice of materials throughout the design process.

Acoustic Environment

The acoustic environment in a building is all about protecting against undesirable noise. This is important in a nursing home for two reasons. First of all is the fact that many elderly suffer from hearing loss which makes it difficult for them to understand speech and thus grasp the surrounding activities. Secondly is the fact that nursing home residents live closely together and might be disturbed by nearby activities such as a neighbor with different circadian rhythm.
(Heiselberg in Møller & Knudstrup, p.58, 2008)

In DS490 the quality of acoustic environment is divided into categories just like the thermal environment and indoor air quality were in CR1752. As a common basis the presented categories all discuss the following aspects:

- Airborne Sound Insulation
- Impact Noise Reduction
- Reverberation Time
- Noise level from Installations and Traffic (DS490)

In regard to this project category C is chosen and will be considered when choosing the construction materials and details.

Category	Percieved Air Quality		* Required Ventilation Rate 1/s x olf
	Dissatisfied %	dp	
A	15	1,0	10
B	20	1,4	7
C	30	2,5	4

* The Ventilaion Rates given are Examples referring execlusively to Percieved Air Quality. They apply only to clean Outdoor Air and a Ventilaiton Effectiveness of one.

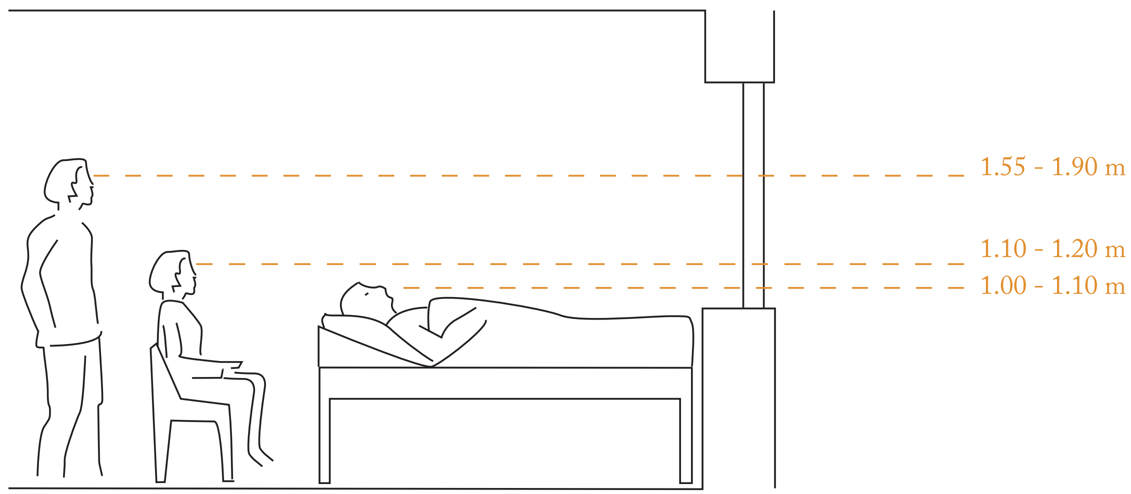
ill. 2.11.7 Categories of IAQ (CR1752, p.23)

Lighting Conditions

"The good indoor climate should not only be defined by an absence of influences experienced as unpleasant or provoking illness, but also by contributing to positive sensory perceptions, particularly in regard to lighting conditions and acoustics." (Indeklimahåndbogen, p.18, 2000)

The beneficial sensory perceptions provided by good lighting conditions were discussed in the chapter 2.6 and so will not be repeated in this chapter. Compared to the other three main areas of indoor climate lighting conditions is a more complex matter not easily defined by means of a categorization scheme. Instead the discussion of good lighting conditions revolves around recommendations regarding e.g. the intensity and distribution of light along with the avoidance of glare and other discomforts. These recommendations include:

- The daylight supply should be sufficient, which as a rule of thumb is achieved when the daylight factor is minimum 2 % .



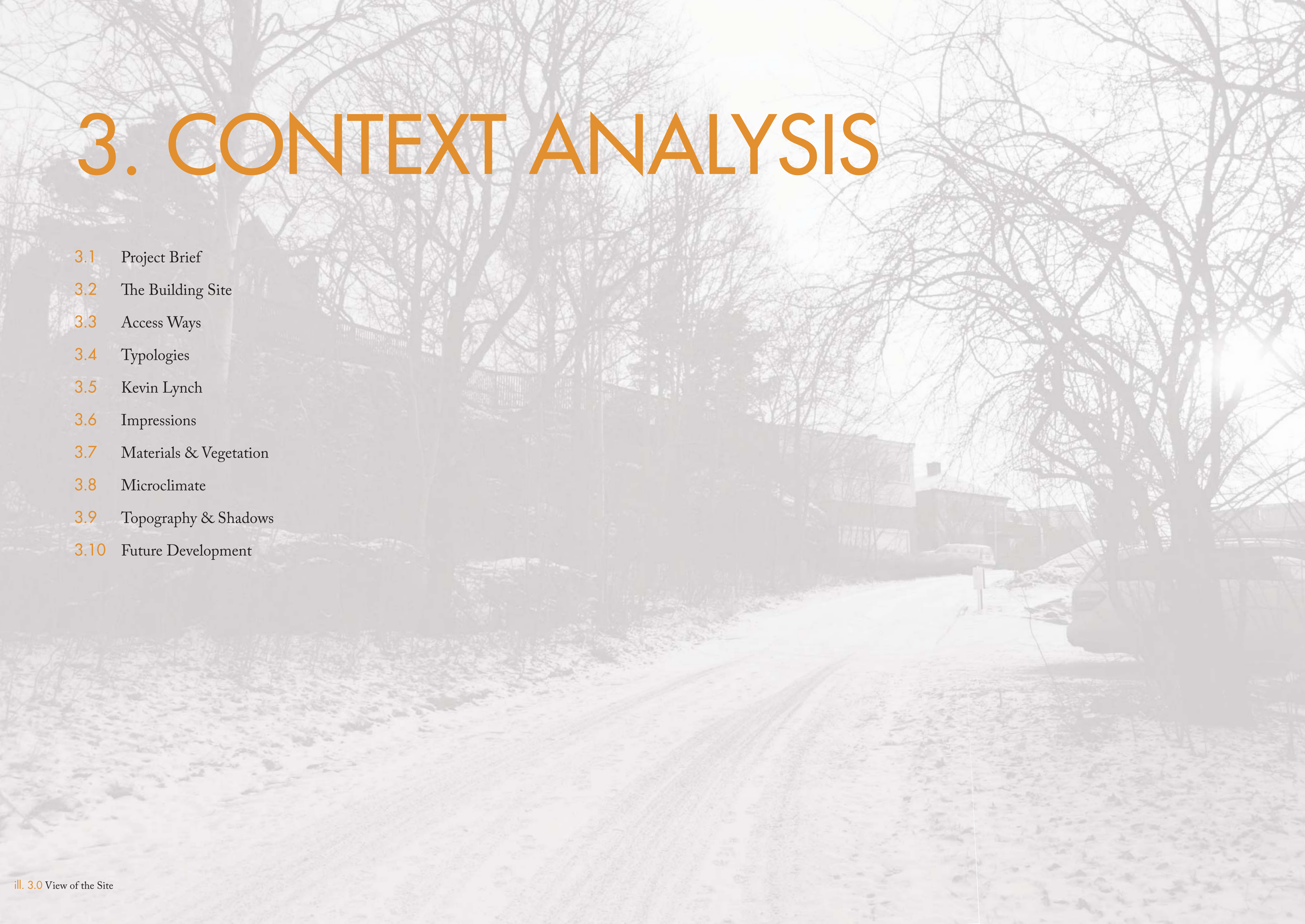
ill. 2.11.8 View through Windows (Indeklimahåndbogen, p.304, 2000)

- A good distribution of light should be secured, which is said to be the case, when the ratio between the height, from the floor to the top of the window opening, and the depth of the room lies between 1:2 and 1:3

- Glare should be avoided, which in regard to windows can be aided by means of bright surroundings reducing the contrast to the sky outside or by adjusting the daylight intake using controllable shading devices
- View to the outside should be established, which can be achieved by careful consideration of the window height (see ill. 2.11.8).
(Indeklimahåndbogen, 2000)

During the design process of this project good lighting conditions will be greatly emphasized. This means that both form studies and computer aided simulations will be conducted supporting the design progress. The aim is to achieve the best possible lighting conditions for the nursing home residents.

3. CONTEXT ANALYSIS



ill. 3.0 View of the Site

Project Brief

As was earlier stated, this project is based on a project brief published by the Municipality of Linköping and the Swedish Architect's Association with the title "Majelden – framtidens vårdbostäder I Linköping". The following text resumes the essentials of the project brief, and provides the basis for a subsequent analysis of the characteristics of the site.

"The aim of the competition is to stimulate the interest for construction of nursing homes, which, with point of departure in elaborate functionality and architectural qualities, make it possible for elderly people to continue living in their neighborhood…"
(Linköpings Kommun 2011)

- The fact that the building must become a future *home* for the users is emphasized. As the earlier studies proved (re the chapter 'Well-being in Nursing Homes'), the project brief also encourages great awareness to homeliness, minimization of long, monotonous corridors, and a good interrelation among private apartments and shared facilities.

- The project brief accentuates that the rough, hilly nature of the area is an important parameter to consider in the planning of a new nursing home. Interplay among the building and the surrounding topography is at aim.

- The facilities included in the new building should provide for interaction among the elderly people living in the nursing home and the people living in the surrounding housing facilities.

- The project brief and the new local plan for the neighborhood (re chapter 3.10) call for awareness to energy efficiency and the environment.

(Linköpings Kommun 2011)

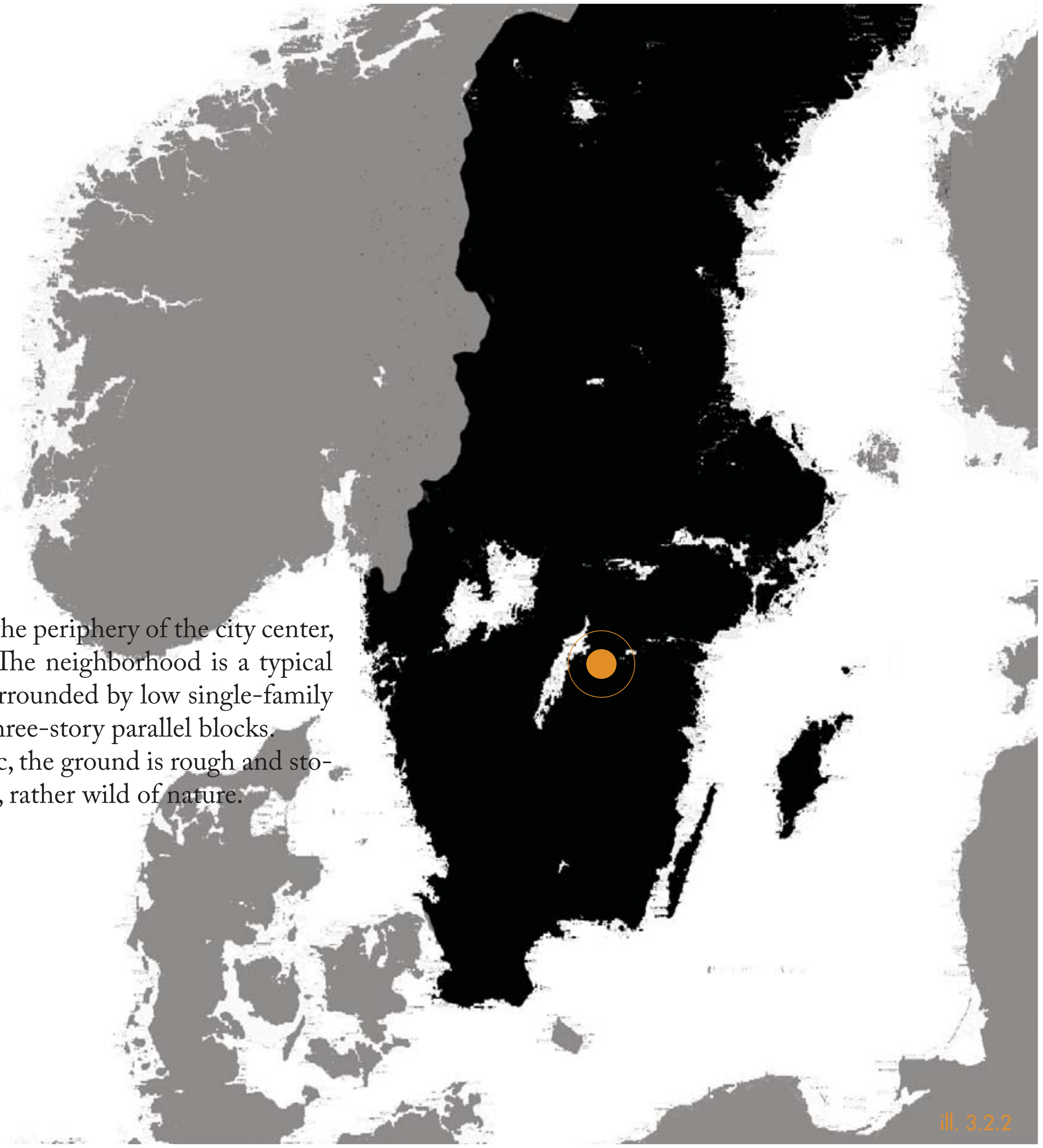

ill. 3.1.1

The Building Site

Linköping
Linköping is a mid-size Municipality in south east Sweden. Linköping has about 150.000 inhabitants and is one of the fastest growing cities in Sweden (Linkoping.se 13.02.12).

ill. 3.2.1

Majelden
The building site is situated in the periphery of the city center, part of the district Majelden. The neighborhood is a typical housing area, and the site is surrounded by low single-family houses, green areas as well as three-story parallel blocks.
The topography is characteristic, the ground is rough and stony, and the vegetation is mixed, rather wild of nature.



ill. 3.2.2

Access Ways

There are two possibilities for entering the site through already established streets. The map shows the two possibilities, and the advantages and disadvantages for each of them are listed. The black lines mark the main roads which provide easy access to the site from the general infrastructure.

1: Access through Vimansgatan
Vimansgatan is a narrow street with low single-family houses on both sides.

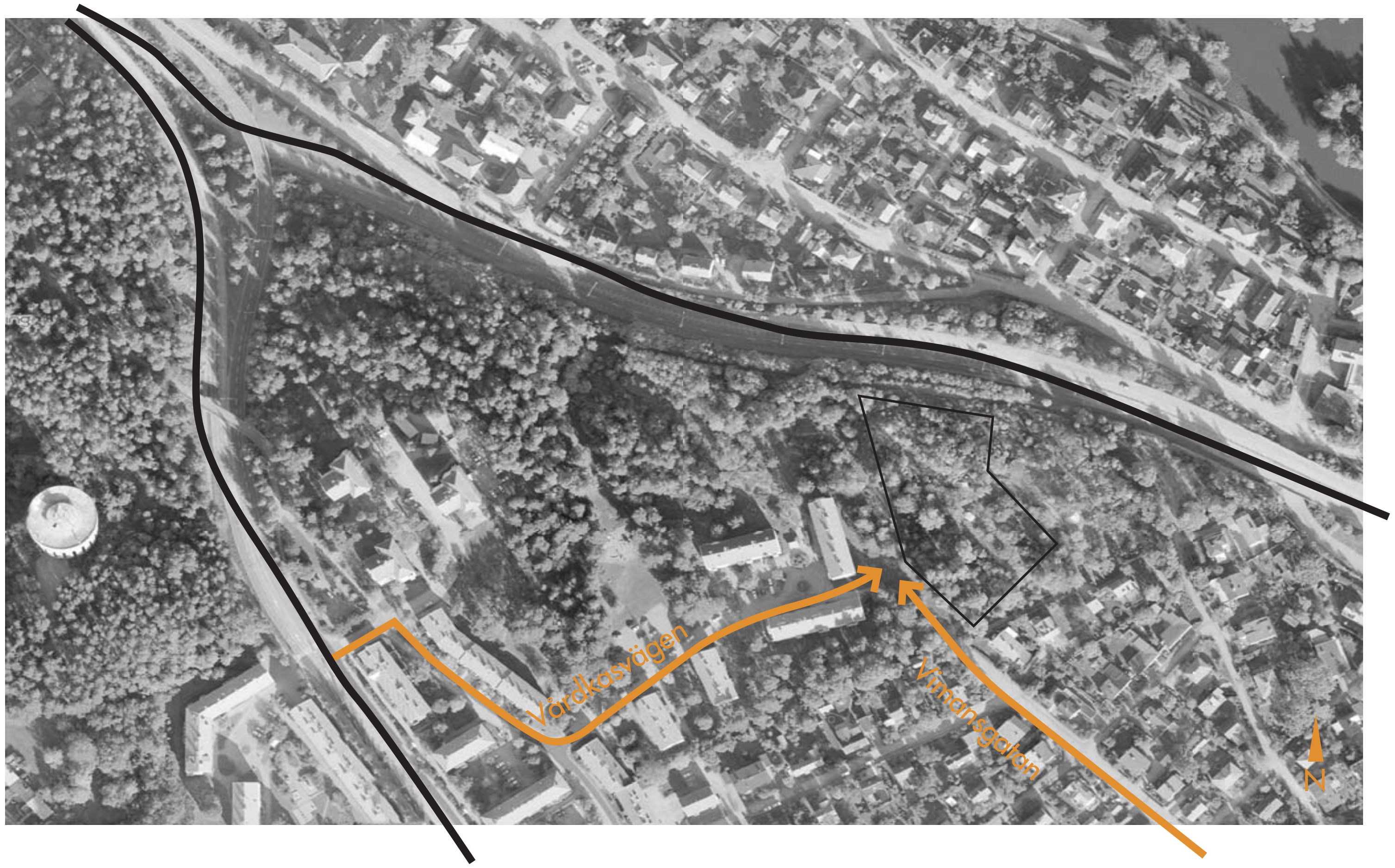
+ small scale, accentuating privacy and homeliness

- if the nursing home creates much traffic, it may disturb the home owners

2: Acces through Vårdkasvägen
Vårdkasvägen is a medium-size street flanked by housing blocks, open green areas and parking areas.

+ the street is wide, and there are parking areas

- the scale is medium, and the connection between the housing blocks and the street are less detailed, less inviting



ill. 3.3.1

Typologies

The near surroundings consist of two main typoligies divided into two districts and large green areas. This page lists the characteristics of each area, and photos illustrate the experienced atmospheres.

1: Housing Blocks, Vårdkasvägen ill. 3, 6 & 7
The area around Vårdkasvägen consists of 3-5 story housing blocks. The detailing is rather low, the expression is repetitive, and the infra structure is rational.

2: Single Family Housing, Eklundsgatan/Vimansgatan ill 1, 2, 4, 5
This area consists of individualized single-family houses. The building styles are varied, ranging from typical Swedish wooden country houses to modernistic and villas and funkis.

3: Green Areas ill 8 & 9
The site is situated in the periphery of a larger green patch. The area is forest - rough and undulating.

ill. 3.4.1

Kevin Lynch

American Kevin Lynch has set up an analysis scheme based on a number of elements, which can help understanding how a city or part of a city works in terms of access ways, barriers and orientation. The elements included in the analysis method are listed and explained below, and subsequently applied to a map of the site and its surroundings. This leads to a number of elements, which are described one on one and documented with photographs.

Paths are lines along which people move through the city. It could be streets, walkways, canals, railways etc.

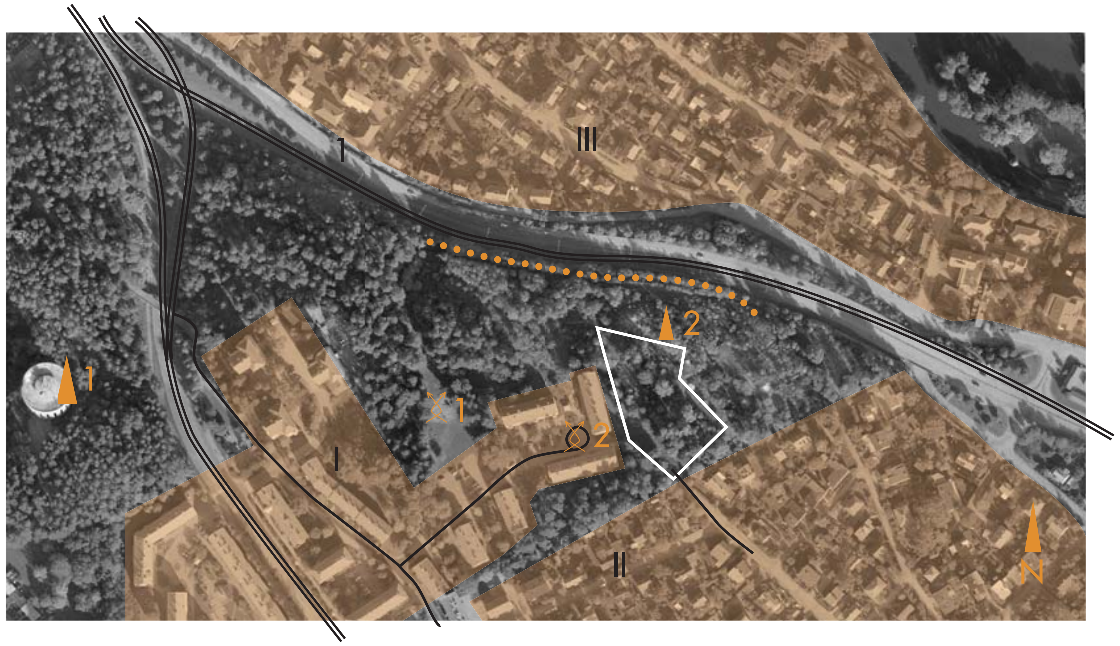
Nodes are meeting points, crossings, places of certain value for a district

Districts are sections of the city, which have certain characteristics, distinguishing them from other city parts or districts

Edges can be barriers or seams in the cityscape. It could be railway cuts, hills, walls etc.

Landmarks are elements of special interest, and which people can orientate according to

(Lynch 1960)



ill. 3.5.1

Impressions

This collection of photos show the building site viewed from different positions. Each view is numbered and described below.

1: From the periphery of the site. The view is directed towards the city center. The city center hides behind the steep slope in front.

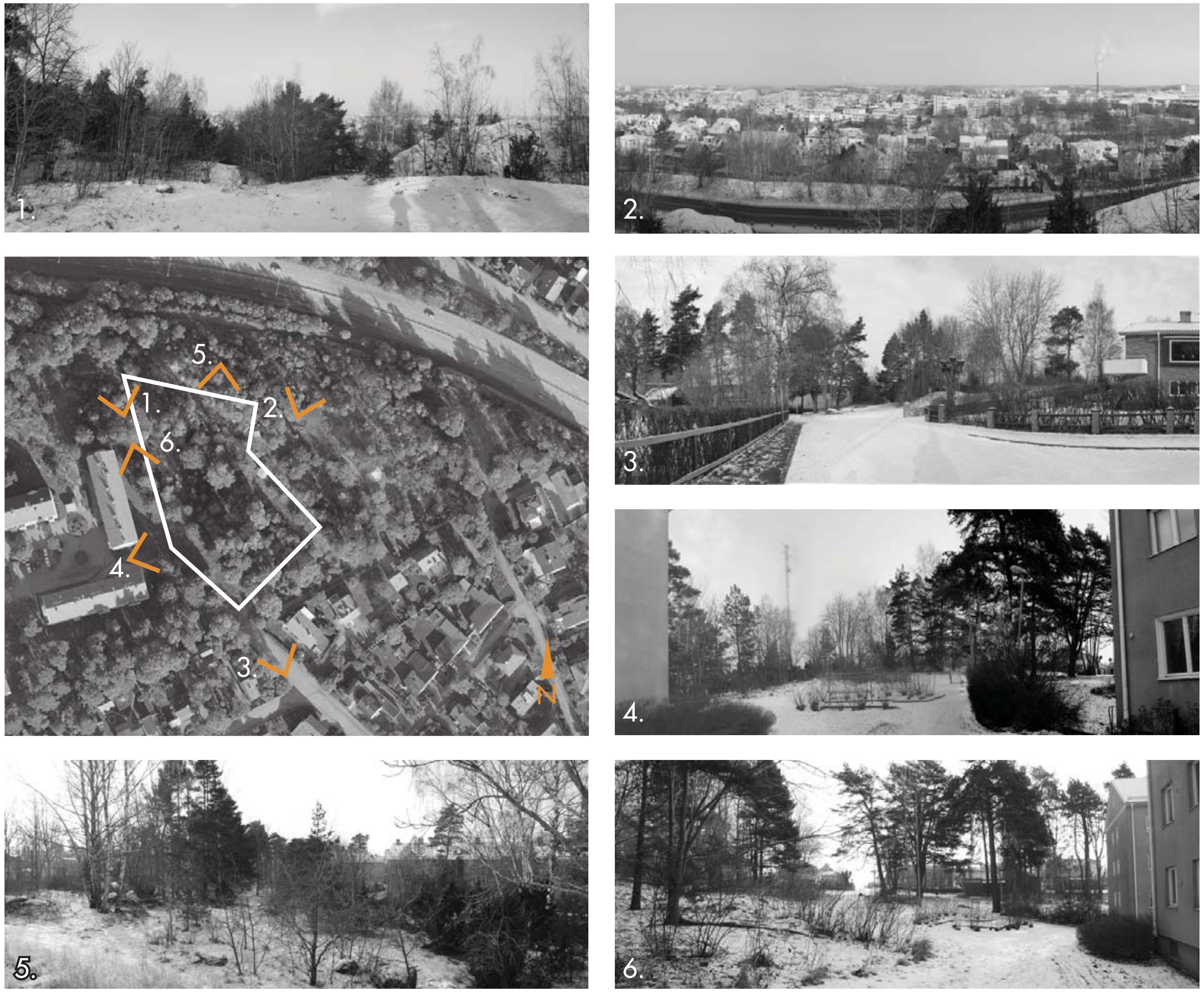
2: Standing at a little vantage point just outside the site, over-looking the city. This is an important recreational point in the area.

3: Existing access way to the site (see Access Ways p. 40). The site starts where the small shown street ends.

4: Existing access to the site (see Access Ways p. 40). The view is directed towards the site.

5: Standing at the periphery of the building site, overlooking the site facing south/south west.

6: Standing on the site, facing south. Both existing access ways are visible - one to the east, one to south.



ill. 3.6.1

Mappings & Site

Materials & Vegetation

The building site and its surroundings consist of housing areas with different characteristics and typologies. As shown on the diagram Functions & Typologies, the near surroundings can be divided into three main districts - low single-family housing, housing blocks and green areas. This material analysis has its point of departure in the same division of typologies, thus further exploiting the characteristics of the different adjacent areas.

Ill. A- E **Low Single-family Housing**
The materials are typically natural and local materials such as wood and brick. The execution of the buildings is good, and the detailing is high. Combinations of wood and bricks occur.

Ill. F, G, K **Housing Blocks**
In this area, the materials are not natural, and the detailing is rather low. Typical materials are plaster and roughcast and metal plates visually resembling wood were found as well.

Ill. H **The Pavilion**
The small pavilion is located just outside the site, and is included because it is an important point of reference. The pavilion is made of painted wood.

ill. 3.7.1

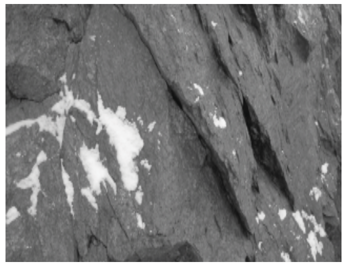
Ill 3.7.2 **Vegetation**

The building site is very dominated by nature. Therefore the vegetation and the colors of same are given value in the striving to understand the site. The first site visit happened in winter, while the paths and streets were covered by snow. The colors of the site stood out with great power.
The colors and the vegetation will be brought on as inspiration for the future building's relation to the spirit of its surroundings.




ill. 3.7.2





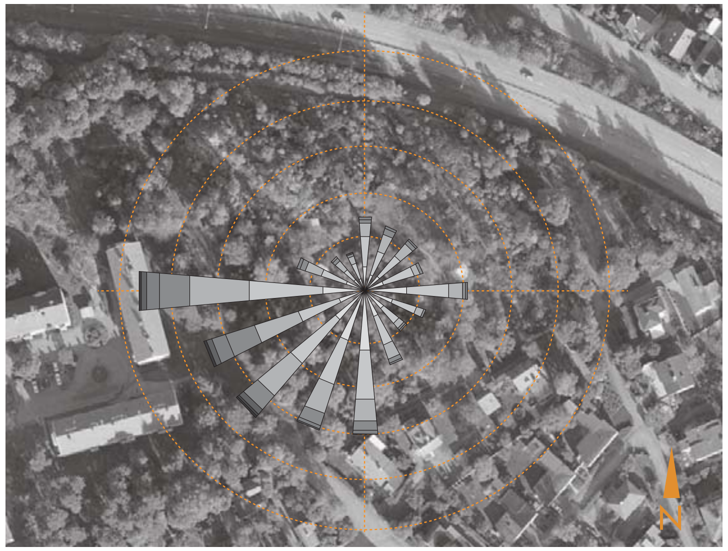

Microclimate

When designing a building, the microclimate is an important factor to consider. This chapter treats the site specific conditions and discusses their importance to the design of a new nursing home.

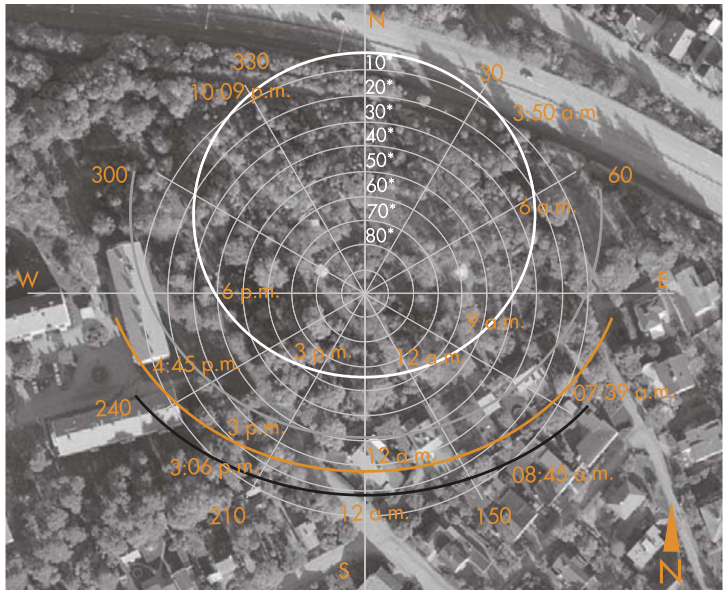
Sun & Wind Conditions

The wind rose (see ill. 3.8.1) shows how speed and direction of wind are distributed over a period of time. The wind rose clearly shows that the majority of wind comes from the south to west quarter of the rose with west being the dominant wind direction. During two site visits no discomfort caused by windy conditions was identified. This is not assumed to be due to low wind activity but rather due to protection from the trees and wild greenery on site, maybe assisted by the nearby stock buildings on the west side of the site as well. As much of the greenery on site will be removed to make room for the new nursing home it is important to keep in mind the strong wind coming from south, southwest and west and design accordingly. Outdoor places not screened by the building itself can e.g. be screened by planted greenery which also adds to the atmosphere.

The sun path diagram (see ill. 3.8.2) shows the position of the sun at different times of day and year. Overall it shows that the sun is high and the day is long during summer, while the sun is low and the day short during winter – not much different from Danish conditions. In regard to the risk of overheating during summer it is important to be aware of the fact that small east and west orientated rooms are posed to a higher risk than similar south orientated rooms due to the smaller angle of incline more difficult to screen. In regard to the placement of functions it is important to consider the path of the sun as well, especially regarding outdoor functions where sun light is desired.



ill. 3.8.1 Wind Rose (Linköping.se, 10.02.12)

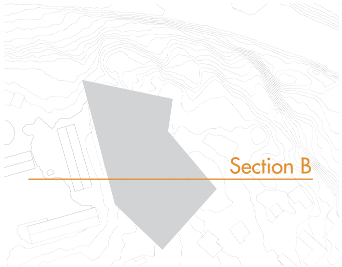


ill. 3.8.2 Sun Path Diagram (gaisma.com, 10.02.12)

Topography & Shadows

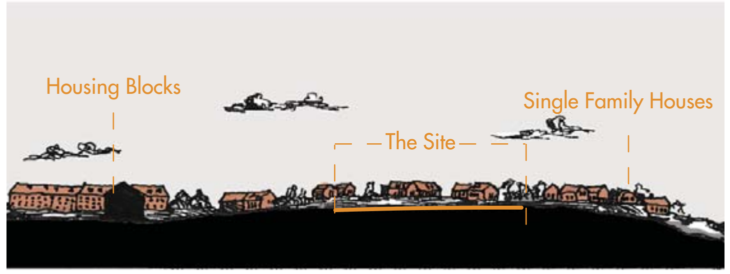
The topography of the site and its nearby surroundings is very characteristic and poses a great challenge for the project as the outdoor environment should be inviting and accessible for elderly people with reduced mobility. Sections can be seen on the following page. The site is positioned high and slopes down primarily towards west, which is considered okay in regard to energy as it allows for building design to utilize solar energy from south. Here the matter of existing shading also comes into questing. A set of simple shading diagrams, representing morning, noon and afternoon for equinox and winter solstice (see ill. 3.9.5 to 3.9.10), have been conducted to evaluate the existing shading conditions. As evident from the diagrams the building blocks to the west of the site only weakly shade the site during equinox. This implies that shading caused by buildings nearby will not pose a problem during the summer period as the shading conditions will be better than at equinox. During winter, on the other hand, shading might pose a problem as the winter solstice diagrams show areas of shading located differently at different times of day. Consequently the matter of shading, both from the building itself and from other built objects, needs to be paid attention to in the design process.

Furthermore, on the first site visit it was witnessed that no noise pollution from the nearby road Brokindsleden disturbs the acoustic environment. Evidently this must be due to the fact that the steep slope bordering the area and the road functions as a sound barrier. Thus no special attention is required to avoid traffic noise.

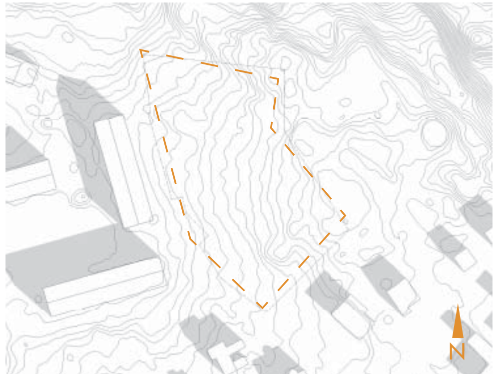


ill. 3.9.1

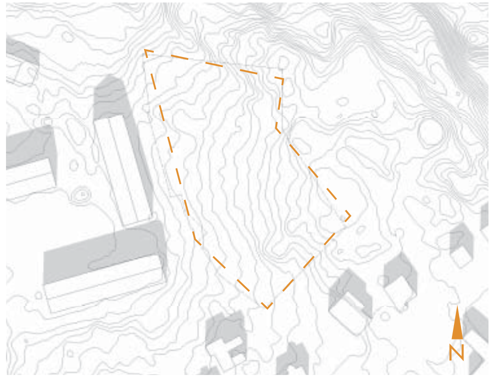

ill. 3.9.2 Site



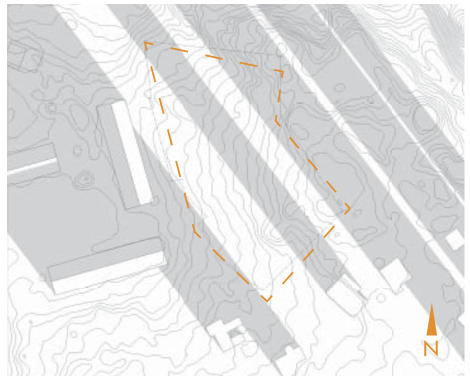
ill. 3.9.3 Section B



ill. 3.9.5 Shadow Diagram, Equinox, 3 p.m.



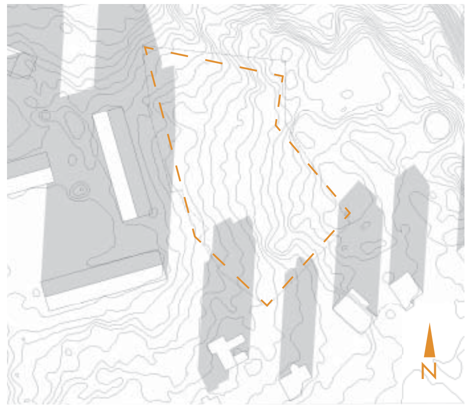
ill. 3.9.6 Shadow Diagram, Winter Solstice, 12 a.m.



ill. 3.9.7 Shadow Diagram, Winter Solstice, 3 p.m.

ill. 3.9.8 Shadow Diagram, Winter Solstice, 9 a.m.

ill. 3.9.9 Shadow Diagram, Equinox, 9 a.m.



ill. 3.9.10 Shadow Diagram, Equinox, 12 a.m.

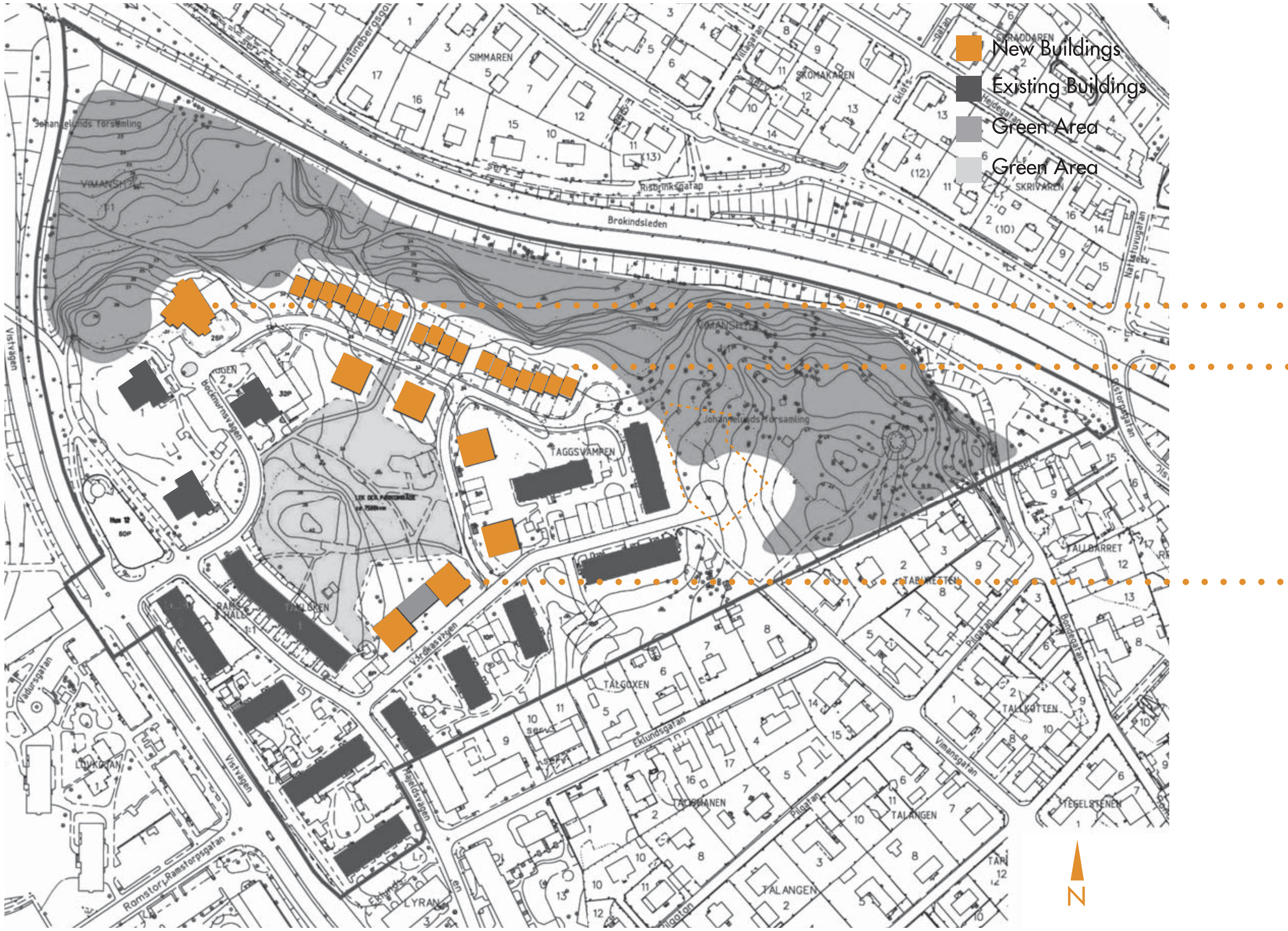
Future Development

Linköping Municipality set up a local plan for the area Vimanshäll, in which the area Majelden where the future nursing home should be placed is included. These plans are interesting due to their affect in the form of the character of the neighborhood and environmental influences such as shadows and wind.

The area marked on ill. 3.10.1 will comprise 135-140 new dwellings, divided on blocks of minimum 5 and maximum 14 floors and 15 terraced houses. Besides the dwellings the area should comprise a kindergarten with a capacity of 40-50 children and the nursing home, which is subject for this project.

The local plan states the area is dominated by nature and green areas, which should be respected and kept accessible for the general public.

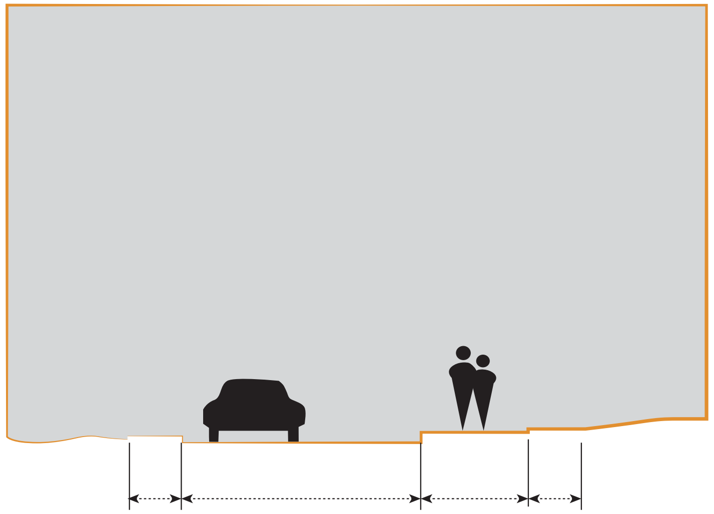
The overall aim of the local renewal is, according to Linköping's Municipality, to reactivate the area which is currently dominated by elderly residents. The new buildings with mixed ownership/rental possibilities and the kindergarten should attract the younger audience, and the nursing home should make it possible for the elderly already living in the area to keep living in their neighborhood, even when their need for assistance increases.
The Illustration shows the different types of buildings planned for the area.



ill. 3.10.1 (Linkoping.se)

ill. 3.10.2 (Linkoping.se)

ill. 3.10.3 (Linkoping.se)



ill. 3.10.4 (Linkoping.se)

The 7 Aims

The following 7 points are included in the new local plan 'Vimanshäll 1:1' relevant for the area. The points clearly suggest a sustainable approach for the new buildings.

- *Variety*

A socially and economically sustainable area - mix of dwellings, commercial uses, service etc.

- *An Attractive Area*

The area should comprise social, recreative and cultural activities.

- *Density*

High density entails better possibilities for businesses to survive, and for establishing good public transportation facilities.

- *Energy Efficiency*

A future-safe development.
Buildings should at least comply with Energy Class B (low energy) – in some cases the minimum demand is even Energy Class A (passive house).

- *Sustainable Transportation*

The Municipality and the Builders want great awareness to the needs of bike riders. The aim is to make the number of people using bikes increase. Proposed road division ill. 3.10.4.

- *Sustainable Technical Systems*

The buildings should use environmental friendly heating systems, reuse heat, minimize outlet of waste water, and allow for presorting of waste.

- *Environmental Friendly Building Process*

Use environmental friendly building materials chosen through an accepted data base of sustainable materials.

(Linköpings Kommun 3, 2011)

4. RECAPITULATION

ill. 4.0

Recapitulation

This section shortly sums up the knowledge gained through the foregoing analysis, and emphasizes key factors to bring on to the sketching phase.

Organization
A nursing home is a complex building, as it must meet the needs of both residents, staff and visitors.
The overall organization of the complex determines the visual and physical connections among the different parts of the building. It also determines the building's more or less open relation to its surroundings.

Well-being
As regards well-being of nursing home residents, a number of factors must be responded to. Most important is the feeling of homeliness and thus suppression of an institutional atmosphere. Additionally, stimulation of senses has proven beneficial to elderly nursing home residents. This calls the importance of outdoor spaces e.g. gardens to mind. A well planned garden brings up memories while activating the senses, and strengthens physical and cognitive abilities.

A good Working Enviroment
These requirements do occationally conflict, entailing discomfort for one or more of the user groups. Therefore it is important to carefully consider the needs of each group - in every part of the building.

The visit at 'Birkebo' showed evidently that good intentions must be supported by careful detailing to harness their potential.

The working environment at 'Birkebo' was generally well-functioning, but the staff voiced a few lacks such as meeting rooms and additional assistive technologies.

Daylight & Nordic Architecture
Daylight is of course a main influential phenomenon. Through investigations based on research it became clear that not only does daylight define the character of the spatial settings, it also affects human health positively.

Thoughtful use of daylight is further one of the main characteristics of Nordic architecture. The Nordic tradition brings about subjects such as reference to nature and honesty towards construction and materials. These subjects will be of great importance in the further development of the project.

Context
The context analysis entailed a basic understanding of the site, its limitations and advantages. Situated in a small forest on very hilly terrain, the building must respect and respond to its natural settings and exploit the recreational values the location brings along.
The complex topography must be carefully considered when planning accessible outdoor areas for the elderly.

Energy and Indoor Climate
Besides these sensous aspects of a new nursing home, in the context of today, of course the building should comply with high standards, both in regard to sustainability and indoor climate.

Sustainability does not only cover environmental aspects, it also covers social and economic considerations.

Indoor climate is a social aspect of sustainability, which is given high priority in this project - in favor of the vulnerable nursing home residents. In such the thermal environment should fulfill a category B standard (according to CR1752). The operational temperature range was determined as 23°C - 25°C. The indoor air quality (IAQ) should comply with a category A standard (according to CR1752). This implies that the CO_2-concentration limit is 460 ppm above outdoor level.

Integrated Design Process
All in all, the building of a nursing home is a complex matter which calls for attention to a wide range of preconditions. Consequently the design process must constantly consult different preconditions, while paying attention to their interrelation. As such, an integrated design process is at aim.

Implementation of all of the above mentioned conditions hopefully results in a design proposal which accomodates the aims and requirements put forward by the municipality of Linköping.

Recapitulation

Vision

The vision of the project is to create a nursing home which embraces the nature it lies in, and contributes to an enjoyable everyday for its residents and the nursing staff.

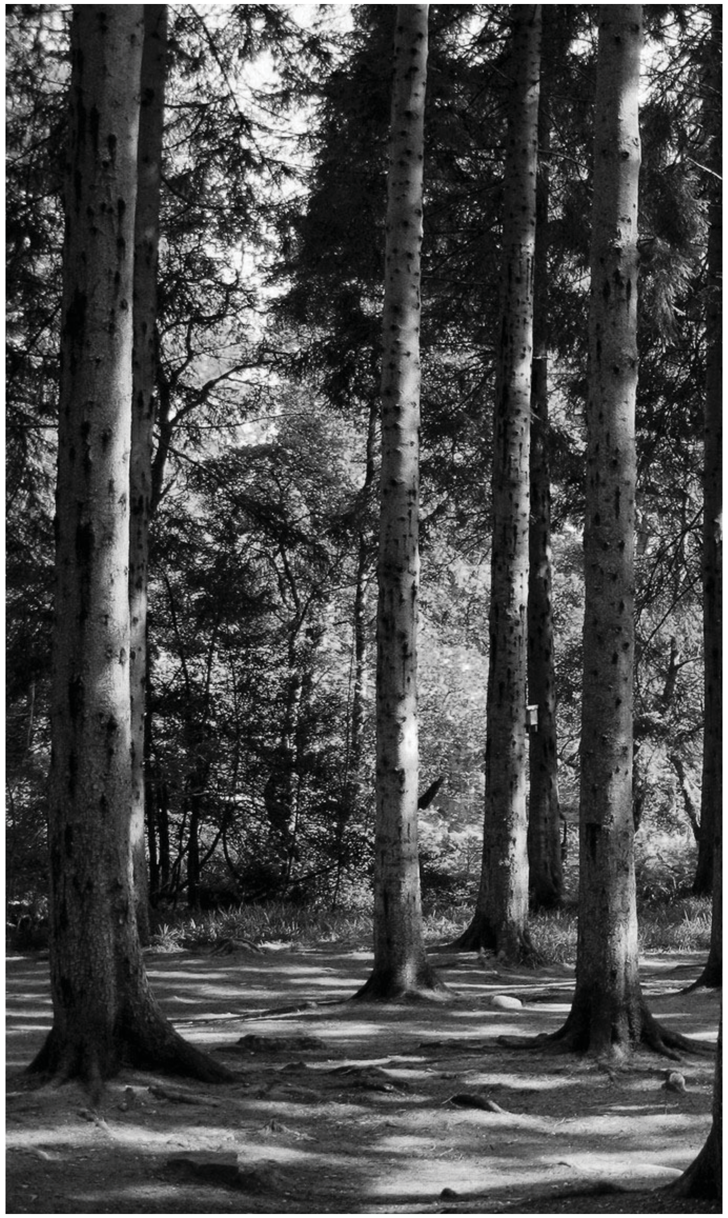
In the nursing home, sensuous qualities and technical aspects should meet and create a symbiosis resulting in a thorough processed home of high architectural quality.

It should provide a safe environment for people living the autumn of life, regardless their physical and cognitive abilities.

The level of detail should be profound, referring to Nordic traditions and values.

As stated in the introduction (p. 6), the problem statement is:

'How do we create a nursing home in a Nordic context with focus on the impact of daylight on human health and psyche, which combines perceived residential quality with functionality and fulfills the 2015 requirements to energy consumption?'



Room Book

On the following spread, the room book is presented. The room book is developed on basis of requirements posed by the municipality of Linköping (Linköping 2011) along with additional conclusions from the analysis.

Room Specification	Main User Group	Number	m2 per unit	Capacity per unit (persons)	Daylight Demands	Lighting Position	Situated close to
CENTER FUNCTIONS							
RESIDENTS							
Assembly Hall	residents/staff/visitors	1	75	70	high	high & middle	
Resident Spa Facilities	residents/staff		15	3	medium	high	Easy access from all living units
Physician consultancy room	residents/staff	1	10	3	high	high & middle	Easy access from all living units
Residents' personal deposits	residents	32	2	-	low	high	Accessible for residents
ADMINISTRATION							
Director's office	staff/visitors	1	15	3	high	middle	
Administration offices	staff	1	12	2	high	middle	Director's office
Janitor's office	staff	1	10	1	medium-high	middle	
Meeting room	staff/visitors	1	15	5	high	middle	Offices
Kitchen	staff	1	25	5	medium	high	high
Staff's bathroom	staff	1	5	1	low	high	Offices/meeting rooms
Print/copy room	staff	1	5	-	low	high	Offices
STAFF							
Changing Rooms w shower and lockers	staff	1	35	20	low	high	-
Janitor's workshop	staff	1	30	1	low	high	-
Staff's bathroom	staff	min. 2	4	1	low	high	Offices/meeting rooms
BUILDING SERVICE							
Goods reception deposit	staff	1	15	-	low	high	-
Deposit, assistive equipment	staff	2	25	-	low	high	-
Technical Room	-	1	35	-	low	high	-
Laundry Room	staff	1	35	3	low	high	-
Waste Deposit	-	1	2	-	low	high	"Easy access for renovation staff"

Room Specification	Main User Group	Number	m2 per unit	Capacity per unit (persons)	Daylight Demands	Lighting Position	Situated close to
3 LIVING UNITS (Incl. one for demented residents)							
RESIDENTS							
"Single Resident Apartments (2 of which can be combined to two-person apartments per Living Unit)"	residents/staff/visitors	12	35	1 (2)	high	high, middle, low	
Kitchen w. Seating	residents/staff/visitors	1	40-60	20	high	high & middle	Visual contact/ easy access from all living units
Outdoor Seating Area	residents/staff/visitors	1	min. 20	20	high	-	
STAFF							
Staff's break room	staff	1	15	5	high	middle	
Staff's bathroom	staff	1	5	1	low	high	
Cleaning Equipment Room	staff	1	10	1	low	high	
BUILDING SERVICE							
Deposits	staff	2	6	-	low	high	
Waste Deposit	staff	1	2	-	low	high	
THE PRIVATE HOME							
Entrance		1	-	min. 2	high	high, middle, low	
Main room, possibly dividable	residents/staff/visitors	1 (2)	-	min. 2	high	high, middle, low	
Kitchen	residents/staff/visitors	1	-	min. 2	medium	high, middle, low	
Bathroom	residents/staff/visitors	1	-	min. 2	low	high	Short distance to bed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5. DESIGN PROCESS

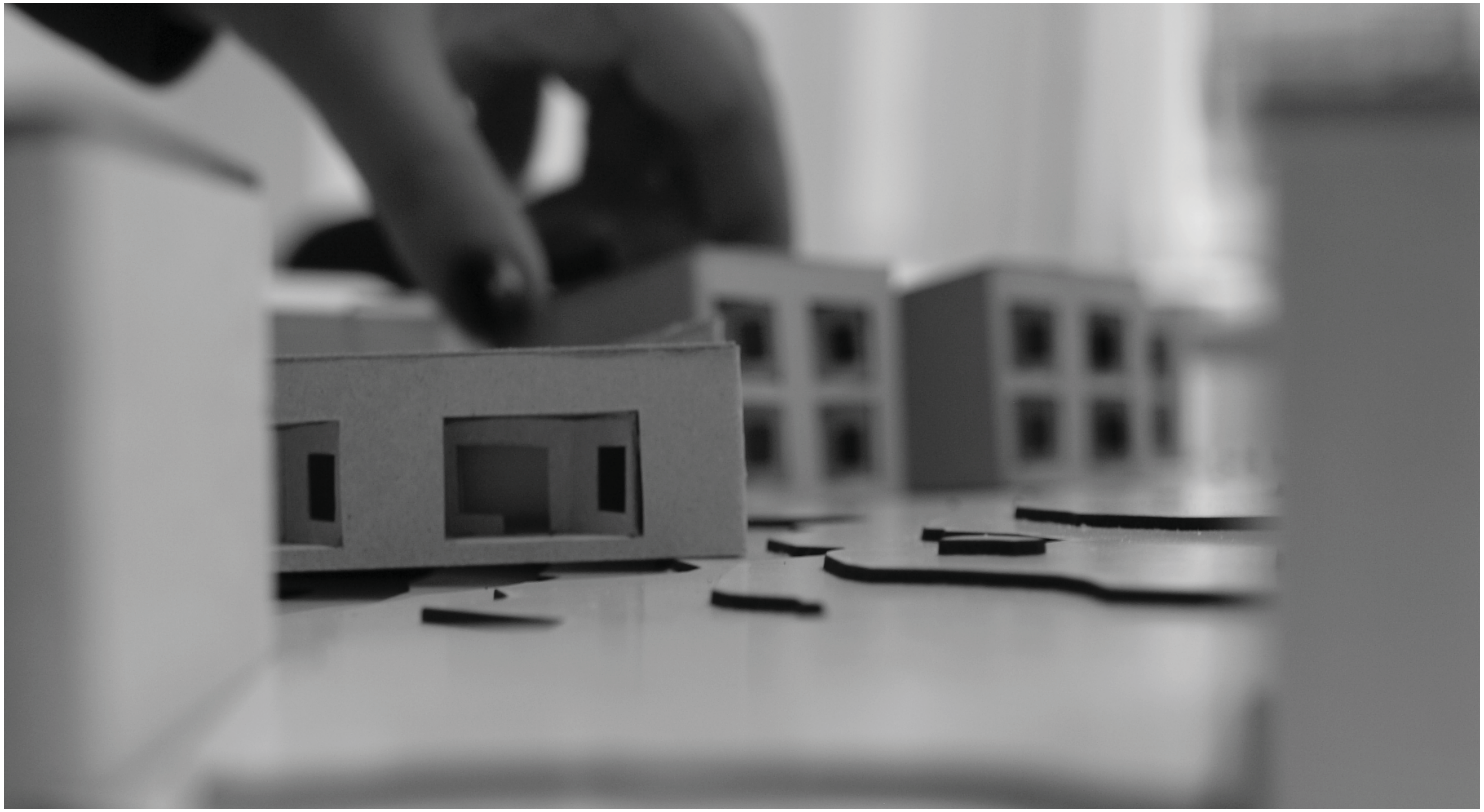
Introduction

In the following, the design process leading to the final design proposal will be described. This chapter aims at highlighting the most important steps in the process. In order to make it easier to keep an overview of the course of development, the complexity of the decision making is brought down. The concepts and the organisation studies are all results of a longer process of experimentation, which is described in Appendix 1.

As written on the first pages of this report (see p. 8-9), the main methods used in the development of the proposed design is the integrated design process (IDP) and evidence based design (EBD). Being of theoretical nature, these methods were naturally integrated with hand sketching, digital sketching and to a wide extent, model building.
The design process has aimed at including user needs, technical considerations and architectural considerations through several iterations at various scales using various tools and methods - a rather pragmatic approach.

User-centered Design
The first essential step in the design process was of course the understanding that a nursing home is and should be all about the users. The users both in the form of the nursing home residents, but also the role and needs of the nursing staff.

Knowing the process in reality has been less straightforward, the following texts are arranged rather lineary.


Ill. 5.1.1 Design Process

Apartment Plans

The Apartment Plans
The complex should comprise suited apartments for three types of users:

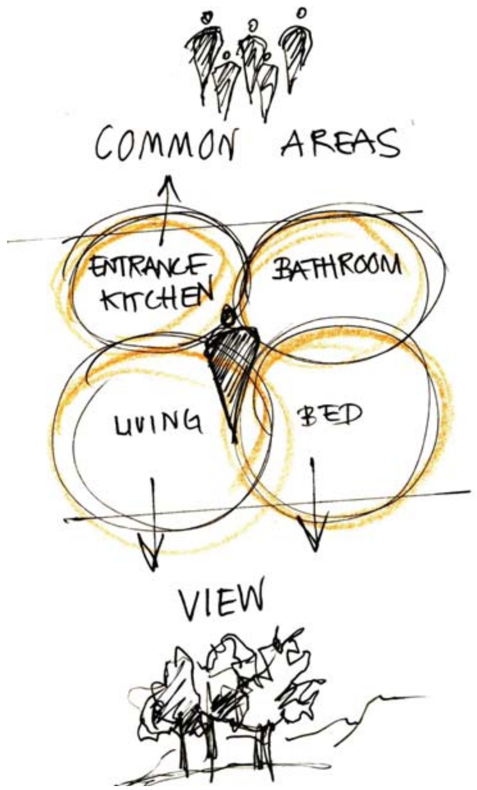
- the care-requiring elderly
- the un-aided elderly
- the demented elderly

Referring to the beforegoing analysis, these three types of users naturally have different needs.

On top of the needs derived from the analysis comes the proposed apartment-size (35 m2) found in the competition brief (see p. 38).

While demented residents as a consequence of their disease resulting in insecurity and fear of being alone, spend a great deal of their time in the common facilities, cognitively healthy residents are more likely to spend time in their own apartment - the care-requiring elderly in particular.
The apartment layouts are naturally widely based on space requirements for care-requiring elderly. In such all distances among functions in the rooms are carefully considered:
The apartment design is based on guidelines found in the publication "Egnet Byggeri" (Ribe Amt, 2001).

Ill. 5.2.1 shows the main distribution of zones inside the private apartment.



Ill 5.2.1 Initial distribution of zones

Entrance-kitchen Zone
The entrance area and kitchen are placed together. Some nursing home residents are unable to use the kitchen, and in that case it is an advantage that the kitchen can be visually concealed, and that it uses as few squaremetres as possible.
From the common side the entrance area is recessed and can be personally decorated or colored while it also marks the transition between common and private areas - like a front yard.

Living Room-balcony Zone
The living room and balcony zones are considered to be of great importance for the general well-being. The living room is suitable for receiving guests, and will in most cases be free of assistive equipment.

Bathroom-bedroom Zone
The bathroom is fitted for full turning with a wheelchair, diagonal transfer from wheelchair to toilet and daily personal hygiene either in wheelchair or bathing chair.
In the rooms fitted for care-requiring elderly the bedroom zone allows turning with wheelchair between bed and bathroom as well as access for nursing staff to help from the opposite side of the bed.
A fixed design criteria is the fact that a ceiling lift must have undisturbed access from bed to bathroom in the case of a care-requiring elderly. Furthermore the bed-to-bathroom zone is where the most accidents due to falls happen (Ulrich, 2012). Therefore the bathroom and bed must be situated directly adjacent to each other, fitted with a handrail on the wall and the ceiling heights in the two rooms must be flush.

Flexibility
The apartment types are dividable, using light walls or moveable cabinets. In that way a small apartment may seem larger, and the degree of personal freedom is enhanced.

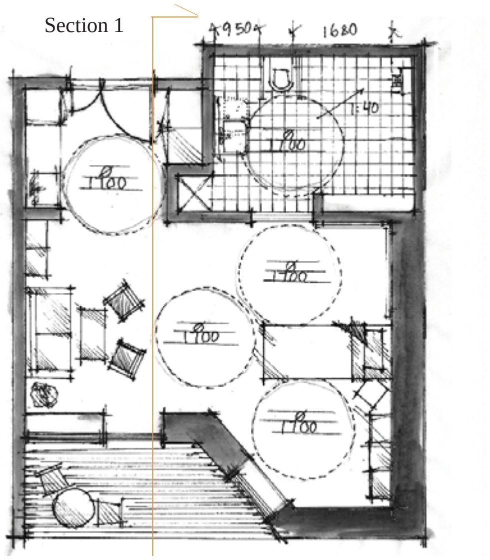
In all apartment types the windows sills are placed at a height of maximum 800mm, which, according to ill. 2.11.8 allows for a view to the outside both standing, sitting and laying in bed.

Selected Models

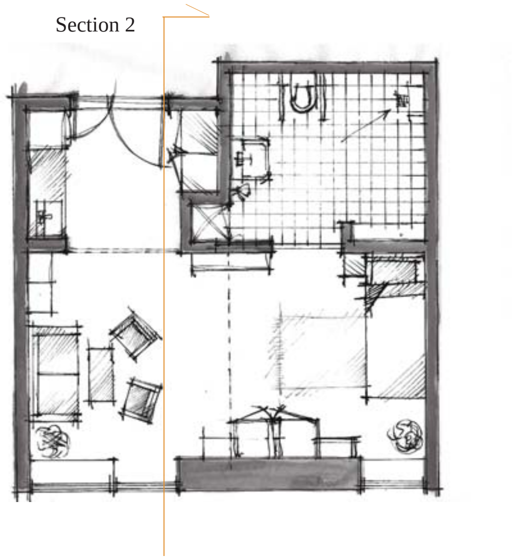
Cognitively Healthy Residents
For the care-requiring and the un-aided elderly residents, one type of apartment plan was chosen (see ill. 5.2.2). The natural reason for this is the fact that the physical condition of the residents may decrease rather rapidly after moving into a nursing home - having to move to another apartment type would be a psychological defeat and should be avoided.
The angled window provides the - possibly bedbound - elderly with a view from the bed to the outside or the possibility to place a chair and enjoy the view, while it also breaks the incoming daylight in the mainly one-sided plan type.
Emphasis is put on giving each elderly direct access to an outdoor protected area, as the benefit of barrier-free access to the outside, even in a building of several stories, is an undeniable quality.

Demented Elderly
The layout for the demented elderly is chosen on basis of their need for a clear an readable layout. The basic organization is based on the same principles as the plans for cognitively healthy elderly. The area of the bedroom-living room zone is lightly decreased, because demented elderly typically spend much less time in their private apartments than cognitively healthy elderly do.

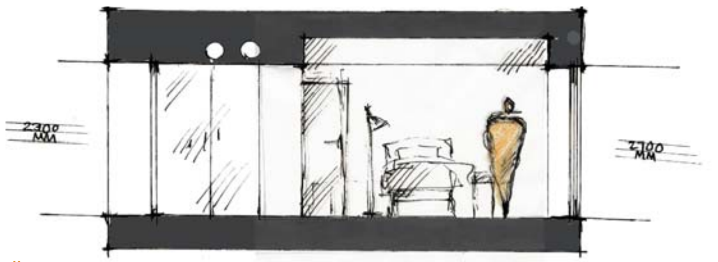
Apartment Section
In order to accentuate the transition among common areas and privacy and to enhance the difference among the zones (ill 5.2.1) internally, the ceiling height is shifted. In such the ceiling height in the living room area is 300 mm higher than the ceiling height in entrance, bedroom and bathroom zones. The drawings ill. 5.2.4 and 5.2.5 show how the suspended part of the ceiling is utilized for piping and ducting.



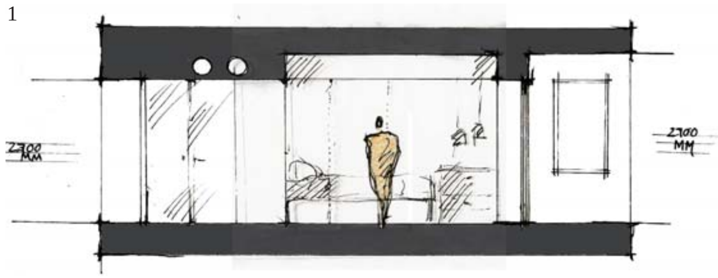
Ill. 5.2.2 Apartment Type A for cognitively healthy elderly, ca. 37 m2



Ill. 5.2.3 Apartment Type B for demented residents, ca. 35 m2



Ill. 5.2.4 Section 1



Ill. 5.2.5 Section 2

Ill. 5.2.6 Varied ceiling heights in small apartments: Skovgården, KHR Arch. (DK)

Design Process

Daylight Studies Type A

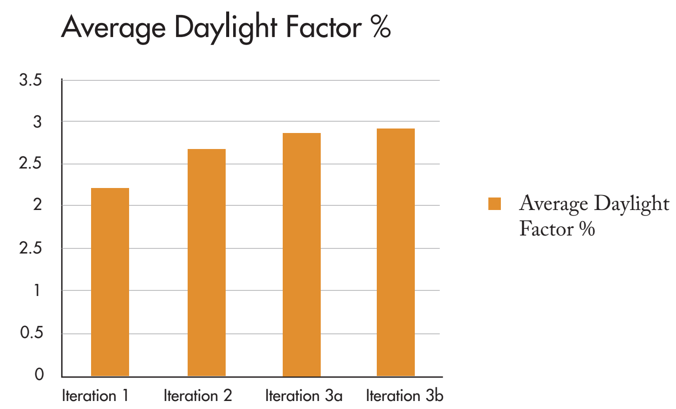
With point of departure in the apartment floor plan for apartment type A, this section aims at determining the window sizes and precise positions of same.
A series of variations have been valued both qualitatively and quantitively through analyses using Velux Daylight Visualizer for considerations regarding daylight and BSim as regards thermal indoor climate.

Daylight & Overheating
Ill. 5.3.3 shows the daylight simulations from Velux Daylight Visualizer.
Iteration 1 is based on the immediate window positions determined in plan and section.
It shows the distribution of daylight in the apartment is rather uneven, especially in the bedroom zone. The aim is to reach a daylight factor of 2% in the bed area and the living room and possibly minimize dark corners.
A rather low factor in the entrance area is accepted, as this contrast also helps accentuating the transition between private apartment and common facilities.

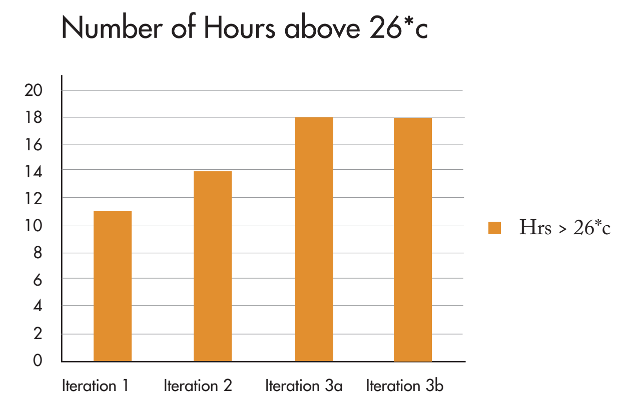
The smaller window was extended to the top, so that the light reaches in and brightens up a part of the ceiling. As the sun travels across the sky and the light reaches further or shorter into the room, the appearance of the ceiling material changes accordingly.
The third iteration is based on the aim of making the sun reach further into the bedroom, where the light situation around the bed area in iteration 2 did not reach higher than 1.7%.

Simultaneously the models were analyzed using BSim in order to determine the amount of hours the apartment may be overheated. As the diagram suggests, the amount of hours increase the bigger the window areas are. As the hours keep quite low in this apartment, mainly due to the large overhang provided by the roof or the apartment on top, the daylight factor is considered of greater importance for the daily comfort in this case.

According to illustration 1, the quantitatively best solution is Iteration 3b. Nevertheless, Iteration 3a is chosen out of qualitative considerations, because it provides the elderly with a second view direction from the bedroom. For a possible bedbound person this is given great value. Furthermore the vertical direction of the window fits into the rhythm of the facade and refers to the verticality of the surrounding trees.

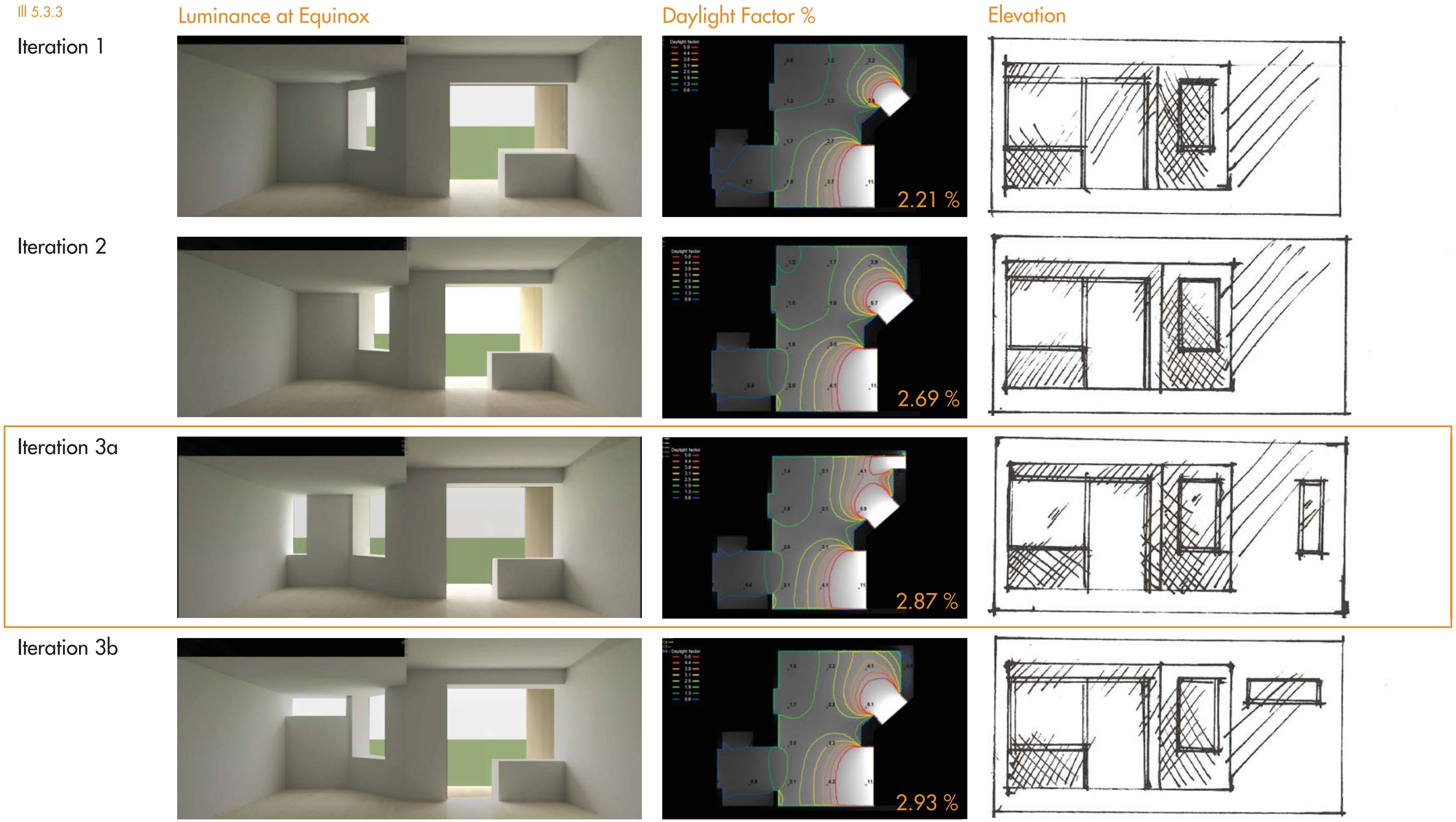


Ill 5.3.1



Ill 5.3.2

Overheating	nr. 1	nr. 2	nr. 3a	nr. 3b
> 26	11	14	18	18
> 27	0	0	0	0


Luminance at Equinox
Daylight Factor %
Elevation
Iteration 1
2.21 %
Iteration 2
2.69 %
Iteration 3a
2.87 %
Iteration 3b
2.93 %
Ill 5.3.3

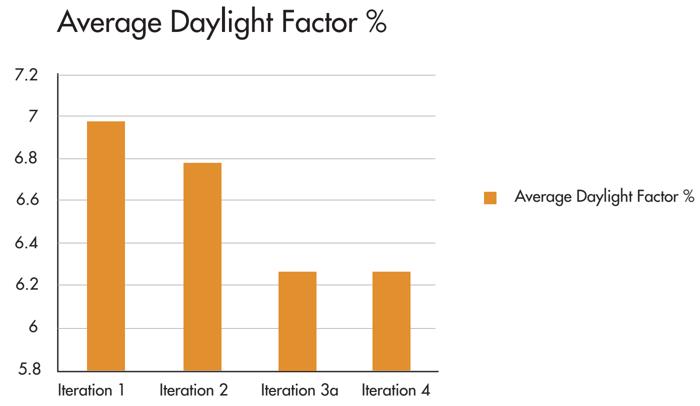
Daylight Studies Type B

This section aims at determining window sizes and positions for apartment type 2.

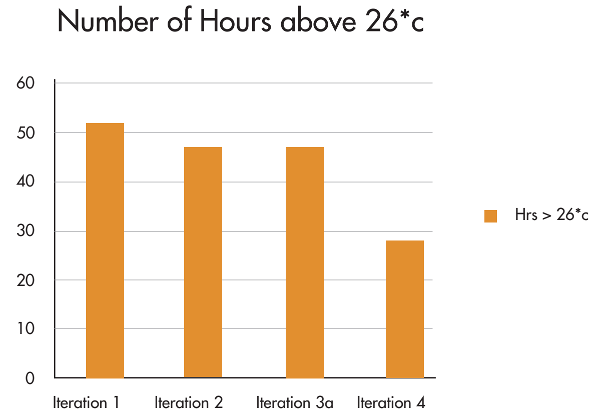
Apartment type 2 suited for elderly suffering from dementia is a bit smaller than the corresponding layout for user group 1. Furthermore the left out terrace means the overhang disappears. In such, intuitively, this apartment is more exposed to overheating and less to lack of daylight. Note, that the BSim simulations are made for a south-west oriented apartment as it is estimated to be more exposed to overheating than similar apartments with different orientations.

Daylight & Overheating
As this apartment type is strongly inspired by apartment type 1 the starting point for the iterations was naturally to integrate the same set of windows and evaluate the result. As expected this means a great increase in overheating (see ill. 5.4.2) along with a significant increase in daylight factor as well. In iteration 2 the smallest window was removed to decrease the total window area and thus bring down the amount of overheating. It was concluded that the daylight factor was still rather sufficient. Due to considerations regarding the rhythm of the facade, the window in the middle of the room was moved out to align with the wall (iteration 3). This brightened up the room as the light coming through the window is reflected on the wall. In addition it was considered beneficial for the interior decoration as it frees up a large coherent wall in the middle - suitable for a wall unit or another personal piece of furniture. Consequently the light situation was as desired. The simulation of the thermal environment however still showed an unwanted number of overheating hours. In iteration 4 an external solar shading device was assigned to the door.
 Aesthetically this enhanced the exterior expression as well. In the simulation the solar shading was set to slide in front of the door when the sun exposure is at a certain level. Note, that when closed it still lets in 50% of the sun. In reality the system would be manually controlled by the staff members, but it is estimated to give approximately the same effect.

After adding this shading device along with internal window blinds to the additional windows the amount of overheating hours (above 26 degrees) reaches an acceptable level and combined with the daylight situation is considered a sensible compromise. In regard to both daylight factor and thermal environment the window area could be further decreased, but this was not applied as it would compromise the view possibilities of the residents and disturb the coherence with the additional building based on the same window sizes.



Ill 5.4.1



Ill 5.4.2

Overheating	nr. 1	nr. 2	nr. 3	nr. 4
> 26	52	47	47	28
> 27	14	9	9	0

Ill 5.4.3

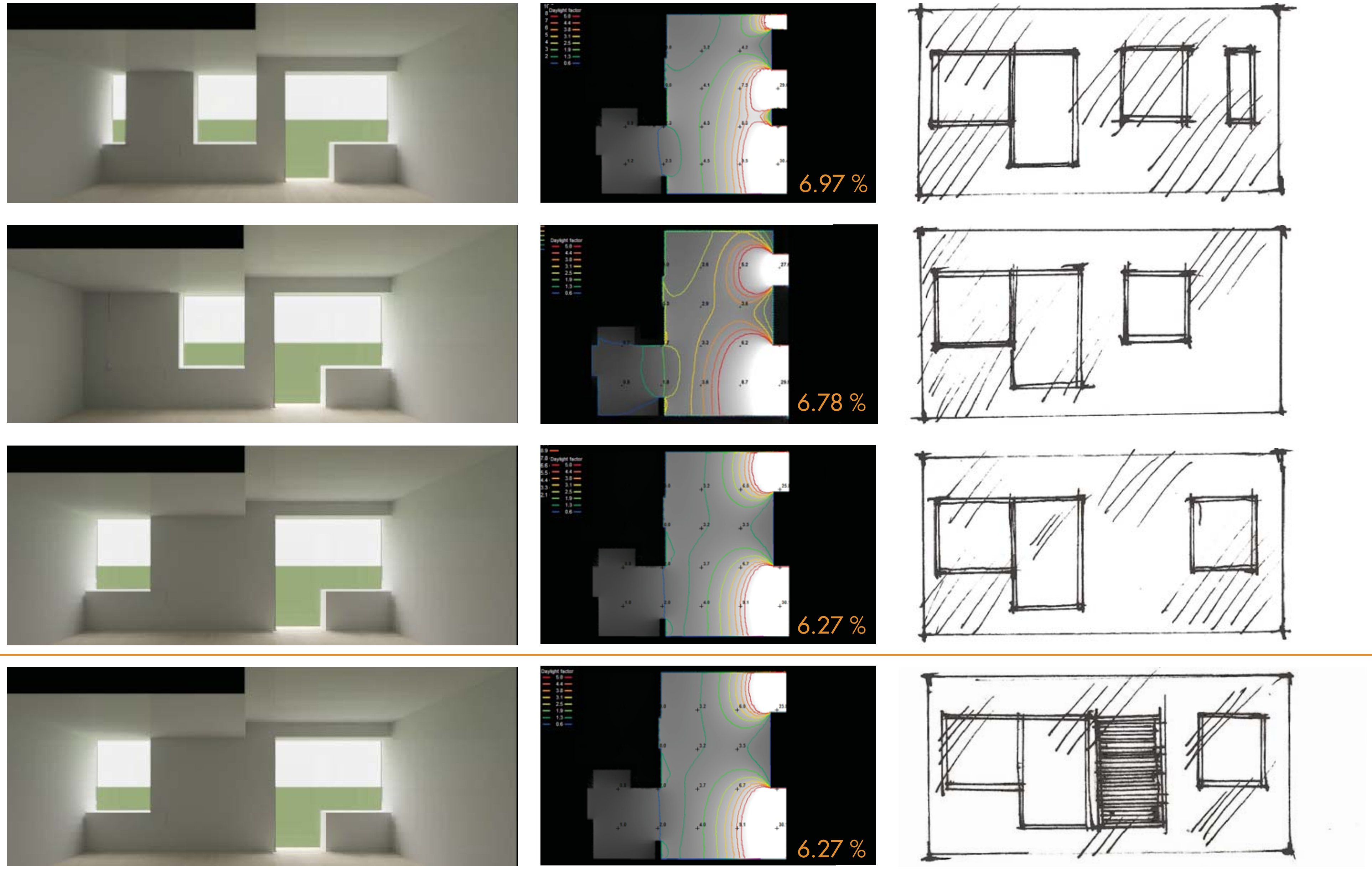
Luminance March 21st 12.00pm | Daylight Factor % | Elevation

Iteration 1

Iteration 2

Iteration 3a

Iteration 3b



Strategic Concept

The strategic concept emerged as a consequence of the beforegoing analysis.

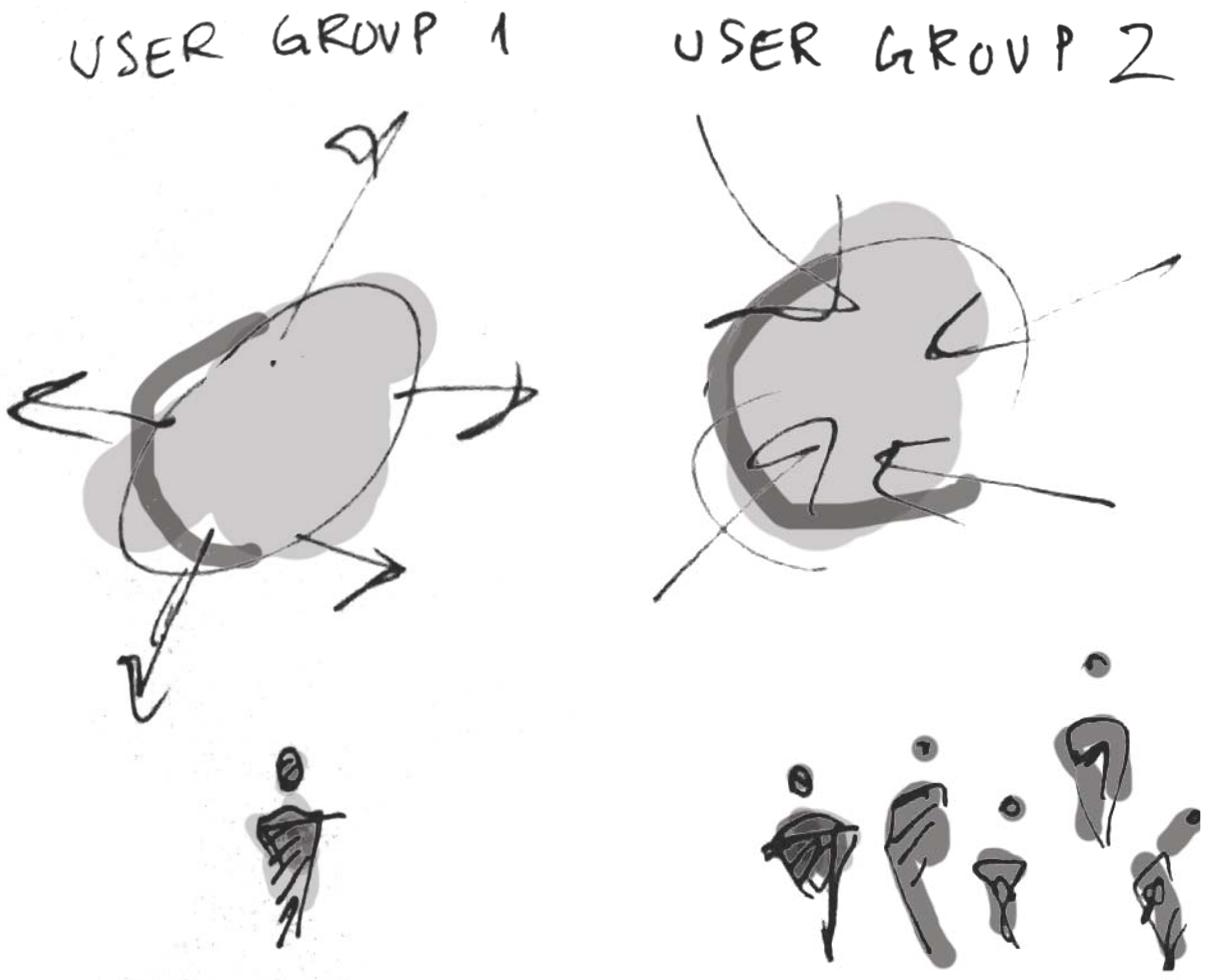
A central conclusion derived from the analysis is the fact that:

Cognitively healthy elderly and elderly suffering from dementia should live separately, according to their different needs

As mentioned in the analysis, demented residents do, as a consequence of their disease resulting in insecurity and fear of being alone, spend a great deal of their time in the common facilities. Cognitively healthy residents are more likely to spend time in their own apartment - the care-requiring elderly in particular.
To embrace these differences, the strategic concept is divided into two.

Demented residents benefit from a closed path, and arrangement of the homes around a continous flow - an inward-facing approach.

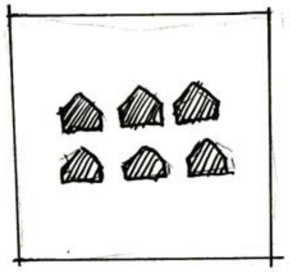
Cognitively healthy residents benefit from privacy and a view to the outside - an outward-facing approach.



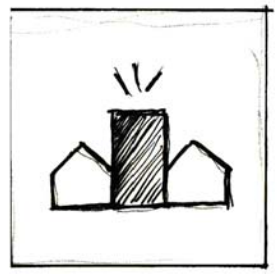
Ill 5.5.1 Strategic Concept

Concretization of Strategic Concept

According to the Room Book the building consists of 5 types of functions - the residential unit for user group 1, the two residential units for user group 2, center functions, administration and service functions. These 5 function types and their characteristcs are shortly recapitulated below.

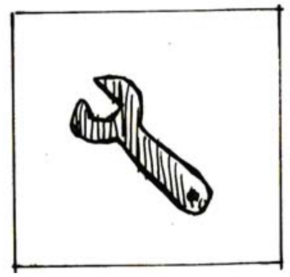


Ill. 5.5.2 Residential Units



Ill. 5.5.3 Center Functions

Ill. 5.5.4 Administration & staff



Ill. 5.5.5 Storage & service

Residential Units User Group 1

The analysis suggested each residential unit to include 12 people. Inviting 12 people to live in one unit and share common facilities enhances the chance of developing a good social environment.

The residential units should have a friendly and homely expression achieved through:

safety - privacy - traditional homely materials - deminition of the feeling of being in an institution

Residential Unit User Group 2

The residential unit suited for demented elderly includes 8-10 people, as people suffering from dementia require much assistance in order to function.

The residential unit should be simple and recognizable through:

safety - easy overview - traditional homely materials (recognizition) - closed paths - focus towards social facilities - an accessible garden for the senses

Center Functions

The center functions such as assembly hall, consultancy room and spa facilities should be placed centrally, so that both the visual and physical contact to these shared functions is kept as simple and short as possible.

The center functions should be clearly recognizable through:

material use - openness - central position

Administration & Staff

Administrative functions meaning offices and meeting rooms will be placed in close connection with the main entrance, making it easy for staff to receive visitors, enter and exit the building without disturbing the residents, and to keep an overview of the place.

Administrative functions should be placed:

centrally - with good overview, and peace to work

Storage, Service & Technical Rooms

These functions do not require much sunlight, and can therefore be placed on or under terrain.

Volume Studies

In order to achieve an understanding of the size of the building on the site, the areas set out for the entire building in accordance with the Room Book (p. 54-55), are tested visually while considering plot ratio on the site.

Site
Area: 4750 m2
Total Floor Area: ~ 3000 m2

A: **One Storey**
Plot Ratio: 63 %

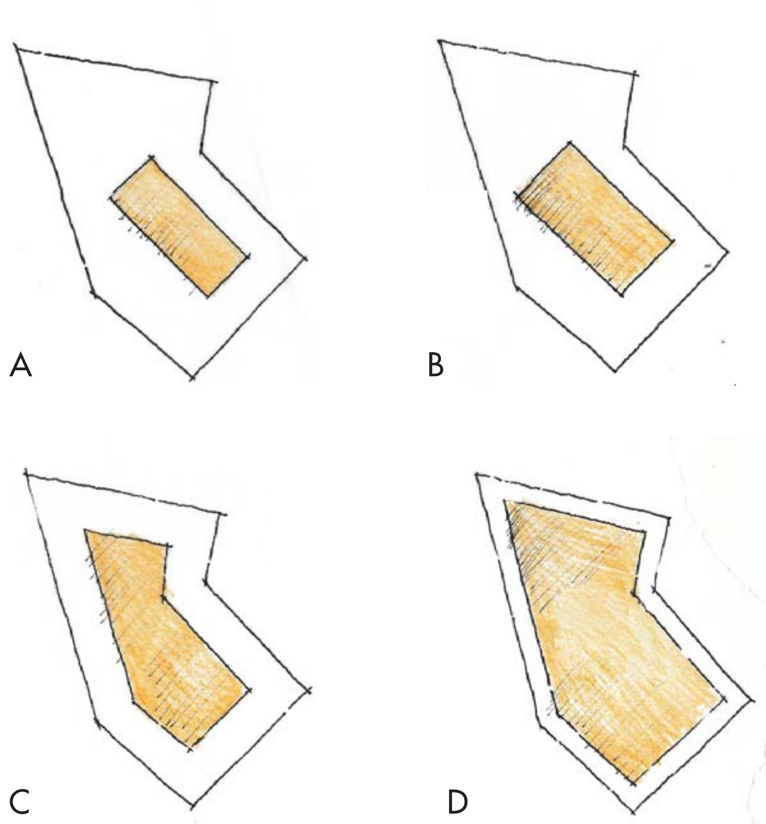
B: **Two Storeys**
Plot Ratio: 32 %

C: **Three Storeys**
Plot Ratio: 21 %

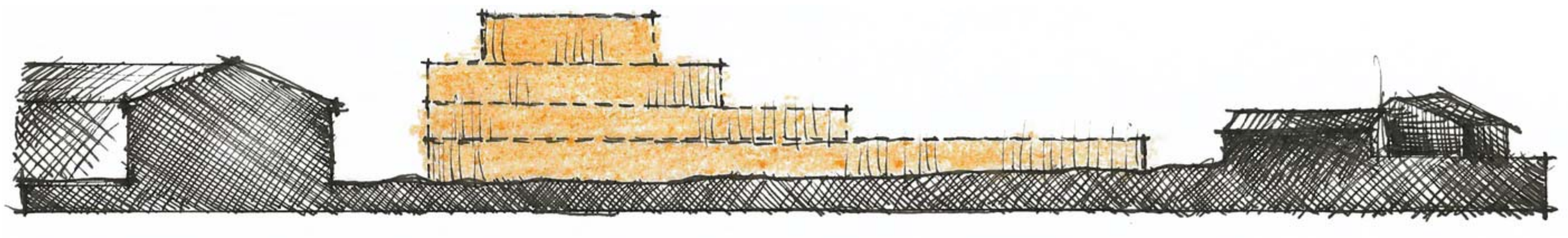
D: **Four Storeys**
Plot Ratio: 16 %

These volume studies clearly suggest that a one-storey building is unsuitable on the site. This would leave very little space for programming of outdoor spaces.

Ill. 5.6.1 illustrates the heights of the existing buildings adjacent to the site. On the south-eastern side of the building plot, a large area of single family-houses are situated. These are typically 1-2 stories high, while the building blocks on the north-western side are 3 stories high. To keep the building at a human scale and not exceed the surrounding buildings in height, this study concludes that the optimal number of storeys is one to three. Three storeys leave lots of space for treatment of the area around the building and will not exceed the height of the building blocks, while a single-storey building will relate scalewise to the single family houses.



Ill. 5.6.2


Ill. 5.6.1

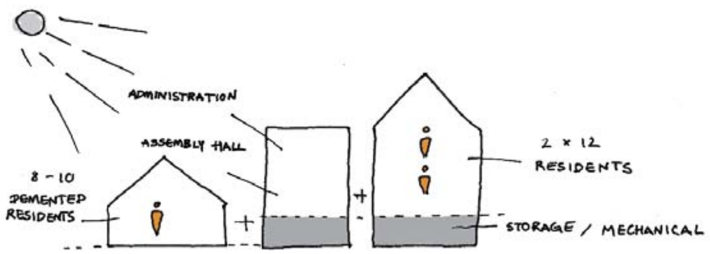
Distribution of Functions

Because the analysis showed that demented elderly have some very certain needs that are often neglected, and benefit from a closed path and a courtyard, this user group is placed on terrain and south to not be disturbed by shadows from other parts of the building.

In order to separate User Group 1 and User Group 2 - thus enhancing the well-being of both user groups, as the analysis suggested - User Group 2 is placed further north and in two storeys.

The two building sections for User Group 1 and User Group 2 accordingly, will be named
The center functions and administration facilities should serve both user groups and guests arriving through the main entrance, and is therefore placed in the middle between the two groups of residents.

The storage, service and technical rooms which do not require much daylight are placed underneath resident group A and the center functions. (see ill 5.6.3)

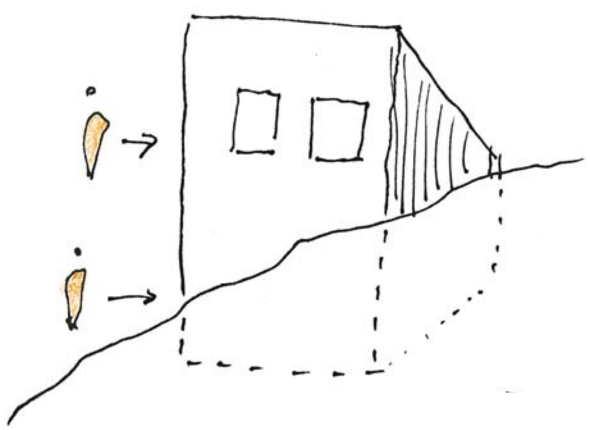


Ill 5.6.3 Distribution of functions

Response to Topography

Situated in an area with rocky, rough topography, it has been important to clarify how the building adresses the natural level differences at an early stage. Because it is a nursing home it is important to avoid level differences within the residential units. Steps and slopes in corridors and common areas would possibly create unwanted internal barriers and limit the residents' feeling of indepence.

In order to avoid level changes inside the building, and to incorporate the functions which do not require daylight, the building will be set upon an exposed basement (see ill 5.6.4). This decission will be further detailed later in the process.



Ill 5.6.4 Exposed basement. The building is inserted into the slope, and the basement is utilized. The layout creates no level differences inside the building.

Basic Organization

Through analyses based on model building, digital models, daylight studies and considerations regarding energy consumption, three basic organization principles for the residential units were further investigated.

The organization of the living units should obey the strategic concept for user group 1 as specified on p 66. This means the 24 apartments for cognitively healthy elderly are arranged with emphasis on privacy, while the apartments for demented elderly are arranged with their common area in the middle, and protected interior corridors in order to comply with their special needs for clarity and overview.

All models are assessed as regards daylight and flow, and with regard to the total surface area in order to ahieve a standard of comparison among the different variations.

Variation 1

Flow

The hallways inside the building section for user group 1 (BS 1) are arranged to minimize the feeling of living in an institution. Instead of being long and straight, the hallway is broken in two and shifted around a common center. Going to the common facilities could then be compared with 'going to the market' or a public square in a city.

Daylight

There are some areas of the corridors which lack daylight. The focus is very much on the middle section of the building, enhancing the focus on the common 'market place'. Nevertheless the corridor layout works against the strategic concept, as it is closed off to the surroundings and does not integrate the undeniable quality of daylight in corridors and views to the surroundings.

Variation 2

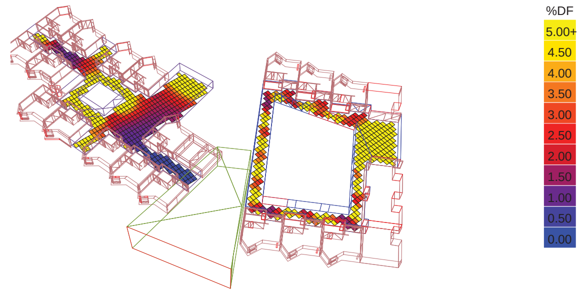
Flow

Understanding the lack of light in the hallways in variation 1, organization principle 2 is an investigation of the maximum potential of achieving good lighting conditions in corridors as well as apartments. In such the apartments are turned out into the light like flowers towards the sun.

Daylight

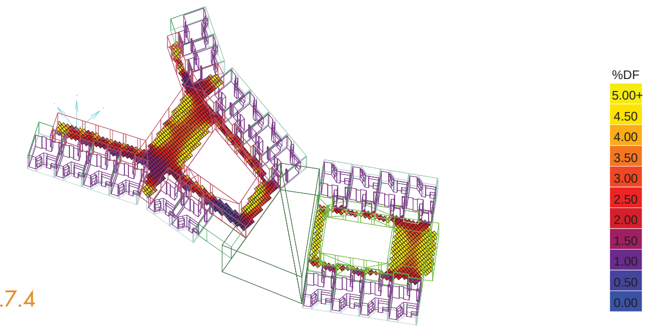
The building is well lit at all places due to the slim corridors lit up from both sides. Looking solely at the distribution of light, variation 2 performs very well. Nevertheless, the daylight's ability to create areas of less or more focus are not fully utilized. In such the light is not used for zoning the corridor as above.

Ill. 5.7.1



Ill. 5.7.2

Ill. 5.7.3



Ill. 5.7.4

Variation 3

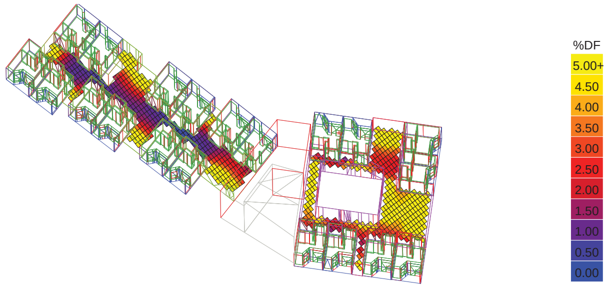
Flow

The apartments are grouped in clusters. The open breaks between the apartments create views to the surrounding nature. The common spaces are spread across the building volume, the corridors are activated and included in the flow as desitinations. In such the corridor is broken up and may appear less institutional.

Daylight

Variation 3, as a consequence of the clustered apartments, includes an idea of zoning with daylight. The ecotect analysis model shows how emphasis is put on the centrally placed 'market place', while the common voids between the apartments drag light into the corridors in smaller quantities and loosens the feeling of institutionalism linked with long, straight, artificially lit transit corridors.

Ill. 5.7.6



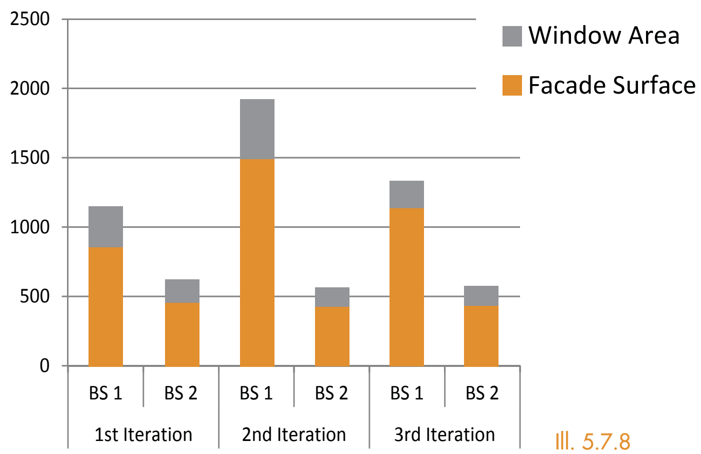
Ill. 5.7.7

Surface Area

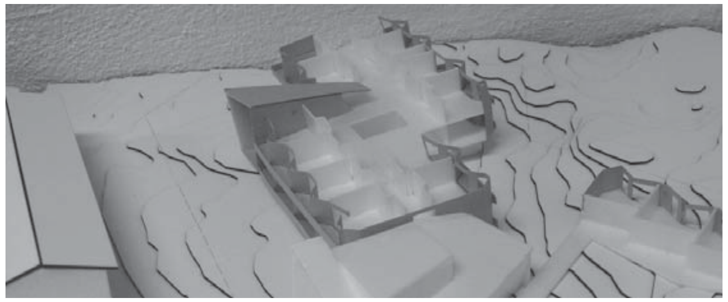
Out of consideration to the expected energy performance of the building, the three investigations are compared as regards surface and window area.

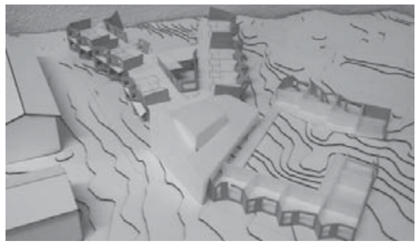
Variation 1 is the clearly most compact, while variation 2, as expected, has a much bigger surface area.

Variation 3 arrives in between variation 1 and 2.



Ill. 5.7.8





Ill. 5.7.5

Conclusion

Concluding on these first basic investigations of building volumes suited to the site, it appears that variation 3 has the most potentials. Wanting to get away from dark and straight corridors, and wanting the achieve daylight and views from several sides, the arrangement of apartments in variation 3 appears beneficial. Out of these investigations came also the idea for the architectural concept presented on the following page.

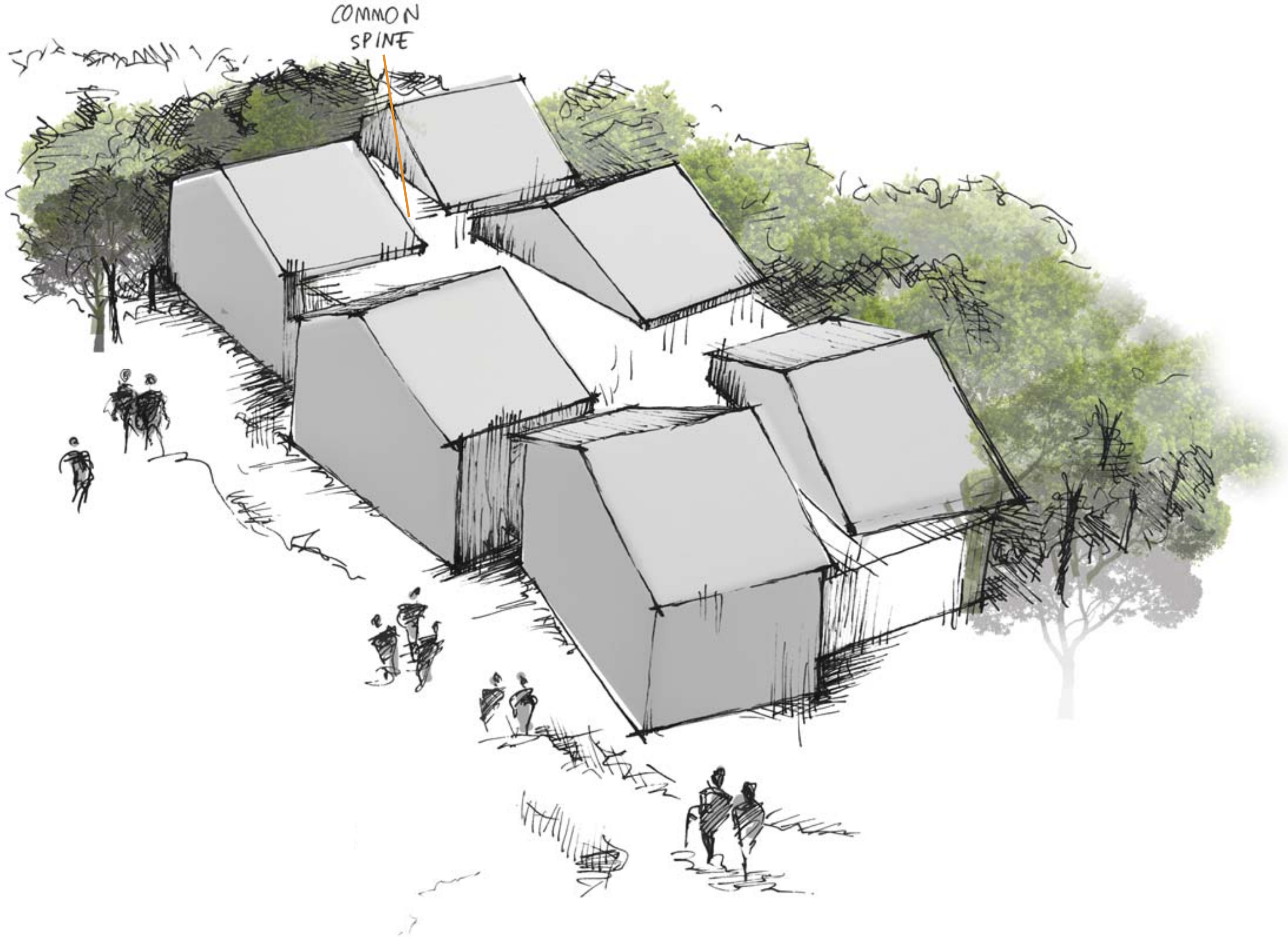
Architectural Concept

The architectural concept emerges from the word home and the Swedish arche type for home - the wooden house (ill. 5.8.1). By using traditional facade materials and scale so that the appearance of a group of apartments stand out in the facade they manifest the function of the building that is: many homes.

The common functions are like the spine of the building. The common spine is necessary for the homes to function, but it does not take over the spirit of the home.

Because the homes are pushed into the spine, every home has a view away from the center, and no homes face each other.

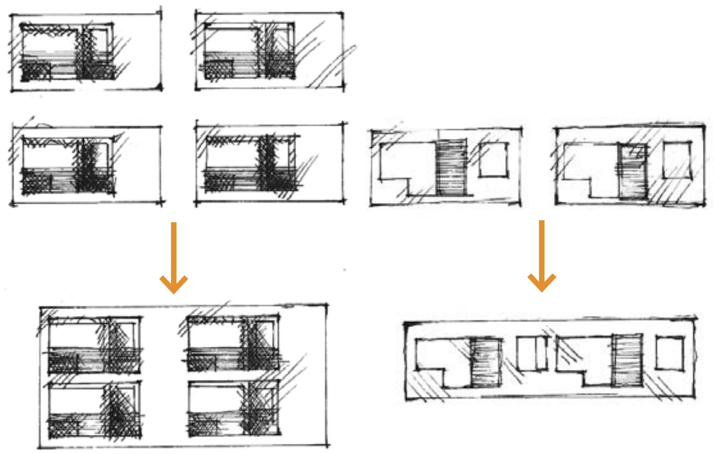
Ill. 5.8.1



Ill. 5.8.2 Architectural Concept

Concretization

As a consequence of the architectural concept the apartments will be clustered 2 and 2 and 4 and 4 for demented and cognitively healthy residents accordingly (see ill. 5.9.1). The introduction of this decission builds upon the idea of the common market place derived from model study 1 and the treatment of daylight in corridors found in model study 3, and led to the initial organization shown on ill. 5.9.2. The organization plan was assessed using Ecotect Analysis.



Ill 5.9.1 Apartment clustering

Flow and Daylight in Corridors

The internal hallways are connected to the outside by niches shaped by voids between the apartment clusters. In this way the surrounding nature is present at all times, while the small niches created allow for resting tired legs or having a coffee with relatives.

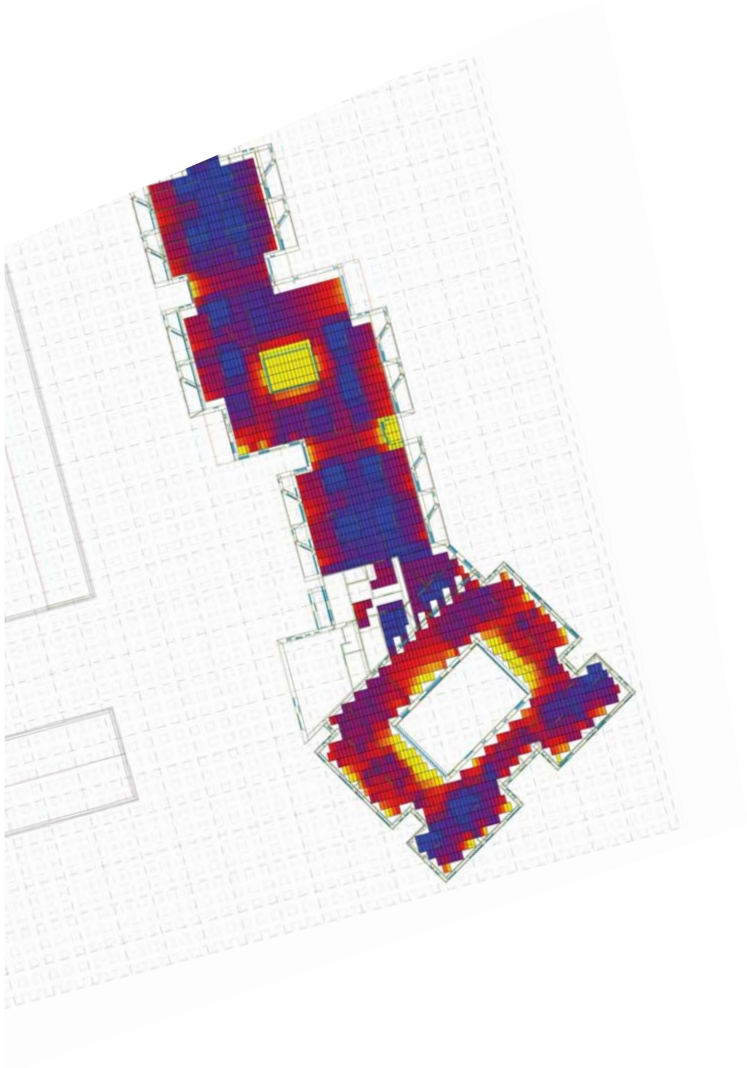
According to the strategic concept the dement section focuses inwards towards the common facilities, while the second building section is rather compact, obeying privacy and outlook.

Daylight Factor Analysis

It appears from the diagram ill. 5.9.4 that BS 2 for demented elderly has a very equal distribution of light around the courtyard. This is desirable, as it accentuates the continous path, and thus communicates the internal flow in the building, minimizing the risk for demented residents to get lost.

The light distribution in BS 1 is focused around the common functions in the middle, but with light entering through the seating niches along the hallway. The hierarchy in the daylight distribution provides the cognitively healthy elderly with freedom to choose their desired degree of socializing at any time.

Ill. 5.9.2 Building layout



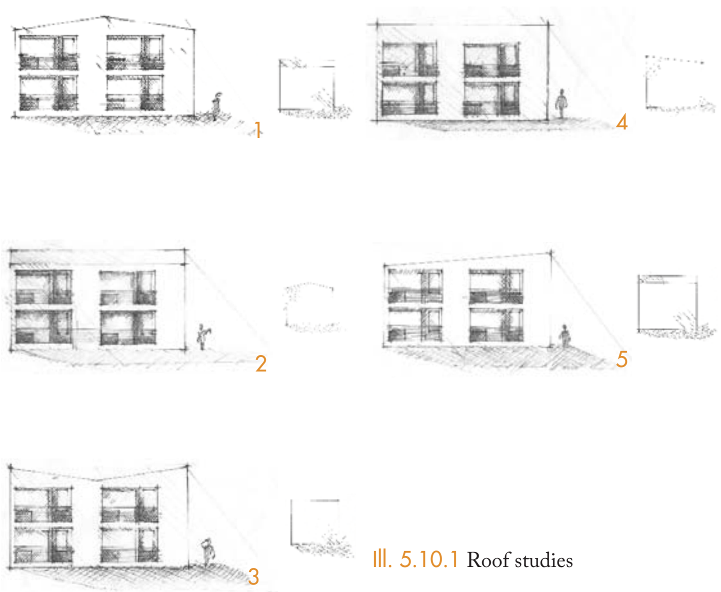
Ill. 5.9.4 Ecotect Analysis

Design Process

Roofs

This section aims at defining the appearance of the roofs on the private apartment units. This determination is based upon a visual investigation of a selection of different possibilities.

Out of the sketches ill. 5.10.1, varation 4 is chosen. The appearance in elevation is undisturbing to the assymetry of the facade expression, which is based on the apartment plans developed on p. 60-65.
The roof tilt accentuates the direction outwards towards the surroundings, and can be successfully utilized in the apartment section, see p. 61.



Ill. 5.10.1 Roof studies

Organization

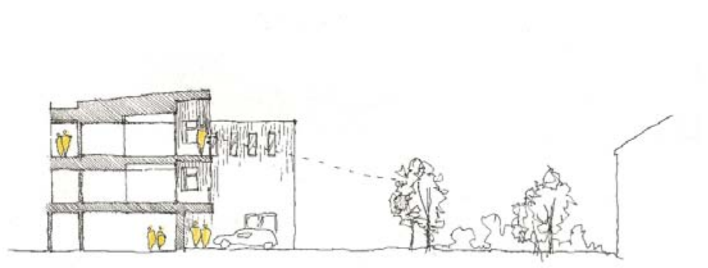
After having decided upon an architectural concept and developed the main organization (re chapter Concretization) a further processing of the floor plans took place.

Careful consideration was given the interrelationship between functions and an overall functional transparency supporting the flow in the building. Regarding functional transparency the aim was to create an easily recognizable environment as it will become familiar at a faster pace, which is an important precondition regarding both homeliness and a safe environment.
Consequently, the main entrance is situated on the ground floor welcoming residents and visitors. From the entrance the flow passes the assembly hall and leads to the first floor where common center functions are placed (spa, kiosk, waiting zone, etc.). Note that by passing the assembly hall its existence becomes noticed by both residents and visitors encouraging participation in ongoing activities. From the center functions the flows spread out leading to each of the three residential units housed by the nursing home complex. It also features a direct access to an outdoor terrace.

As mentioned earlier in the design process emphasis was put on separation of demented and cognitively healthy residents. This decission was implemented rather literally by placing the cognitively healthy residents on one side of the center functions and the demented residents on the other.

Besides from the main entrance the ground floor is utilized for staff, storage and service functions. This provides optimal conditions for goods delivery, access to the private storage rooms, etc. In an unheated part of the ground floor a garbage room and 3 parking lots are situated.
Note that one of the parking lots is dimensioned to fit a minibus. Five additional parking lots are situated between the main entrance and a personnel entrance withdrawn in the west facade. The parking lots comply with Danish recommendations regarding parking areas. It was discussed whether the parking area would reduce the view quality of the above living residents. It was thus evaluated, that this would not be the case as the parking lots do not lie within the field of view of a person looking out the window (see ill 5.11.1).

Last but not least an administration area is situated above the center functions including a staff break room (incl. kitchen), offices, a meeting room, print/copy and staff restroom. The gathering of these functions was directly derived from the casestudy (re chapter Casestudy: Birkebo), where the staff strongly expressed a lack of attention to these function.



Ill. 5.11.1 View from apartment.

Ill. 5.11.2 Perspective, entrance

2nd Floor
1 Residential unit
Administration

1st Floor
2 Residential units
(one for demented residents)
Center functions

Ground Floor
Main entrance
Assembly hall
Staff facilities
Storage & service
Parking

Ill 5.11.3 Exploded axonometry

6. DETAILING

Ill. 6.0

Detailing

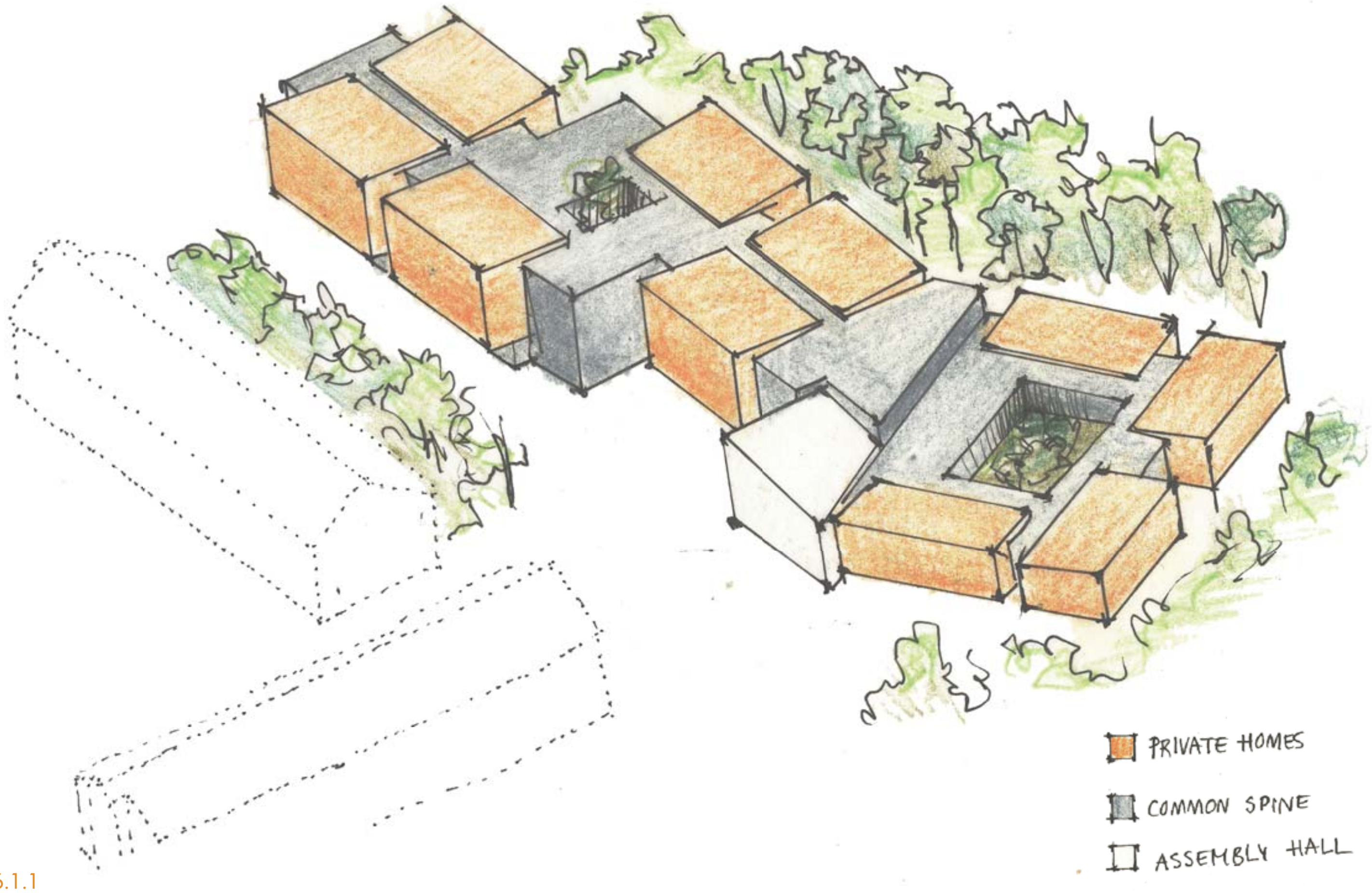
Materials

The following pages will describe the process of choosing and detailing external materials for the three types of functions - private homes, common spine and the assembly hall. This text shortly lists the aimed material expression for each function.

Private Homes
True to the architectural concept the homes should wake reminescence and recognition. The facades should refer to the Swedish archetype of a detached private home, while it should also relate to the nature-dominated surroundings. Based on these preconditions, wood is a natural choice.

Common Spine
The common spine contains all the common and supporting functions which make the nursing home work. The common spine should express earthbound heaviness and stand in contrast to the private homes. With this at aim, a selection of heavy materials will be assessed.

The Assembly Hall
The assembly hall is shared among all residents, and can also be integrated in the local society. It is centrally placed and should be an easily recognizable landmark. A further discussion of materials will be presented.



Ill. 6.1.1

Wood Types for Facades

Building with wood has a long tradition. Through hundreds of years, skillful craftsmanship and industrial treatment methods have resulted in various ways to conserve the living material and make it perform as external façade material.

With the various types of wood and ways of construction come endless possibilities aesthetically and functionally. The following text dives into the properties of different local wood types and cladding methods with the aim of choosing an appropriate combination for the façade of the private apartments.

Facades of wood associate to Swedish traditional home building (see ill. 6.2.1). Consequently the wooden house supports the aspects of homeliness, human scale and reminiscence, which the architectural concept (p. 72) builds upon. To enhance the residential character of the building, each pair of two private apartments is cladded with wood.
The building is situated in a little piece of forest, consisting of both conifer and leaf-bearing trees. In such, using local wood for the dominating exterior expression contributes to the impression of a site-specific and sustainable architecture.

Wood used on the exterior of a building requires special precautions as to how the timber type reacts on the impacts of the microclimate.

Constructive wood protection must be considered if to avoid extensive industrial treatment of the wood. Constructive wood protection means the construction must account for a list of protective measures which to the widest possible extend prevents the wood from general tearing due to exposure to wind, sun and rain.

Importantly:

- Water should be led away from the construction - from cut ends in particular
- Any upward facing surface must be slanted
- The heartwood side of panels should be turned towards the surface
- Overhangs are beneficial

As wood is a living material, it will change radically over time. In such a facade set up in fresh wood will soon be influenced by the weather. Different types of wood naturally age diffently, and this is a point to consider. Wood's natural patina, on the other hand, is exactly what manifests the living character of the material and mirrors the passage of time.

In order to choose an appropriate wooden cladding, three points are taken into account – wood type, surface treatment, and tiling system.
The wood type and cladding principles have been investigated through analyses of a number of different properties including appearance, durability and patina.

Ill. 6.2.1

Ill. 6.2.2

Detailing

Selected Wood Type
The wood type found most appropriate to use as facade material due to its durability, appearance over time and occurrence in Europe is larchwood. An investigation of selected wood types can be found in Appendix 2.

Larchwood is a regularly used wood type for facades - in particular when the facade is exposed to the weather, as larch contains much heartwood (resulting in its high density) and liberates natural self-protecting minerals. Larchwood patinates to a silver-grey color. A condition to consider when working with larchwood is the mentioned tendency to twist and crack. (vot.teknologisk.dk 24.04.2012)
These challenges must be treated in the detailing and construction of the wooden facade.

Cladding Principles
This chapter aims at determining the cladding principle for the facade. Four cladding principles have been investigated according to their architectural abilities.

The determined cladding principle is laths mounted 'one-on-two'. The cladding method is easy to apply, and laths can be easily exchanged if necessary.
The cladding principle can be applied both horizontally and vertically, and the appearance can be easily modifed by varying the width of the laths.

Weatherboards

directional shadow effects and a sense of depth

easy exchange of lowest board in case of fungus attacks

moderate variability according to width of boards

Ill. 6.2.3

One - on - two

variable according to width of boards

strong directional shadow effects and a sense of depth (the gap between boards should be at least 10-20 mm)

easy montage

Ill. 6.2.4

Tongue-and-Groove

surfaces appear smooth

easy montage

Ill. 6.2.5

Open Wooden Laths

strong directional shadow effects

open structure

the facade appears layered - depth

Ill. 6.2.6

Ill. 6.2.7

Patina

Ill. 6.2.8 shows a series of investigations on the direction of the slats and plates using larch appearing 'untreated'.

The investigations show different combinations of directions of slats.

The building design entails that some surfaces are more exposed to the weather than others. In such it is important to consider how the appearance of the building will develop over time.

The chosen combination - ill. D - is vertical wooden slats and a horizontal cladding of the balcony, both made of larchwood.

The vertical appearance of the main body of the unit underlines and supports the verticality of the slender trees in the surroundings, striving towards the sky.

The vertical slats inside the balcony follow the different viewline - namely the horizontal view reaching from the apartments towards the surrounding nature as an extension of the room. Horizontal slats also mark the transition between the larchwood on the facades which is exposed to the weather and will turn grey in short time, and the covered larchwood inside the balcony which is protected and will keep its fresh color longer.

Ill. 6.2.8 1st Iteration - Large Surfaces

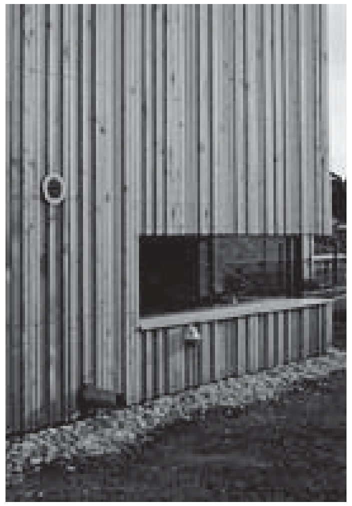
Ill. 6.2.9 2nd Iteration - Balcony Cladding

Materials

Facade Detailing

The determined cladding – vertical slats out of larchwood – opens for a 3rd iteration with the aim of determining the closer detailing of the facade.

The before mentioned verticality referring to the trees surrounding the building is kept, but due to the 'large' scale of the cladded sections, the repetitive character of a usual vertical two-on-one cladding can become monotonuos. Because the private homes should stand out and be lively, and because the surrounding nature is of a rather wild non-repetitive character, the facade expression is detailed in the direction of 'controlled coincidence'.



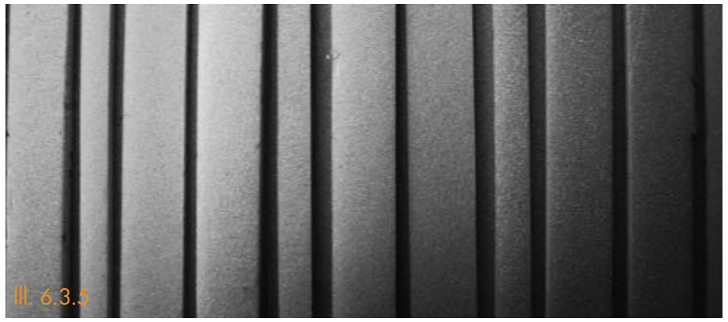
Ill. 6.3.1 Hertl. Architekten

Ill. 6.3.2 C.F. Møller Arkitekter

Ill. 6.3.3 Forest

Ill. 6.3.4

System 1



Ill. 6.3.5

System 2

Ill. 6.3.6

System 3

Inspired by the woods and inspired by the two residential projects (ill. 6.3.1 and 6.3.2), system 3 comprises variation both in width and depth between the larchwood slats.

Detailing

Horizontal Joints
After having determined the facade material for the private homes, there is some detailing left to do. This chapter concerns the open connections among the vertical slats in the facade material.

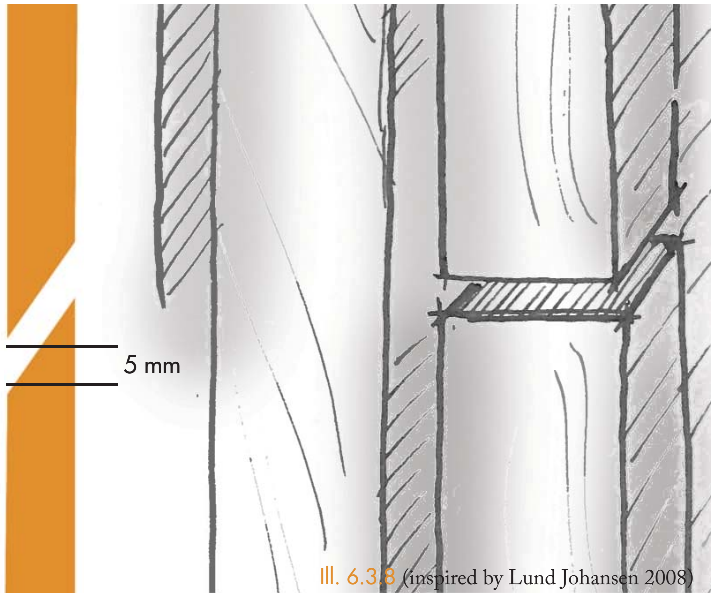
Because wood is a natural material it does not come in any size. In some areas of the facade the slats need to span a distance of up to 6 metres. In such, there should be some internal division of the slats.
There are various ways to define these joints. Ill. 6.3.7 shows some different variations. These variations are based on slats of 3000 mm length.

Variation 1
The joints are placed directly against each other, meaning the surface will appear 'divided'. In such the joints affect the appearance of the facades so much as to be an ornamentation in itself.

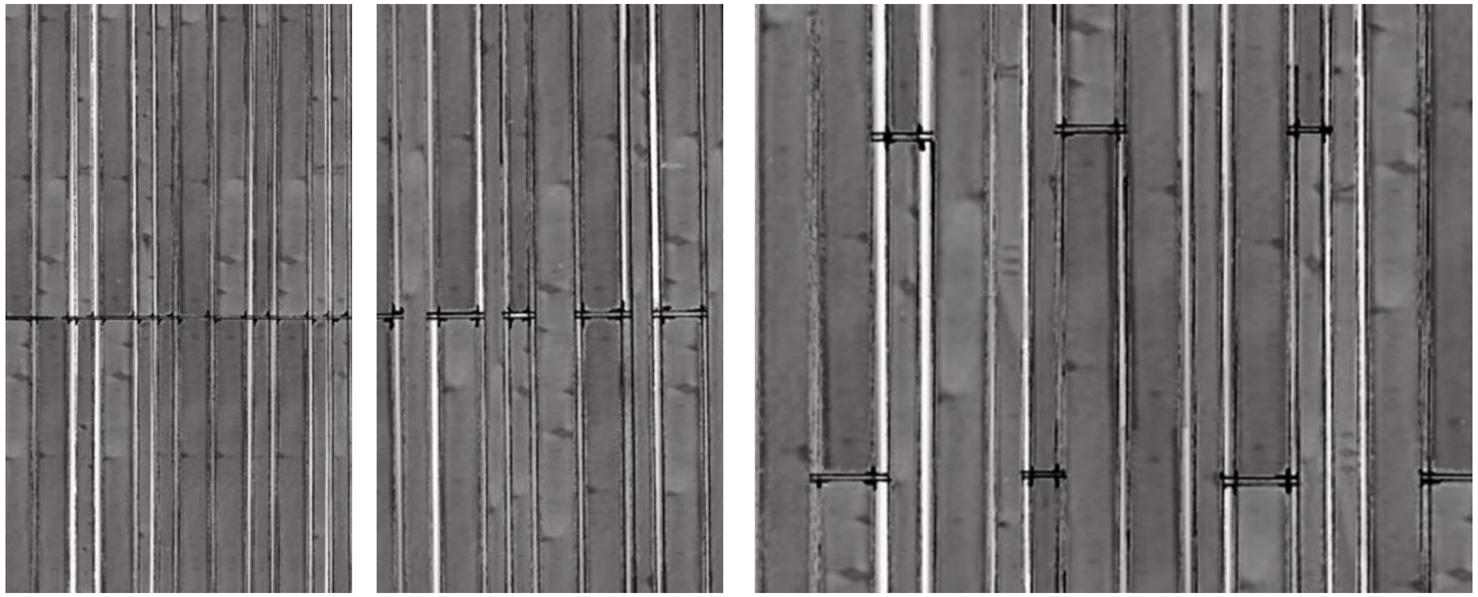
Variation 2
Every second lath is shifted 1500 mm. In such the powerful appearance of the joints right next to each other is weakened. A horizontal division of the surface is still readable, and will appear twice as many times compared to the above.

Variation 3
The laths are shifted 750 mm accordingly. The impression of a horizontal divison of the surface is further weakened, as the joints are distributed across the surface.
In support of the vertical appearance of the facade, and the reference to the surroundings, variation 3 is chosen.

Ill. 6.3.8 shows one joint in section and perspective. The oblique cut makes the water drip off the structure, preventing moist damage of the slaths.



Ill. 6.3.8 (inspired by Lund Johansen 2008)

Ill. 6.3.7


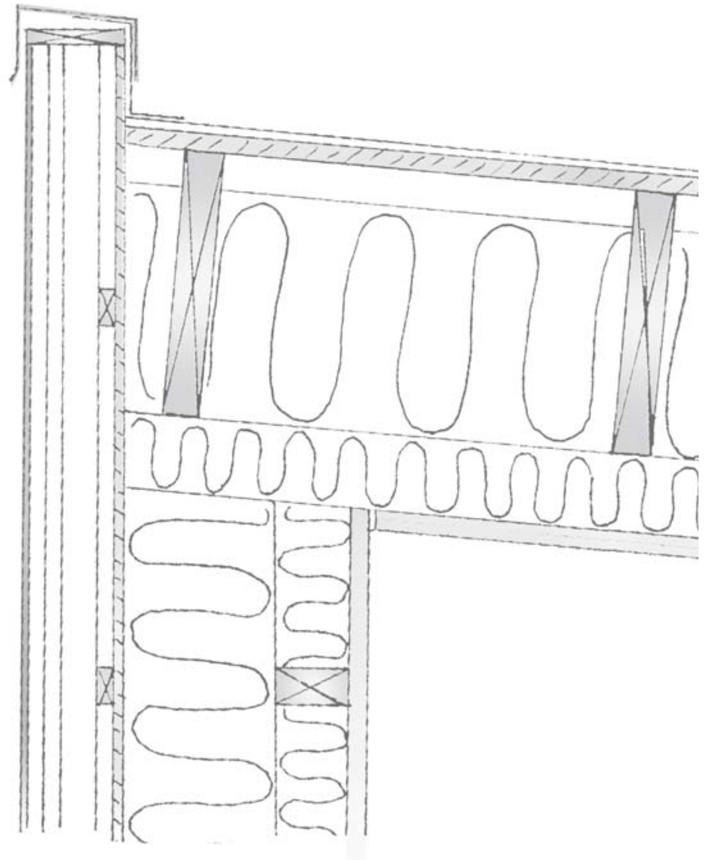
Detailing

Zinc Flashing
In regard to the previously mentioned manners of constructional wood preservation, this chapter specifies how the roof meets the wooden facade. In order to protect the larchwood as well as possible where the vulnerable wood ends are exposed and upward-facing, the edge where wood meets the roofing material should be a slender and precise line.

This slender covering will be made out of zinc. Zinc is appropriate for flashing as it is durable, easy to process and a common occuring material. The silver appearance of zinc appears in a matte grey tone, and seems natural in combination with the silver-grey patina of the larchwood facade, see ill 6.3.9 and 6.3.10.

Ill 6.3.9 SKARAA Architects, Buholmen (NO)

Ill 6.3.10 Daniel Libeskind, Osnabrück (D)



Ill 6.3.11 Detail of flashing 1:10

Detailing

Facades Common Spine

This chapter aims at defining the facade material for the common spine.

According to the architectural concept the common spine is a heavy, earthbound structure supporting the warmer, small scale private homes, which are attached to it like cones on a branch.
Thus the three materials picked out for investigation are heavy materials with a horizontal appearance - dark bricks, dark grey concrete and horizontal zinc cladding.

The three investigations are showed to the right and will be assessed below.

Ill. 6.4.1 Bricks Petersen D-55 with dark joints

The appearance of the facade achieves the horizontality aimed at. The bricks have a heavy, strong and earthbound appearance. Nevertheless the natural complexity of the brickwork seems to coincide with the corresponding complexity of the wooden facades of the private homes.

Ill. 6.4.2 Dark Concrete Smooth from Cast

The appearance of the facade is heavy and strong. The horizontality is less exposed compared with bricks as above. The tactility of smooth concrete is friendly to touch, though less addressing than the bricks. The complexity of the surface is almost absent, and thus gives room for the complexity of the wooden facade pieces.

Ill. 6.4.6 Horizontal Zinc Cladding

The zinc cladding works well with the patinated appearance of larchwood. Nevertheless zinc appears lighter compared with the two other materials tested. There will be a natural complexity to the surface which is dependent on the size of the metal sheets.
Zinc has visible joints, which may once again be too complex on the building.

Concluding on the above listed investigations, the determined facade material is dark grey concrete. The heaviness, smoothness and anonymousity of the material works in support of the architectural concept.

Ill. 6.4.1 Brick

Ill. 6.4.2 Concrete

Ill. 6.4.3 Zinc

Ill. 6.4.4 Facade with brickwork

Ill. 6.4.5 Facade with dark concrete

Ill. 6.4.6 Facade with zinc panels

Detailing

Facades Center Functions

The assembly hall is attached to the common spine beside the entrance. It is a shared function for the entire nursing home, and could be used at occassions for the general residents of the area as well.

This chapter aims at defining the material used for the assembly hall. In order to keep some sort of consistency with the rest of the building, only two materials already used otherwhere, are treated - larchwood and zinc.

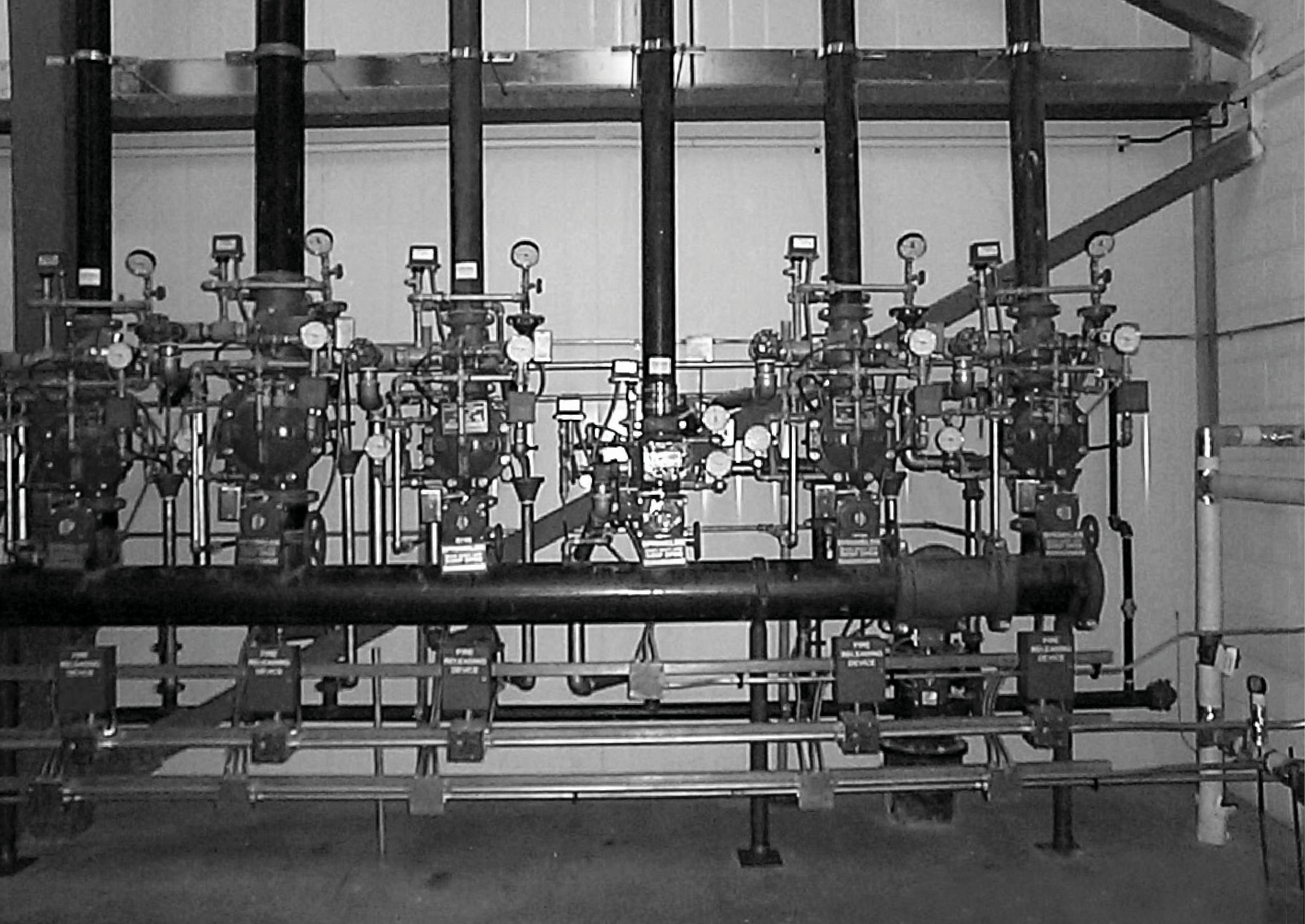
Larchwood
The vertical direction of the larchwood supports the upward-striving appearance of the assembly hall well. It relates to the surrounding nature, but may interfere with the matching facades of the homes.

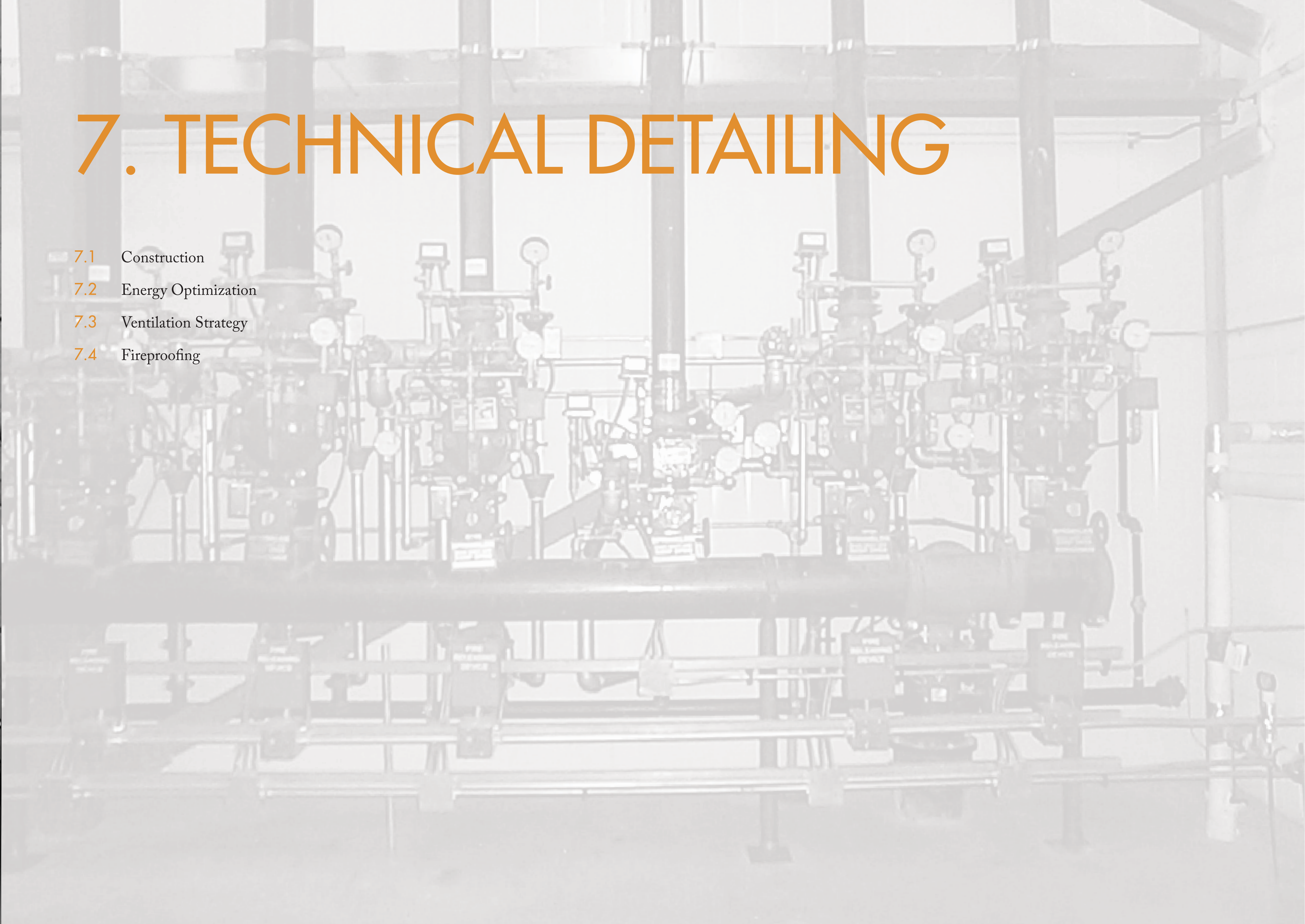
Zinc
Vertical zinc panels naturally support the verticality of the facade well, and can be easily fitted in various widths. Zinc matches the roofing edges of the homes, but is otherwise not used for facades. Therefore the zinc cladding gives the assembly hall its very own expression.

Not to interfere with the general architectural concept, the assembly hall should not be confused with the appearance of the dwellings.

Ill. 6.5.1 Vertical larch slats, untreated

Ill. 6.5.2 Vertically mounted zinc panels





7. TECHNICAL DETAILING

Construction

This section aims to clarify the construction of the nursing home complex. As the building is rather complex, attention will be given to selected aspects of the construction with varying degrees of detailing. This include the building type, load bearing principle and main building elements.

Building Type

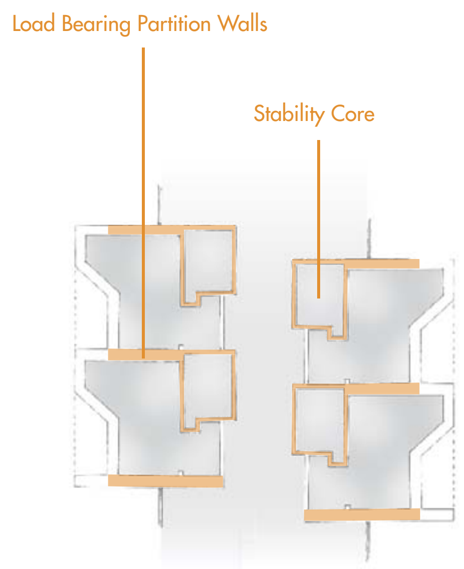
The chosen building type for the nursing home is a combination of heavy deck partitions and heavy double walls. This choice was made based on considerations regarding both the bearing construction and acoustic properties as special attention must be given the sound insulation in dwellings. In nursing homes the sound insulation links directly to the sense of privacy and therefore also to the aspect of well-being. In addition some demented residents tend to produce a great amount of unwanted noise (shouting, screaming, etc.) which is important to isolate from the additional residents, who might be greatly disturbed otherwise. Choosing to design a building with heavy internal walls is considered appropriate as they can carry the load while providing a good sound insulation. In regard to other aspects, heavy internal walls are considered beneficial too, as they have a high degree of fire-resistance and can accumulate heat and thus enhance the quality of the thermal environment.

Load Bearing Principle

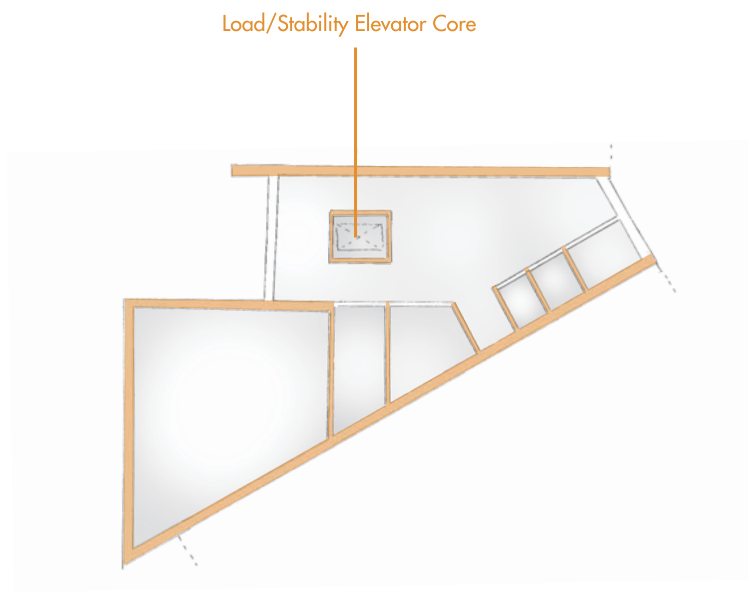
Due to the fact that the nursing home houses small individual dwelling units it was natural to select the partition walls between the dwelling units as the main load bearing elements and secure the stability by means of through-going cores (see ill.7.1.1).

For the building section housing the centre functions the same principle of combining load bearing walls with a stability core was applied. Thus the elevator functions as both bearing and stability core while the two main perimeter walls carry the load together with transverse partitions (see ill. 7.1.2).

As the building layout evolved throughout the design process, an internal light-shaft was introduced along with a relatively wide span across the building. To solve this structurally, the load-bearing partition walls were assisted by additional load-bearing cores containing staff-related functions. Illustration 7.1.3 shows the final load-bearing principle of the nursing home complex.



Ill. 7.1.1 Load Bearing Principle, dwellings



Ill. 7.1.2 Load Bearing Principle, center functions

Ill. 7.1.3 Overview of load bearing elements

Main Building Elements

The Danish Building Regulation divides the acoustic environment in dwellings into categories and for each category follows a set of demands regarding the airborne sound insulation (Rw), the impact noise level (Ln,v) and the reverberation time. Note that the reverberation time will not be further treated.

In regard to this project a category C standard is chosen corresponding to 75 - 80% being satisfied with the acoustic environment. Hence, this means that the following demands have to be met:

Airborne Sound Insulation, Rw

1. Between a dwelling or a common living area and a room with large noise levels Rw ≥ 60 dB
2. Between a dwelling and a room outside the dwelling, including other dwellings Rw ≥ 55 dB
3. Door between dwelling and common area Rw ≥ 32 dB

Impact Noise Level, Ln,v

1. Between living areas within a dwelling, kitchens or common living areas and a room with large noise pollution Ln,v ≤ 48 dB
2. Between a dwelling and a room outside the dwelling, including another dwelling Ln,v ≤ 53 dB
3. Between common living areas Ln,v ≤ 58 dB

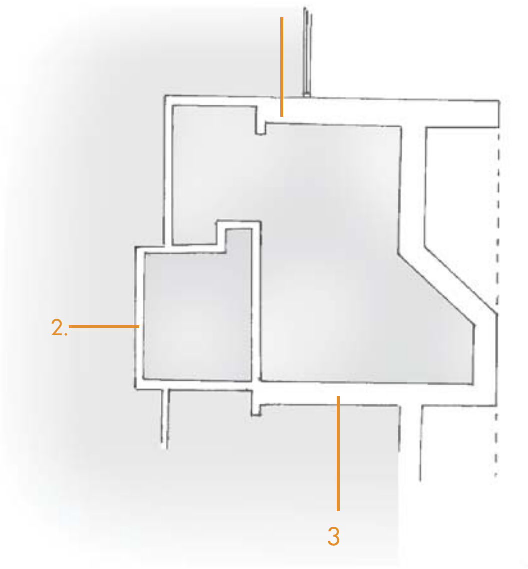
Reverberation Time

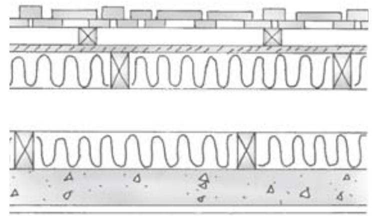
1. Reverberation time in nursing home hallways (SBI-Anvisning 237) ≤ 0.9 s

To meet the demands put forward a set of building elements have been drawn based on construction refereces from betonportal.dk, guiden.rockwool.dk and SBI-Anvisning 237.

In such the airborne sound insulation and impact noise level of the presented elements are estimated.

Illustration 7.1.4 shows the building elements concerning the airborne sound insulation while illustration 7.1.5 shows the deck partitions and a detail of the joint between a bearing partition wall and the deck partition. Hence, this joint is estimated to be the most essential joint in regard to impact noise level.



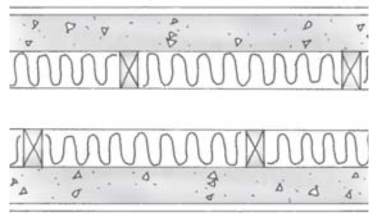


1. Wall Load, Internal
d: 55.5 cm, Rw≥55 dB

Description	[mm]
Wood Cladding	50
48x48 Batten	48
Concrete	100
Insulation	75
Air Gap	85
Insulation	75
Concrete	100
Wall Lining	22

2. Internal Wall, Core,
d: 18.0 cm, Rw≥55 dB

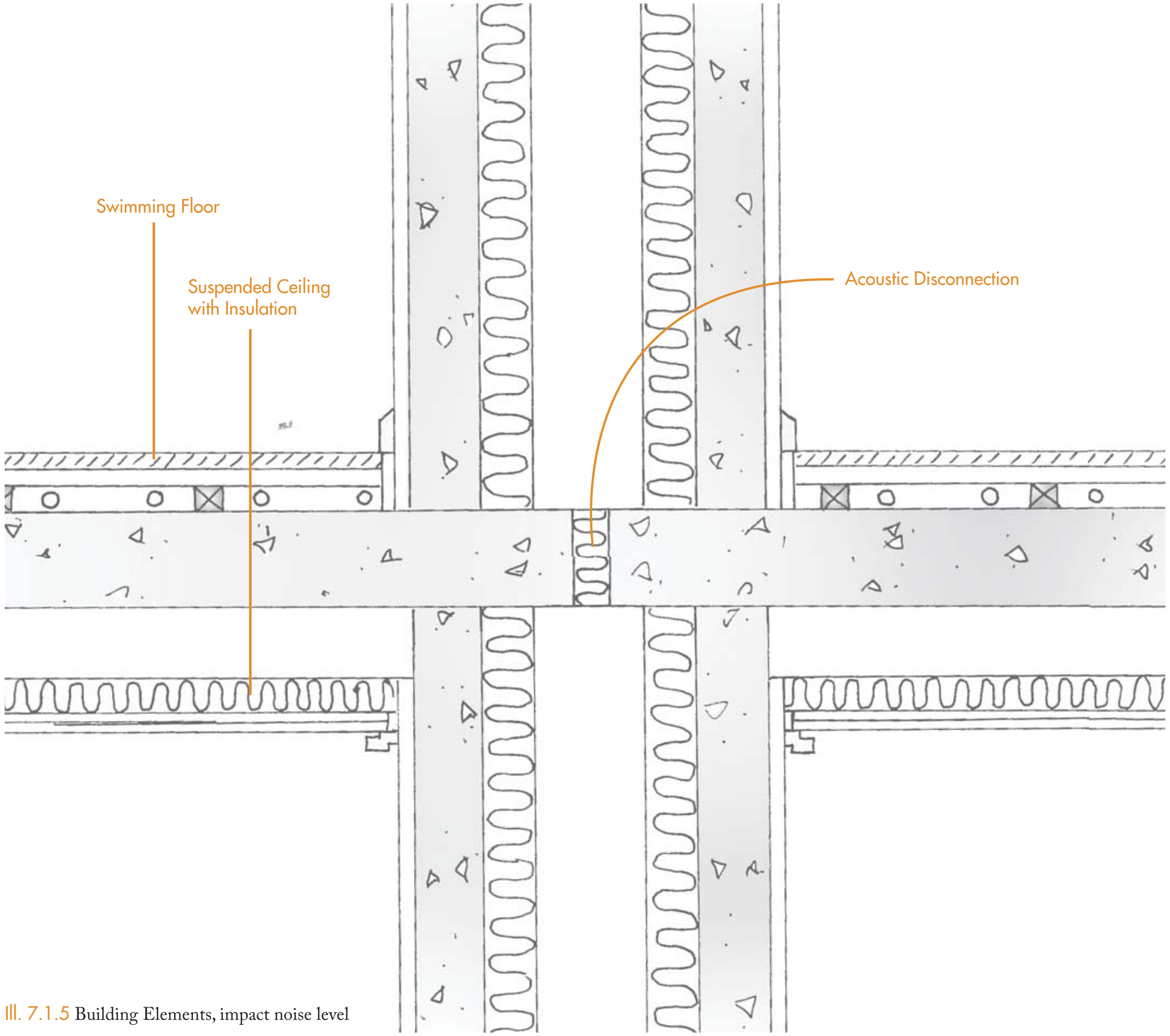
Description	[mm]
Concrete	180

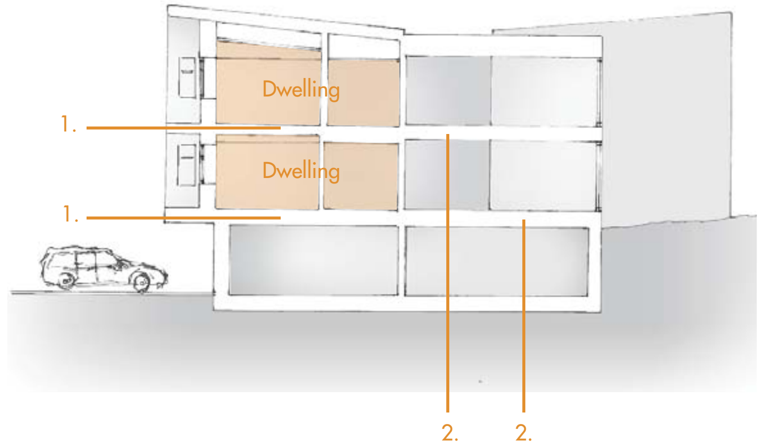


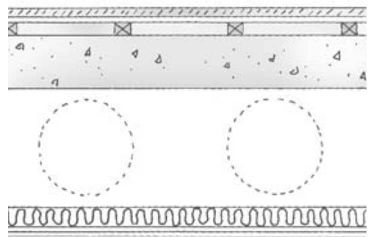
3. Wall Load, Dwelling Partition
d: 55.5 cm, Rw≥55 dB

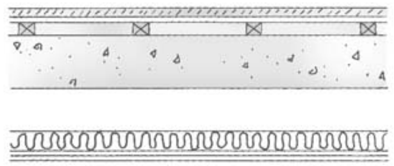
Description	[mm]
Wall Lining	22
Concrete	100
Insulation	75
Air Gap	161
Insulation	75
Concrete	100
Wall Lining	22

Ill. 7.1.4 Building Elements, airborne sound insulation









Ill. 7.1.5 Building Elements, impact noise level

1. Partition Deck, Common Area,
d: 60.0 cm, Ln,v≤58 dB

Description	[mm]
Flooring	22
Sound Insulation Plate	15
Floor Heat Plate/	35
35x40 Joist /20 mm Heat Pipes	-
Radon and Moist Barrier	-
Reinforced Concrete	140
Suspended Ceiling	312
Insulation	50
/48x48 Batten C-C600	
2x13 Plaster Board	26

2.Partition Deck, Dwellings,
d: 40.0 cm, Ln,v≤53 dB

Description	[mm]
Flooring	22
Sound Insulation Plate	15
Floor Heat Plate/	35
35x40 Joist /20 mm Heat Pipes	-
Radon and Moist Barrier	-
Reinforced Concrete	140
Suspended Ceiling	112
Insulation	50
/48x48 Batten C-C600	
2x13 Plaster Board	26

In regard to thermal insulation the Danish Building Regulation sets up demands as well. These are naturally integrated in the design of the building elements and a comparison of the chosen building elements and the design criteria from the Danish Building Regulations can be seen below:

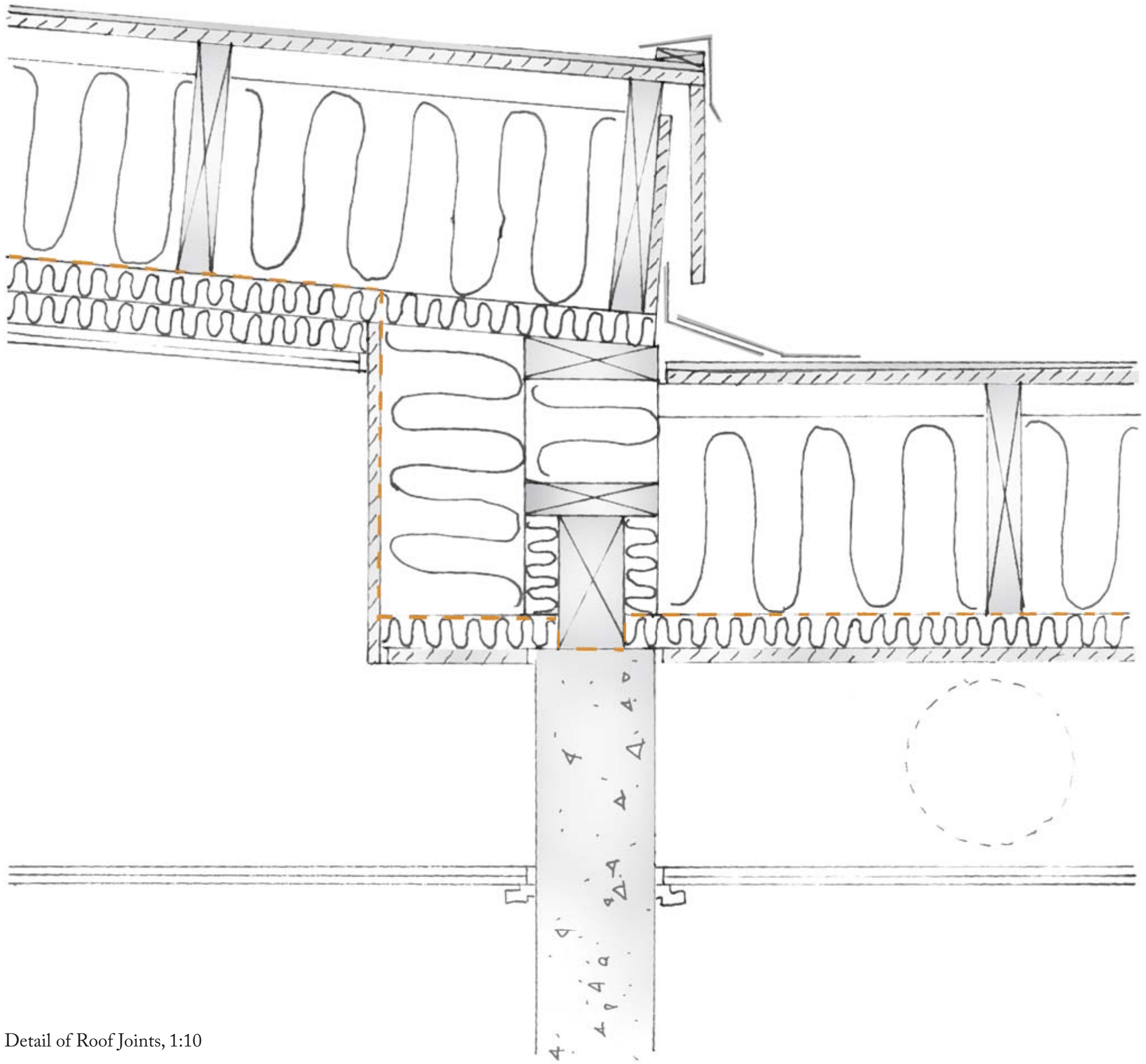
Comparison of Transmission Coefficients, [W/(m2K)]

	Project	BR10
External Walls	0.11-0.12	≤ 0.15
Deck Partitions	0.10	≤ 0.10
Roof Construction	0.08-0.10	≤ 0.10
Windows	0.85	≤ 1.40

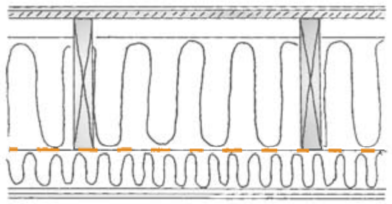
Note, that the presented U-values are calculated using a spreadsheet in the PHPP.

Illustration 7.1.6 shows the joint between the roof of the dwellings and the roof of the common area while illustration 7.1.7 presents the drawn building elementes concerning the thermal envelope of the building.

Note that work done in both Bsim and Be10 are based on the constructions presented in this chapter.

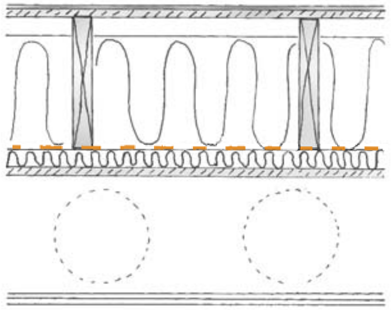


Ill. 7.1.6 Detail of Roof Joints, 1:10



1. Roof, Dwelling,
d: 50.8 cm, U-value: 0.08 W/(m2K)

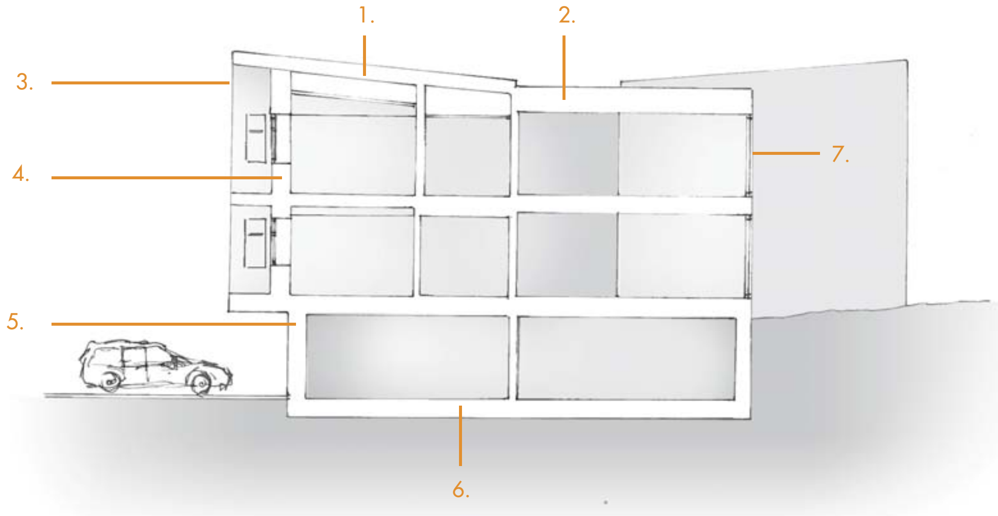
Description	λ [W/(mK)]	[mm]
2xRoof Coating (Asphalt)	-	10
Coverboard	0.13	22
50x350 Rafter	0.13	350
/300 Insulation	0.034	
Moist Barrier	-	-
Insulation	0.034	100
/48x98 Batten C-C600	0.13	
2x13 Plaster Board	0.88	26

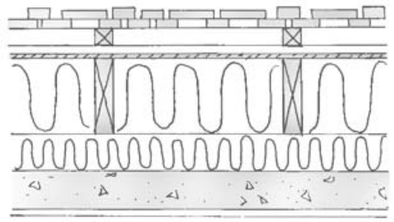


2. Roof, Common Area
d: 77.0 cm, U-value: 0.10 W/(m2K)

Description	λ [W/(mK)]	[mm]
2xRoof Coating (Asphalt)	-	10
Coverboard	0.13	22
50x350 Rafter	0.13	350
/300 Insulation	0.034	
Moist Barrier	-	-
Insulation	0.034	50
/48x48 Batten C-C600	0.13	
Suspended Ceiling		312
2x13 Plaster Board	0.88	26

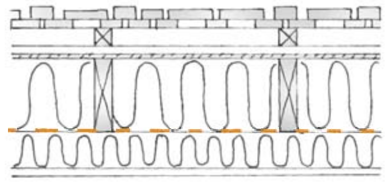
Ill. 7.1.7 Building Elements, thermal insulation





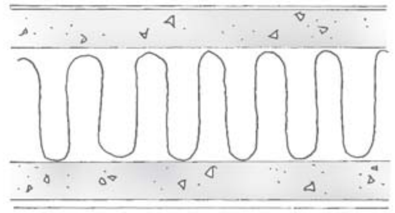
3. External Wall, Load
d: 55.5 cm, U-value: 0.12 W/(m2K)

Description	λ [W/(mK)]	[mm]
Wood Cladding	0.13	50
48x48 Batten	0.13	48
23x48 Batten	0.13	23
Wind Barrier	-	-
Board	0.13	12
Insulation	0.034	200
/48x198 Stud C-C600	0.13	
Insulation	0.034	100
/48x098 Stud C-C600	0.13	
Concrete	2.3	100
Wall Lining	0.88	22



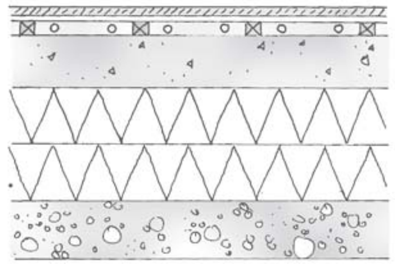
4. External Wall, Light
d: 45.5 cm, U-value: 0.12 W/(m2K)

Description	λ [W/(mK)]	[mm]
Wood Cladding	0.13	50
48x48 Batten	0.13	48
23x48 Batten	0.13	23
Wind Barrier	-	-
Board	0.13	12
Insulation	0.034	200
/48x198 Stud C-C600	0.13	
Moist Barrier	-	-
Insulation	0.034	100
/98x48 Stud C-C600	0.13	
Wall Lining	0.88	22



5. External Wall, Common Area
d: 53.2 cm, U-value: 0.11 W/(m2K)

Description	λ [W/(mK)]	[mm]
Wall Rendering	-	10
Concrete	2.3	100
Insulation	0.034	300
Concrete	2.3	100
Wall Lining	0.88	22



6. Ground Deck
d: 66.2 cm, U-value: 0.1 W/(m2K)

Description	λ [W/(mK)]	[mm]
Flooring	0.13	22
Sound Insulation Plate	0.04	15
Floor Heat Plate/	-	35
35x40 Joist /20 mm Heat Pipes	-	-
Reinforced Concrete	2.3	140
Rigid Insulation	0.034	300
Granular Capillary Break	-	150

7. Windows
U-value: 0.85 W/(m2K)

Energy Optimization

This section aims to clarify the energy considerations being incorporated into the project throughout the design process in order to attain a building design capable of satisfying the Danish Energy Frame for low Energy Buildings 2015.

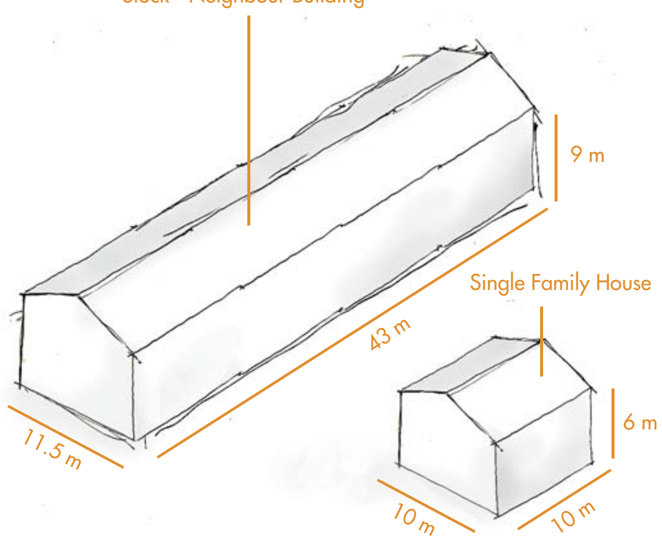
Initial Considerations

Due to the large range of design parameters dictated by the evidence based design considerations, the common guidelines for low energy buildings - usually prescribing a high-insulated compact building orientated towards south - could not easily be followed without compromises. The well-being of the residents was highly prioritized resulting in a predetermined east-west orientation and rather jagged facades. Comparing the building envelope to a standard single family house and a standard building block (the neighbour building) the compactness was considered decent (see ill. 7.2.1. and 7.2.3).

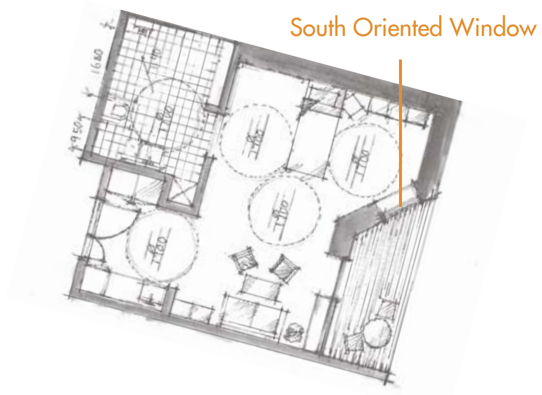
Given the predetermined east-west orientation, focus was given to the positioning and sizing of the window area, aiming to minimize northerly windows while optimizing the daylight access to reduce the energy consumption for artificial light. A specific initiative worth mentioning was the integration of southerly windows situated in the slated walls of apartment type A.

Not only do they add value to the visual quality of the rooms and provide sunlight from a second angle, they also enable a surplus of passive solar heat from south (see ill. 7.2.2).

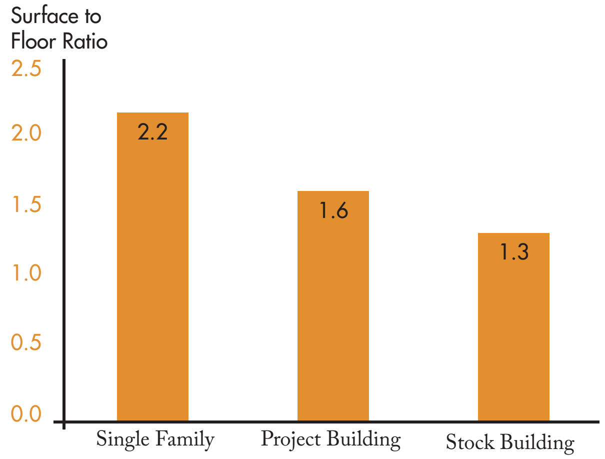
Introducing active energy initiatives was included in the initial considerations, along with including a mechanical ventilation system with heat recovery, a heat pump and solar cells on the roof top of the center functions. The mechanical ventilation system is discussed in the following chapter (Ventilation Strategy) while the solar cells are further discussed on the next page in connection with the energy optimization iterations.



Ill. 7.2.1 References Typologies



Ill. 7.2.2 Comparison, surface to floor ratio



Ill. 7.2.3 Comparison, surface to floor ratio

Building Type	Width [m]	Length [m]	Height [m]	Surface Area [m²]	Floor Area [m²]	Surface to Floor Area -
Single Family	10	10	6	440	200	2.2
Stock Bulding	11.5	43	9	1970	1484	1.3
Project Building	-	-	-	6450	3956	1.6

Energy Optimization Iterations

After having determined the overall building shape and the enclosed functions, windows were added to the common spine accounting for iteration a1 - Initial Design (see ill. 7.2.5).

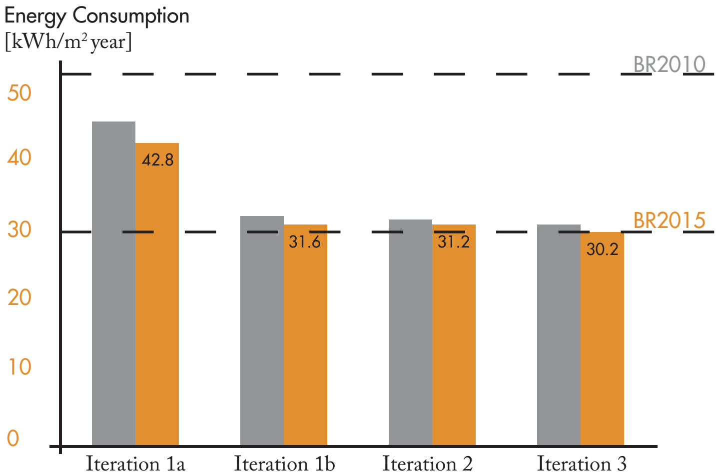
Note that the windows in the private dwelling were considered fixed in regard to energy optimization as they were earlier optimized according to their indoor climate and daylight penetration (re chapters Daylight Studies in Apartment Type A and Daylight Studies in Apartment Type B). The niches between the dwelling clusters were considered fixed as well due to their essential role of delivering light to the otherwise dark hallway.

In iteration 1b a heat pump was added along with solar cells covering the assembly hall (68m² - 10 degrees) and the center functions (146m²- 5 degrees) to estimate the reduce in energy demand. Note that solar cells are not placed on the shadowed area of the assembly hall due to its reduced sun exposure. (see ill. 7.2.6). In addition, the roof areas were subtracted 12 and 9 m² respectively to estimate the actual panel area.

This iteration turned out not to be sufficient. Consequently, the window area of the living room facing west was reduced (from 23 to 10 m²) as the view in the east orientated common room was considered of higher visual quality (iteration 2). As this was still not sufficient in regard to BR2015 and it was decided not to add additional solar cells, a critical view went to the courtyard in the demented building section. Initially, the courtyard walls were designed to be all glass, but due to considerations regarding energy consumption and indoor climate, the glass areas towards north and towards south-east were reduced by 20 and 23 m² respectively.

The latter was primarily due to the risk of overheating the common room during summer.

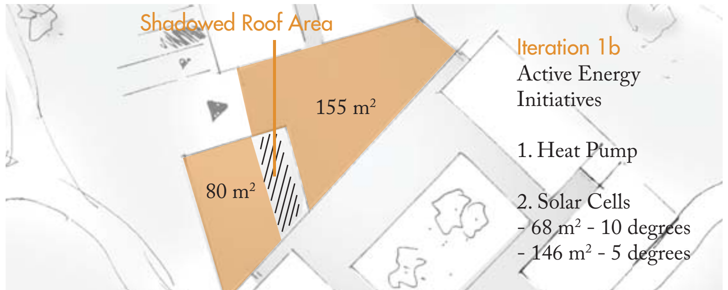
These initiatives represent iteration 3, which according to the energy calculations fulfils the energy frame for low energy buildings 2015. It should be mentioned, that the energy calculations are to be regarded as estimations, as they are somewhat simplified to lighten the work extend and further based on general assumptions to compensate for unknown data input. Hence, guidance is found in SBI-Anvisning 213 offering a thorough summary of BE10 and the input data associated.



Ill. 7.2.4 Energy Iterations

Be10 Iterations [kWh/m² Year]	BR2010	BR2015
	≤52.9	≤30.3
1a Iteration 1 - Initial Design	46.0	42.8
1b Active Energy Initiatives (Heat Pump + Solar Cells)	32.6	31.6
2 Reduced Window Area in Living Room (West)	32.2	31.2
3 Reduced Window Area in Courtyard Walls	31.2	30.2

Ill. 7.2.5 Sketch of Energy Iterations



Ill. 7.2.6 Positioning of Solar Cells

Ventilation Strategy

The ventilation strategy for the nursing home complex is based upon seasonal considerations inducing mechanical ventilation during the heating period and support by natural ventilation during summer (May-August) in order to eliminate overheating. The mechanical ventilation serves the purpose of securing a good indoor air quality while keeping the heat loss from ventilation to a minimum by utilizing heat recovery.

Air Quality Design Criteria

The first thing to consider when discussing ventilation of a building is the desired air quality. CR1752 defines 3 different categories of perceived air quality corresponding to 15, 20 and 30 percent dissatisfied - category A, B and C respectively. It was initially decided that the private dwelling units of the nursing home should fulfill a category A standard due to the excessive hours a day spend inside by many elderly in nursing homes.

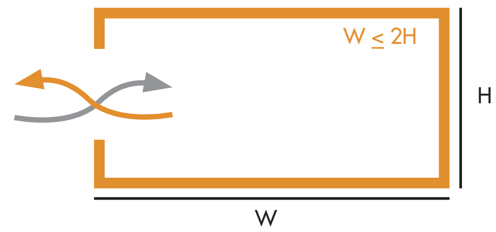
Initial Design Considerations

From the beginning of the project considerations regarding the ventilation strategy were processed. At an early stage the decision of introducting both mechanical and natural ventilation was made. This triggered design discussions regarding both natural and mechanical ventilation.
Regarding natural ventilation, it was established that the principle had to be one-sided as cross ventilation would compromise the privacy of the residents in regard to noise nuisances. A rule of thumb states that the width to height ratio must be less than or equal to 2 for single-sided ventilation (see ill. 7.3.1) and 2.5 for double opening ventilation (see ill. 7.3.2). This was considered a design criterion for the initial design phase corresponding very well to similar considerations regarding daylight penetration.

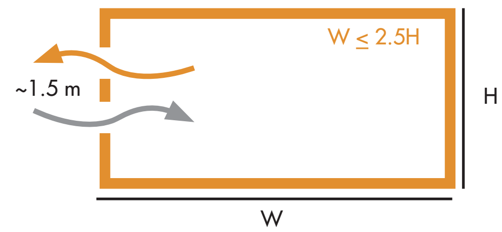
Regarding mechanical ventilation, design discussions involved the placement of exhaust zones near each other and on top of each other. Thus it was decided to place the apartments of the different levels directly on top of each other. This was not solemnly due to ventilation considerations, but rather a part of an integrated design decision, owing to both the load-bearing principle of the building and the architectural expression. The question of a central or several decentralized ventilation aggregates was discussed for the private dwelling units. The advantage of a centralized aggregate is that it is simpler to both control and manage. On the other hand it requires larger duct dimensions along with more space in general. If decentralized aggregates were installed there would still have to be a central aggregate servicing the common spaces and center functions. Resultantly, the decision was made to install only one central aggregate, servicing the whole building complex. It should however be designed with individualized fan control for each dwelling to meet the different needs of the residents.
The organization of the building was further discussed in regard to symmetry and the possibility for creating relatively straight logical ventilation routes securing low pressure losses and an economic operation.

Dimensioning of Air Quantities

An equation for comfort ventilation presented in CR1752 was used to calculate the corresponding required air flow rate for the two private dwelling types of the project occupying the demented and the cognitively healthy residents (see appendix 3 - Ventilation). Additional calculations were preformed for



Ill. 7.3.1 Single-sided ventilation (Heiselberg Lecture Note)



Ill. 7.3.2 Single-sided ventilation, two openings (Heiselberg Lecture Note)

category B and C as well in order to compare the calculation results. As the required ventilation rate for category A showed to be 44% higher than category B it was decided to limit the category A standard to the private dwelling units in order to confine the excessive energy consumption of the ventilation system and thus prescribe category B to the rest of the nursing home complex. Note, from previously that category B corresponds to 20% of the occupants being dissatisfied with the air quality. Consequently, the total basic air flow rate was calculated to 1591 l/s ≈ 5728 m^3/h (see appendix 3 - Ventilation).

Ventilation Aggregate

In order to estimate the space requirements for the technical room and the necessary technical data for energy calculations it was necessary to determine the ventilation aggregate. The calculation of basic air flow rate prescribed previously enabled an estimate of the required ventilation capacity of the ventilation aggregate which further allowed for a qualified guess regarding the selection of aggregate. The chosen aggregate was Exhausto VEX 270 (see Ill. 7.3.5).

As the basic air flow rate was calculated to 5728m^3/h and the chosen aggregate has a capacity of maximum 7600m^3/h, it allows for a peak performance approximately 30% higher than the calculated basic air flow rate, which seems appropriate.

As a rule of thumb the technical room must be twice the length of the aggregate and 2.5 times the width of the aggregate in order to allow for maintenance and service. In such the dimensions of the technical rooms must be at least 3.8 m x 4.1 m. Regarding the positioning of the technical room it should be located near the borders of the envelope, minimizing unnecessary heat losses.

Sketching the Ventilation Principle

Illustration 7.3.6 on the next spread shows a sketch of the duct system concentrating on the air transfer while leaving out further detailing of components (duct types, silencers, filters, fire dampers, heat plates etc.).

Calculations of duct type diameters and pressure losses are left out too, as they are not considered necessary for the overall development of the design proposal. As an exception a rough estimate of the dimension of the most burdened distribution duct is performed as it greatly influences the storey partition height, where the ventilation ducts are going to be positioned inside suspended ceilings.

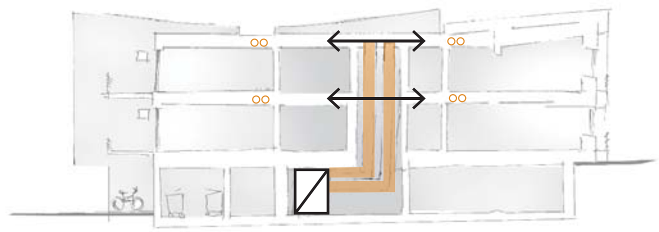
This position makes the ventilation ducts easily accessible for service and the suspended ceiling can further be utilized for additional service piping. In the calculation of the duct dimension the air speed was estimated to 6m/s and the most burdened distribution duct is approximated to deliver air corresponding to ten private units of around 25 l/s (total:0.25 m^3/s). This leads to a duct diameter of 250 mm as:

$q = v·A$ and $A = π·r2$ -> $r = \sqrt{(q/v·π)}$, where:

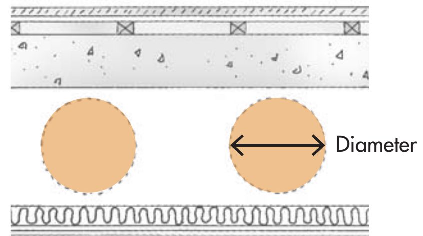
q: Flow Rate [m^3/s]
v: Speed of Air [m/s]
A: Duct Area[m^2]
r: Duct Radius[m]

$r = \sqrt{(q/v·π)} = \sqrt{((0.25 m^3/s)/(6 m/s·π))} = \underline{0.115\ m}$
-> diameter of 0.230 m

The closest standard diameter is: 250 mm.



Ill. 7.3.3 Ventilation Shaft, sketch



Ill. 7.3.4 Partition Deck with Ventilation

Ventilation Aggregate	Capacity	Effect	Heat Recovery	Height	Width	Length
	[m^3/h]	[kW]	[%]	[m]	[m]	[m]
Exhausto VEX 270	1300-7600	6.1	80	1900	1525	2050

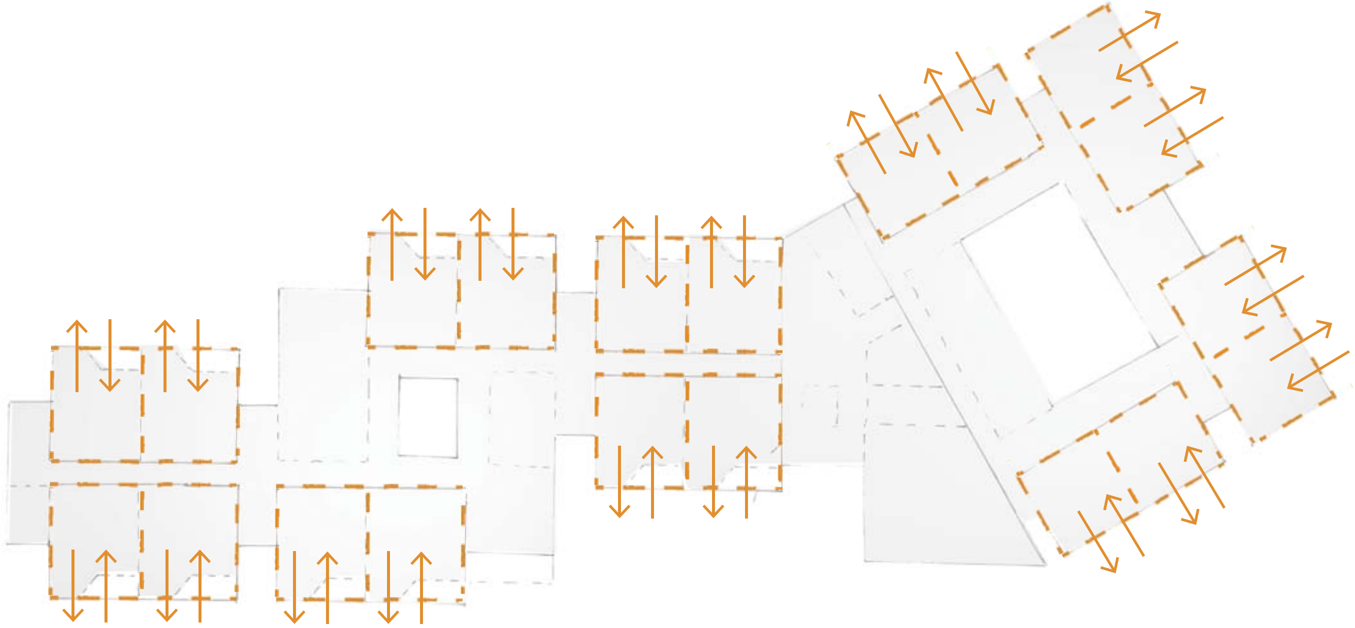
Ill. 7.3.5 Ventilation Aggregate (Exhaust.dk, 120516)

Ill. 7.3.6 Mechanical Ventilation, duct routes

Natural Ventilation Capacity

In order to proscribe natural ventilation for the summer period, an estimate of the air flow capacity for dwelling type A was calculated using a spreadsheet in the Passive House Planning Package (PHPP – SummVent) which allows for a rough estimate of the natural ventilation capacity (see appendix 3 - Ventilating). Counting only the terrace door as ventilation opening – and using recommended climate boundary conditions regarding temperature difference (interior-exterior) and wind velocity - the ventilation capacity is estimated to 765m3/h ≈ 212.5l/s. As the terrace door will probably not be open all day (and certainly not all night) this ventilation capacity needs to be assessed more realistically. This is done in illustration 7.3.8 presenting different ventilation scenarios and their corresponding mean air flow rates per day (24 hours).

Recalling that the category A standard required around 25 l/s this means that the door should be open 3 hours a day. Note, that choosing to open the door only 1 hour a day will still fulfill a category C standard. As the above evaluation of the natural ventilation is of guiding character, more accurate simulations of the indoor climate were done using B-sim to evaluate if the dwelling units can maintain an acceptable indoor climate throughout the year, even during the warmest days of the year. This simulation was done in connection with the detailing of the window area and evaluated concurrently with light intake (re chapters Daylight Studies Type A and Daylight Studies Type B).



Ill. 7.3.7 Natural Ventilation Sketch

Nat. Vent. Capacity	Duration	Temp. Diff.	Wind Velocity	Width	Height	Mean Air Flow Rate	Mean Air Flow Rate	Mean Air Change Rate	Air Quality Category
Hours a Day	[%]	[◦C]	[m/s]	[m]	[m]	[m^3/s]	[l/s]	[h-1]	
1	4	4	1	1	2	31	9	0.35	C
2	8	4	1	1	2	64	18	0.69	B
3	13	4	1	1	2	96	27	1.04	A
4	17	4	1	1	2	128	36	1.39	A
6	25	4	1	1	2	191	53	2.08	A
12	100	4	1	1	2	765	212	8.31	A

Ill. 7.3.8 Natural Ventilation Capacity

Fireproofing

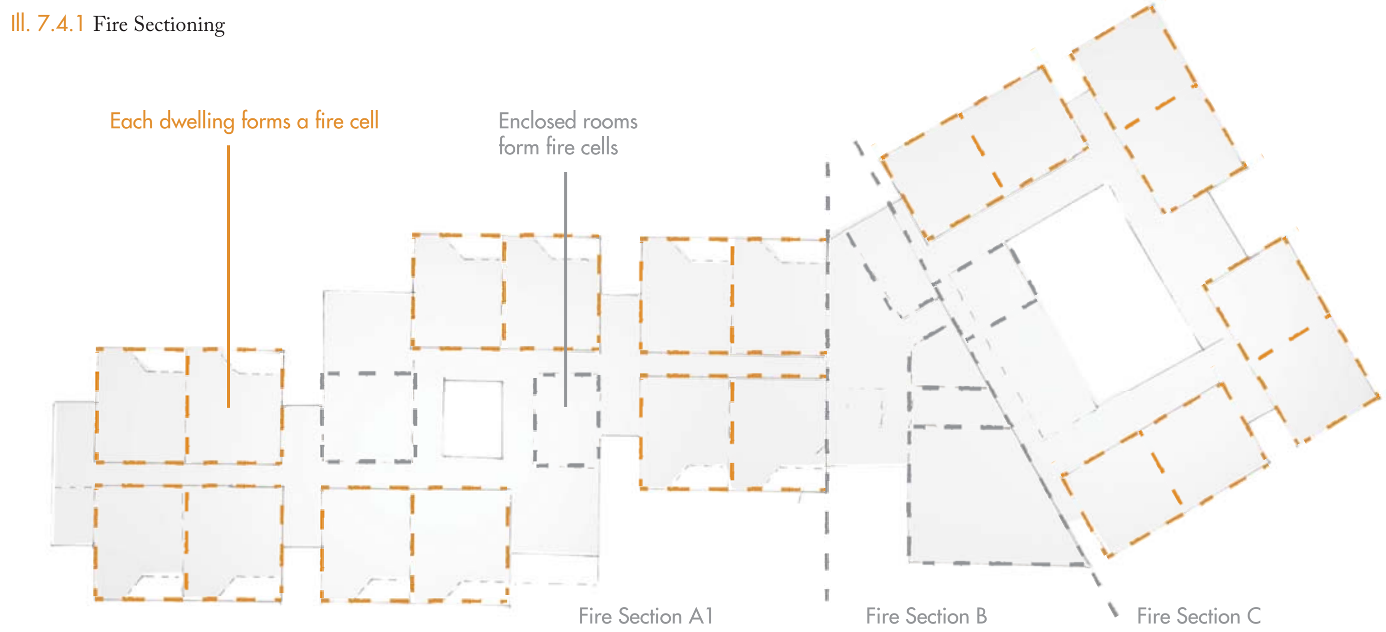
This chapter presents the necessary precautions being processed in the project concerning fireproofing.

Application Category
The first step in connection with fireproofing is to define the application category of the building. The Danish Building Regulations distinguish between 6 categories. Nursing homes belong to category 6 as it includes: "Building sections for daily and/or nightly stay, where the occupants present are not capable of bringing themselves to safety." (ebst.dk,120430)
For each application category a set of specific regulations concerning escape route conditions, passive and active fireproofing initiatives, the rescue effort possibilities etc. apply to the building. This project will not deeply investigate all aspects of the fireproofing strategy but rather concentrate on the most essential ones.

Fire Sectioning
Due to the scale of the building a division into fire sections is necessary. Illustration 7.4.1 diagrammatically shows how this is done. Illustration 7.4.2 further shows the main organization of fire cells within A1, B and C.

The general principle is that each dwelling forms its own fire cell. Enclosed groups of rooms do the same and the remaining hallway of each fire section is regarded a fire cell of its own. Note that the area of each fire section is below 2000m2, which is in accordance with the fireproofing regulations. These regulations however demand that the building be applied an au-

Ill. 7.4.1 Fire Sectioning



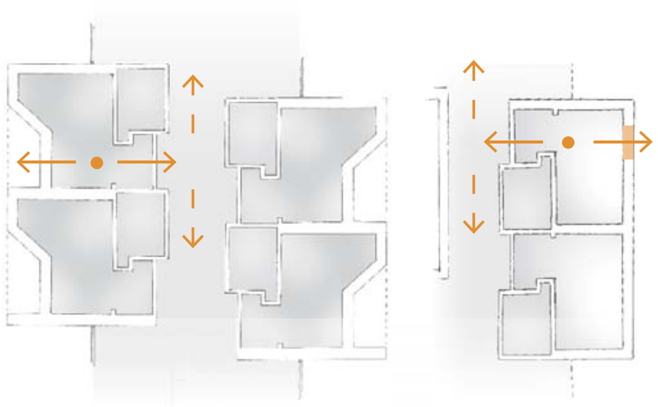
Ill. 7.4.2 Distribution of Fire Cells

tomatic sprinkler system if the fire sections cover more than 600m2 each, which is in fact the case. Besides from a sprinkler system, the building must also be assigned an automatic alarm system along with fire dampers in the ventilation ducts, fire escape route signage and lighting. These so-called active fireproofing initiatives will however not be elaborated further in this project.

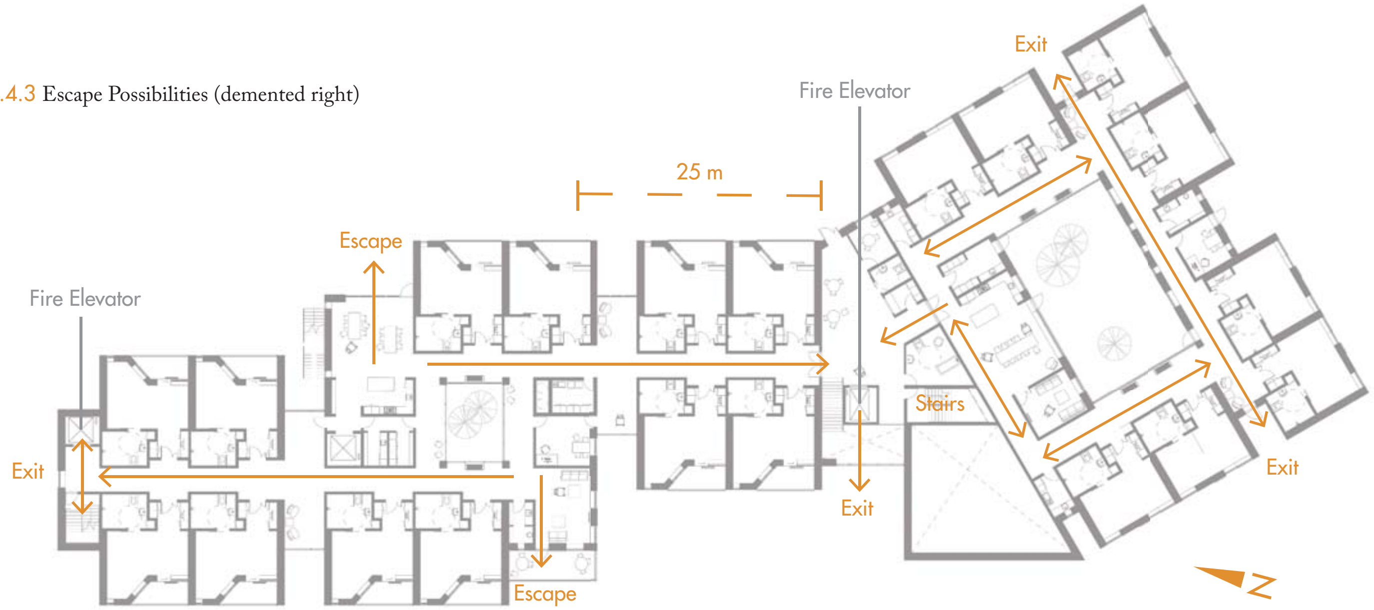
Escape Route Conditions

The escape route strategy assigned to the building is presented in illustration 7.4.4. From each private dwelling unit (both apartment types) the residents are provided escape routes in two opposite directions with the nearest exit being placed less than 25 meters away. Note, that the two main elevators in the building are prescribed as fire-safe due to the reduced mobility of many eldery (for whom stairs compose physical barriers).

Within dwelling type A (cognitively healthy residents) a balcony is situated across the room from the entrance door utilizing the terrace door as an escape opening. The conditions of dwelling type B (demented residents) are somewhat different from type A, as demented residents are not expected to recognize the fire themselves and most likely need the staff to assist them out of the building. Still the dwelling units for demented must be equipped with a rescue opening measuring at least 1.5 meter when adding the free width and height together (the free width must be at least 0.5 m and the free height at least 0.6 m). Regarding non-fire related aspects of safety, the fire regulations do acknowledge the unstable mindset of demented people and thus allow the rescue openings to be locked down by staff members (ebst.dk, 120516).



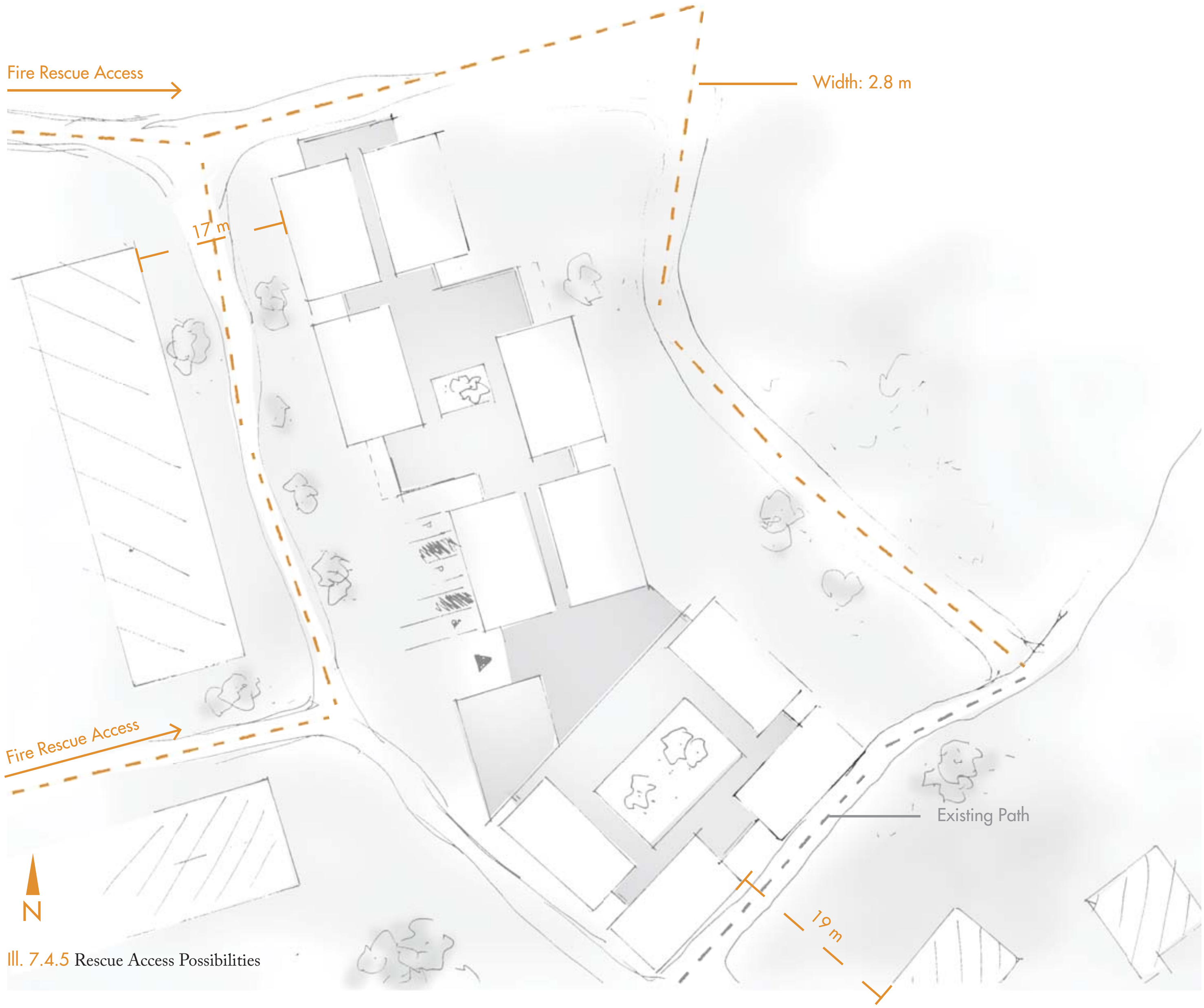
Ill. 7.4.3 Escape Possibilities (demented right)



Ill. 7.4.4 Escape Routes

Constructive Conditions
The constructive conditions in regard to fire resistance and categorization of fire resistant materials (both internal and external) are beyond the scope of this project. This does not mean that considerations regarding appropriate fire resistant construction types are neglected, only that they will not be further specified.

Fire spreading prevention and Rescue Possibilities
Regarding fire spreading the building is not assumed to pose any risk, as the building is drawn back on site providing sufficient distance to any surrounding buildings. In addition a fire access road is –when considered necessary - situated just within the perimeter of the building plot. Consequently no rescue access way is situated south of the building where a broad forest path already exists. From the fire access ways all parts of the building can be reached within a range of 40 meters. The width of the rescue access road is set to 2.8 meters which complies with the fire regulation demands. All in all these measures secure a sensible rescue access possibility.



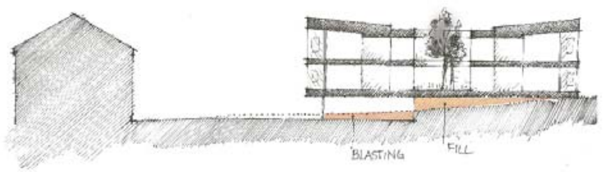
Ill. 7.4.5 Rescue Access Possibilities

Blast & Fill

Illustration 6.6.3 shows the treatment of the site. The building volume cuts through the site at basement level. The site is then blasted where the building cuts, but remains untreated east of the building.
Where the height of the basement level causes voids below the building, these are filled with soil.

As the building for demented is one storey high, placed at level +1, the void appearing beneath the building to the west is filled.

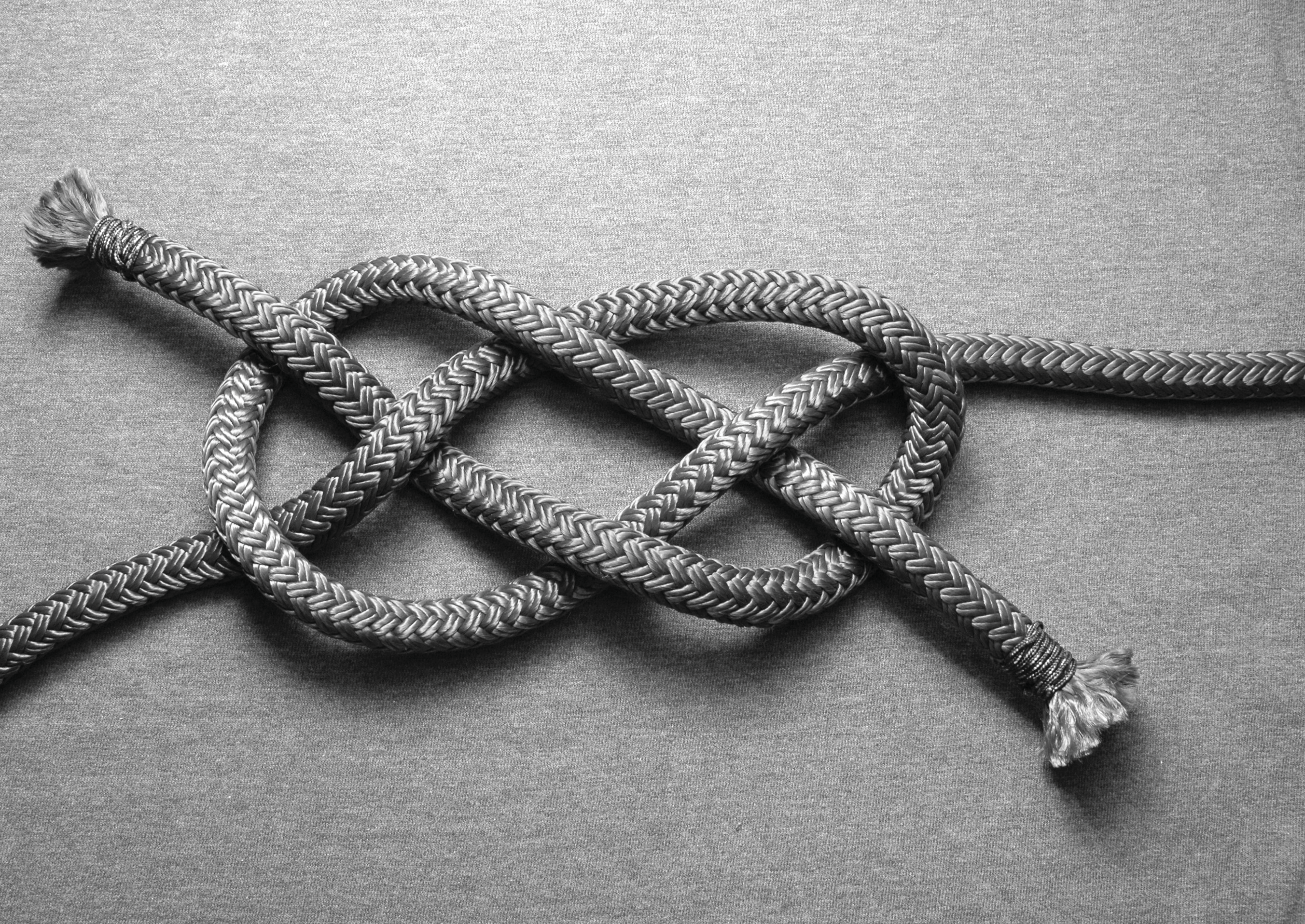
Ill. xx and xx show picked out sections explaining how the treatment of the site balances among blasting and filling.



Ill. 6.6.1. A section through BS 1. This section includes both filling and blasting.

Ill. 6.6.2. Section through BS 2. In this case there is only used filling.

Ill 6.6.3. Area of blast.



8. EPILOGUE

Epilogue

Discussion

The architectural challenge of designing a nursing home is a complex matter. The aim is however clear – it is all about well-being. In this project we applied a user-centered focus through an evidence based design approach. Aiming at designing spaces worth living in, the building was dictated by the needs of the occupants and not the other way around.

Through research a clear connection between the state of health and a range of amenity values were documented. These amenity values can be created through architecture, so in other words architecture can enhance health if designed properly. This statement is the bedrock of reasoning applied to various decisions throughout the project.

Consequently, it has led to other aspects being deprioritized. This involves for instance the compactness of the building, which could have been further optimized if the architectural qualities of e.g. the jagged west façade had been neglected.

Given more time an obvious next step would be to optimize the construction of the building by introducing modules. Despite the complexity of the building, quite a few repetitions occur - thus initiating a consideration of modules. Adjusting the building to modules is estimated to require only a few alterations to the design. Additionally, these alterations will expectedly enhance the exterior expression as the complexity level will be brought down. After introducing modules an additional step could be to discuss prefabricated building elements, which will ease the construction on site and probably reduce the building costs as well.

Conclusion

The aim of this project was to design a nursing home situated in a little piece of forest in the periphery of a housing area in Linköping, Sweden. The vision was to create a home tailored the needs of the elderly, which utilizes the closeness to nature, relates to its surroundings and can adapt to the needs of its users, also over time.
The impact of daylight on human health and psyche was emphasized and supported by the chosen technical foci: daylight and indoor climate. As regards energy consumption, the aim was to fulfill the Danish energy frame for low energy buildings 2015.
To assess if and how these aims have been met a discussion will bring forward important aspects of the project process.
It appeared through the analysis phase that a central conclusion of great importance for the well-being of the residents is the fact that demented elderly and cognitively healthy elderly do not interact well socially – on the contrary. A mix of users would have a negative influence on both user groups. Based on the analysis it was further concluded that demented elderly benefit from a continuous flow in corridors arranged around a common courtyard.
With point of departure in the investigations of daylight, based on e.g. Roger S. Ulrich's research projects about the importance of a window with a view, the next focus was to arrange the apartments in relation to the corners of the earth and the view – including a decision to completely avoid north facing apartments and living rooms.

The strategic concept was, based on the user needs and the analysis, fixed at an early stage. The further work towards the architectural concept built upon the integrated design process, and thus naturally induced some discourses to various technical aspects of the architecture and back.
Generally this method entailed considerations to many different subjects, which influence the architecture, but it soon appeared that there are contradictory parameters too. In such the design process has had a rather pragmatic touch, and this complexity appears from the final design proposal. There is no doubt that a nursing home is a complex building, as it includes many functions, which should supplement each other, but also sometimes have interfering needs.

From the user's point of view a degree of flexibility and relation to the surroundings, both in the private spaces and the common facilities is reached, and is assessed to support a bright, homely environment. Everywhere in the building, emphasis is put on the view to the outside. Staff has easy access to the entire building with offices in the center building and a dedicated entrance to the complex. Nevertheless it is clear, that when straight up contradictory needs appeared, the resident was given priority. Such priority applies to the energy strategy. The aim was to fulfill the energy frame for low energy buildings 2015. Through energy calculations it was estimated that the aim could be fulfilled by integrating active energy initiatives including a decent amount of solar cells. Preferable the building should have been able to fulfill the energy frame without assistance from such technologies. This was however not considered possible due to the higher priority of well-being aspects working against energy initiatives.
All in all it is estimated that the building is able to perform as a nursing home in its surroundings, but a larger degree of homogeneity in the overall architectural expression would be an aim for a further development of the project.

9 PRESENTATION

Presentation

In the following the developed design proposal for a new nursing home in the outskirts of Linköping will be presented.

Content:

- Apartment Type A
  - Floor Plan, care-requiring, 1:100
  - Floor Plan, furnished, 1:100
  - Visualization
- Apartment Type B
  - Floor Plan, care-requiring, 1:100
  - Floor Plan, furnished, 1:100
  - Visualization
- Common Facilities in Section A
  - Visualization of Hallway
  - Visualization of Common Room
- Common Facilities in Section B
  - Visualization of Hallway
  - Visualization of Common Room
- Site Plan, 1:500
- Floor Plans, 1:500
- Elevations, 1:500
- Sections, 1:200
  - longitudinal and transverse sections

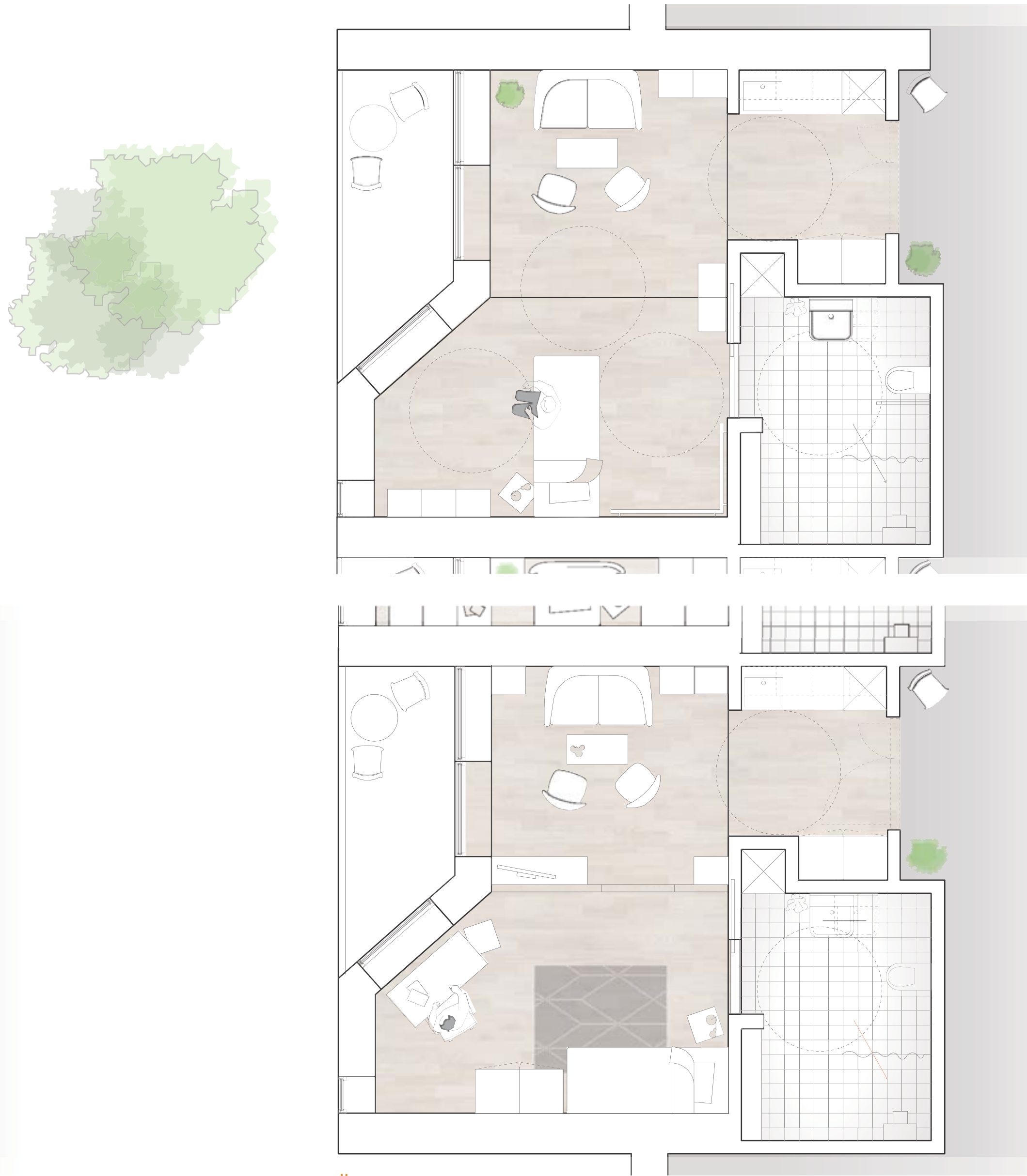
Ill. 9.0 Design Proposal, bird eye

Ill. 9.1 Apartment Type A

Apartment Type A

Apartment type A is suited both for impaired and independent residents. Emphasis is put on view to the outside, sufficient daylight and bright, homely materials. The apartment plan is divided into an entrance zone with a concealable kitchenette, a living room zone and a bedroom zone. The division of zones are emphasized by introducing suspended ceilings in entrance, bedroom and bathroom zone. If the resident wishes, the apartment can be divided by a removeable partition wall.

Besides the angled views, the benefits of closeness to nature is utilized by extending the apartment outwards with a protected outdoor terrace.



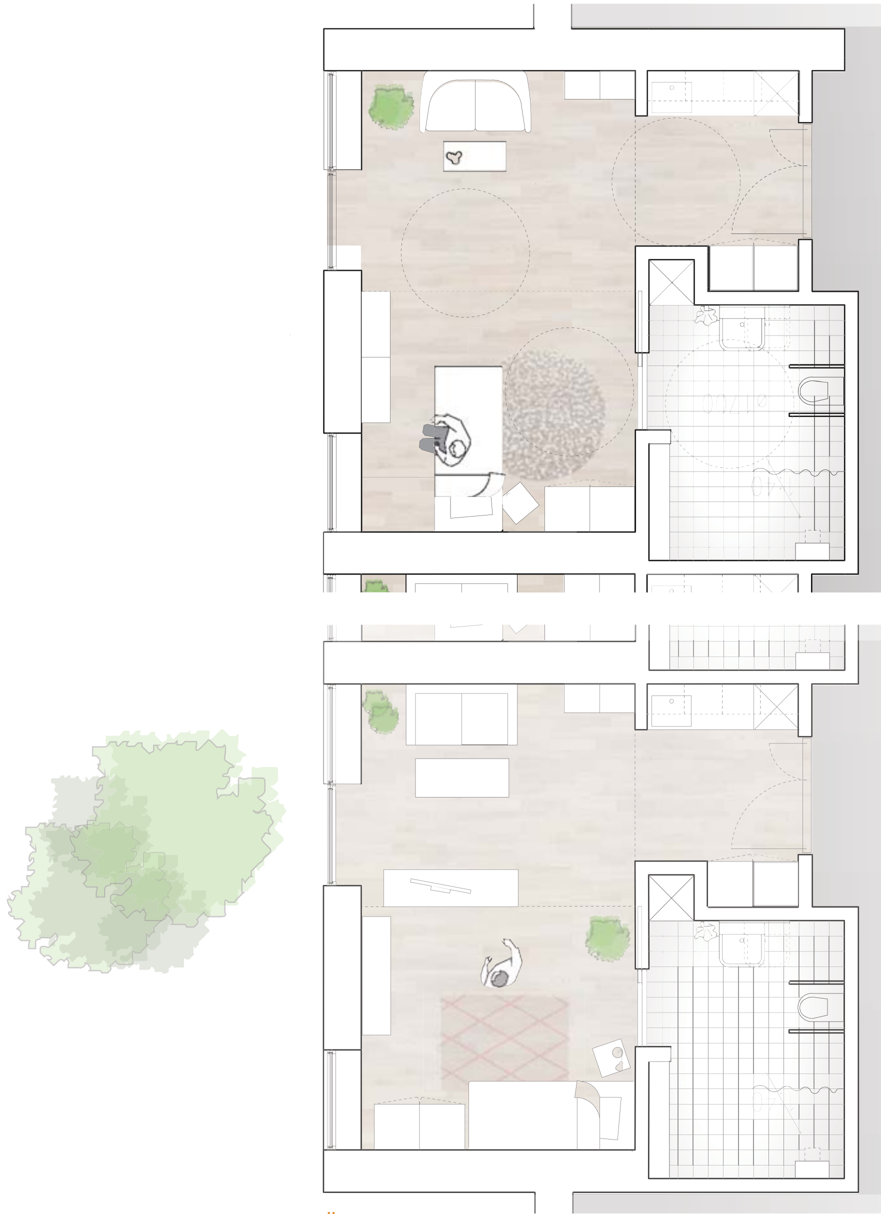
Ill. 9.2 Apartment Type A, 1:100
Suited for care-requiring elderly (upper) / furnished (lower)

Ill. 9.3 Apartment Type B

Apartment Type B

Apartment type B is suited for residents suffering from dementia. People with dementia have a need for clarity and readable surroundings. Demented residents spend little time alone in the apartment due to insecurity, so the layout is compact and simple. The glass door is intended for the quality of the view to the outside and natural ventilation purposes, and is thus only tiltable in horizontal direction.

The apartment can be layoutet both for disabled and independent demented residents.



Ill. 9.4 Apartment Type B, 1:100

Suited for care-requiring elderly (upper) / furnished (lower)

Common Facilities in Section A

The common facilities for the cognitively healthy residents are centered around a 'market square' securing short distances to and from the common facilities. Two main common rooms situated on each side of the building (east and west) provide the residents with the choice of where to go and who to socialize with. They further secure an access of daylight throughout the day as the eastern common room captures the morning light while the western common room is penetrated by light in the afternoon. An internal light shaft embraces the natural light and thus creates an atmosphere dissociated with an institution.

Ill. 9.5 Light Shaft, Östra Psychiatric Hospital (vardbyggnad.se, 120520)

Ill. 9.6 Overview of Building Section A, 1:200

Ill. 9.7 Hallway, Building Section A

Ill. 9.8 Common Room, Building Section A

Hallways

The light shaft penetrating the building brings brightness and nature to the hallway of the 'market place'. It has a calming influence and minimizes any institutional touch. For each private unit a different colour occurs on the walls bringing personality to the atmosphere, which is further supported by a careful consideration of artificial lighting.

Common Room

The common room with kitchen for the cognitively healthy residents is placed in the east-oriented common room, as the view towards the rough surrounding nature is outstanding. The scenery is framed by large floor to ceiling windows, and a glazed terrace door further provides direct access to either a terrace or a balcony. The kitchen includes a moveable kitchen element allowing for flexibility and participation in the cooking processes by the residents. If the residents are unable to participate in the process, the open kitchen lets the smell and viewing of the cooking situation enhance the feeling of integrity.

Presentation

Common Facilities in Section B

The common facilities for the residents suffering from dementia are arranged around a safe protected courtyard. The courtyard should preferably be designed as a garden for the senses, evoking old memories while stimulating cognitive and physical abilities. Both the courtyard and the enclosed hallway compose endless circles preventing the residents from getting lost in a dead end street. Each apartment has an entrance niche which can be colored or otherwise emphasized to help the residents orientate.

Ill. 9.9 Garden for the Senses, Östra Psychiatric Hospital (vardbyggnad.se, 120520)

Ill. 9.10 Overview of Building Section B, 1:200

Ill. 9.11 Hallway, Building Section B

Ill. 9.12 Common Room, Building Section B

Hallways

The enclosed courtyard has a stress reducing effect and provides the residents with a view to nature as they walk around inside the building. It further reminds the residents of the weather situation and encourages them to walk outside if the sun is shining. On a rainy day the residents can sit inside and still feel the proximity to nature. Thus it is important that the choice of greenery reflects a consideration of the different seasons of the year and secures a pleasant view all year long. In addition color coding is used to help the orientation and ease the atmosphere.

Common Room

The kitchen for the demented residents is located with direct access to the enclosed courtyard. The concept of an open kitchen with a moveable kitchen element is applied in order for the demented residents to have the possibility of either participating in or observing the cooking processes. A common living room for watching television or simply relax is situated right next to the common room with kitchen.

Ill. 9.13 Site Plan 1:500

Ground Floor, 1:500

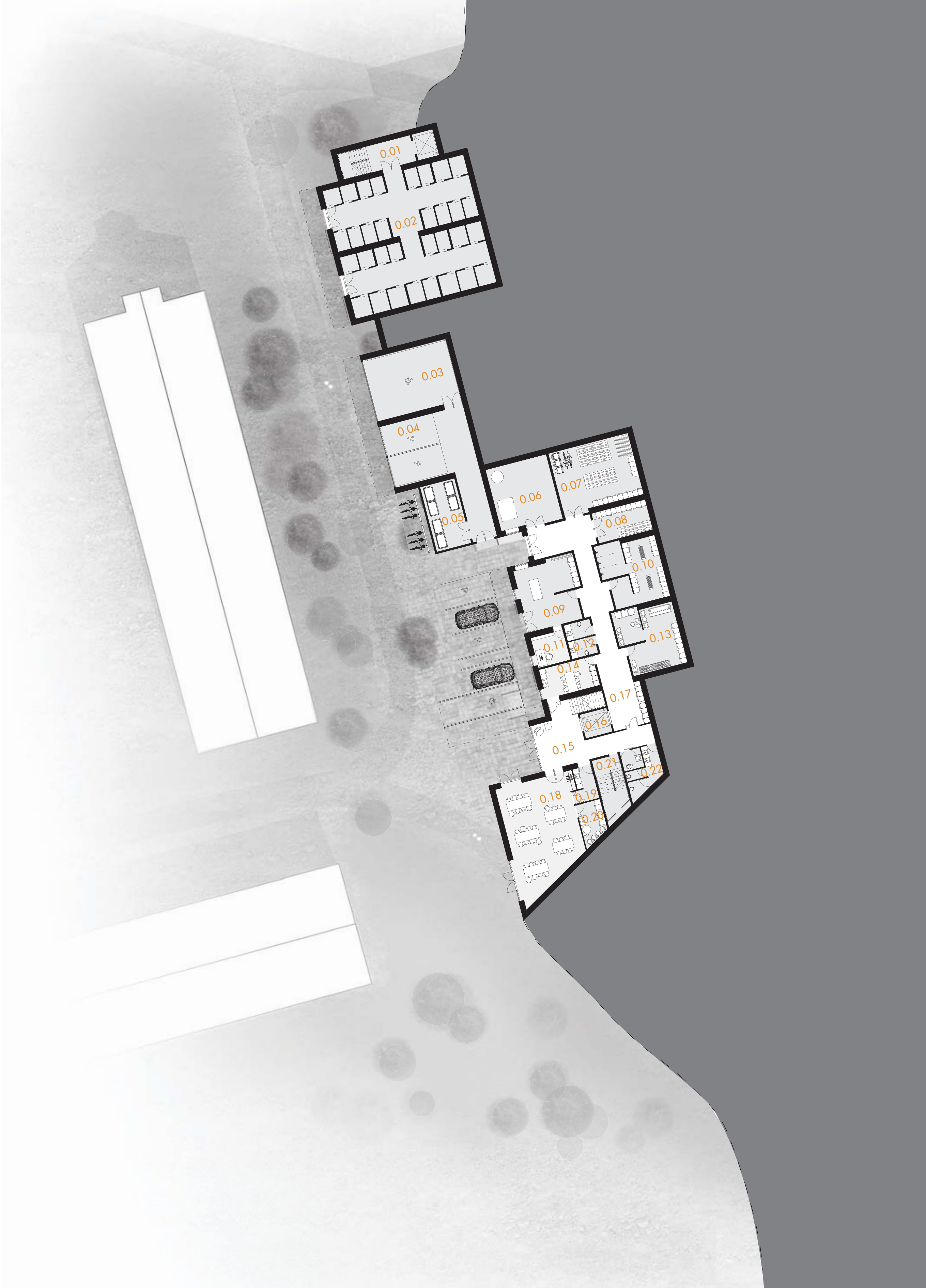
0.01 Stairs / Elevator, 24 m²
0.02 Residents' Deposits, 167 m²

0.03 Garage - Unheated (Minibus), 51 m²
0.04 Garage - Unheated (2 Parking Lots), 68 m²
0.05 Garbage Room - Unheated, 22 m²

0.06 Technical Room, 38 m²
0.07 Deposit, 50 m²
0.08 Goods Reception Deposit, 16 m²
0.09 Janitor's Workshop, 35 m²
0.10 Locker Room with Showers, 35 m²
0.11 Janitor's Office, 10 m²
0.12 Staff Toilets, 8 m²
0.13 Laundry Room, 35 m²
0.14 Activity Room, 16 m²
0.15 Entrance, 41 m²
0.16 Elevator
0.17 Hallway, 67 m²
0.18 Assembly Hall, 72 m²
0.19 Kitchenette (Assembly Hall), 7m²
0.20 Deposit (Assembly Hall), 9 m²
0.21 Stairs, 16 m²
0.22 Toilets (incl. 1 Handicap Toilet), 14 m²

Area (Brutto - Heated): 824 m2

N



Ill. 9.14 Ground Floor Plan C 1:500

1st Floor, 1:500

1.01 Stairs, 10 m^2
1.02 Elevator
1.03 - 1.14 Private Dwellings, 37 m^2
1.15 Elevator
1.16 Kitchenette / Deposit, 13 m^2
1.17 Common Room with Kitchen, 55 m^2
1.18 Staff Toilet, 5 m^2
1.19 Common Living Room, 24 m^2
1.20 Staff Break Room, 16 m^2
1.21 Deposit, 8 m^2
1.22 Common Hallway with Niches, 218 m^2

1.23 Elevator
1.24 Stairs, 16 m^2
1.25 Spa, 15 m^2
1.26 Kiosk, 4 m^2
1.27 Handicap Toilet, 5 m^2
1.28 Consultancy Room, 8 m^2
1.29 Common Area, 85 m^2

1.30 - 1.37 Private Dwellings (Demented), 35 m^2
1.38 - 1.39 Deposits, 6 m^2
1.40 Common Living Room, 15 m^2
1.41 Common Room with Kitchen, 36 m^2
1.42 Kitchenette / Deposit, 11 m^2
1.43 Staff Break Room, 11 m^2
1.44 Staff Toilet, 7 m^2

Area (Brutto): 1822 m2

Ill. 9.15 1st Floor Plan C 1:500

2nd Floor, 1:500

1.01 Stairs, 10 m²
1.02 Elevator
1.03 -1.14 Private Dwellings, 37 m²
1.15 Elevator
1.16 Kitchenette / Deposit, 13 m²
1.17 Common Room with Kitchen, 55 m²
1.18 Staff Toilet, 5 m²
1.19 Common Living Room, 24 m²
1.20 Staff Break Room, 16 m²
1.21 Deposit, 8 m²
1.22 Common Hallway with Niches, 218 m²

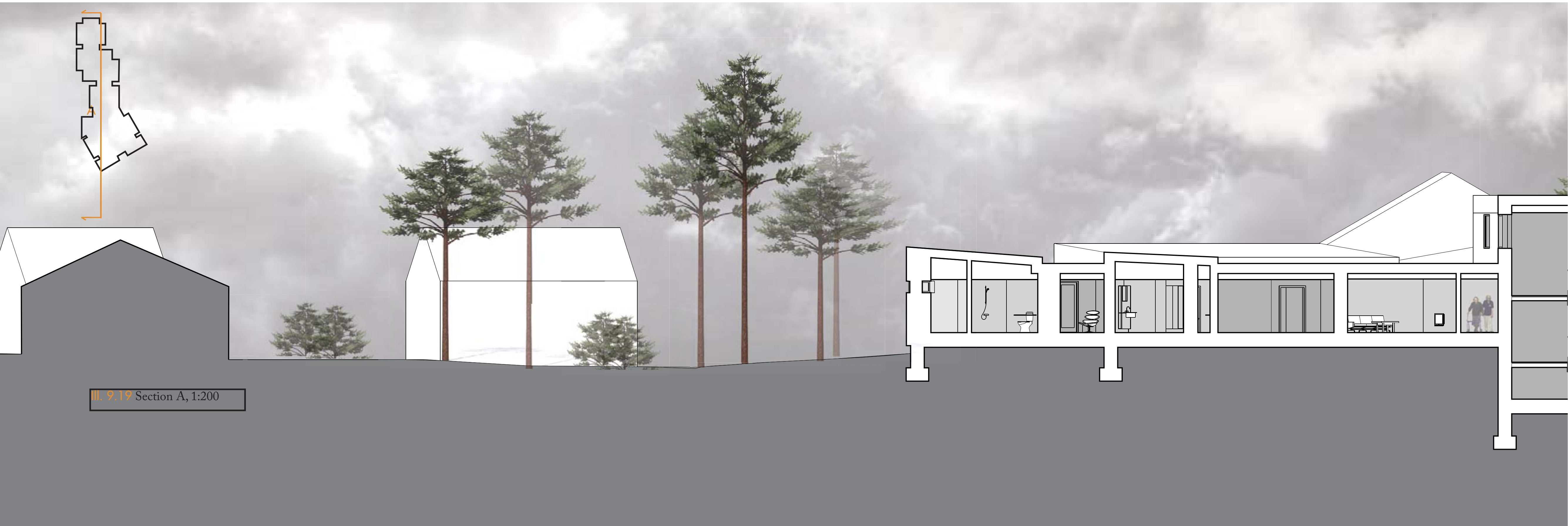
1.23 Elevator
1.24 Stairs, 16 m²
1.25 Director's Office 15 m²
1.26 Office, 11 m²
1.27 Staff Toilet, 5 m²
1.28 Staff Kitchen, 9 m²
1.29 Staff Room, 17 m²
1.30 Common Area, 37 m²
1.31 Meeting Room, 16 m²
1.32 Print / Copy, 4 m²

Area (Brutto): 1122 m2

Ill. 9.16 2nd Floor Plan C 1:500

Ill. 9.17 North Elevation, 1:500

Ill. 9.18 East Elevation, 1:500



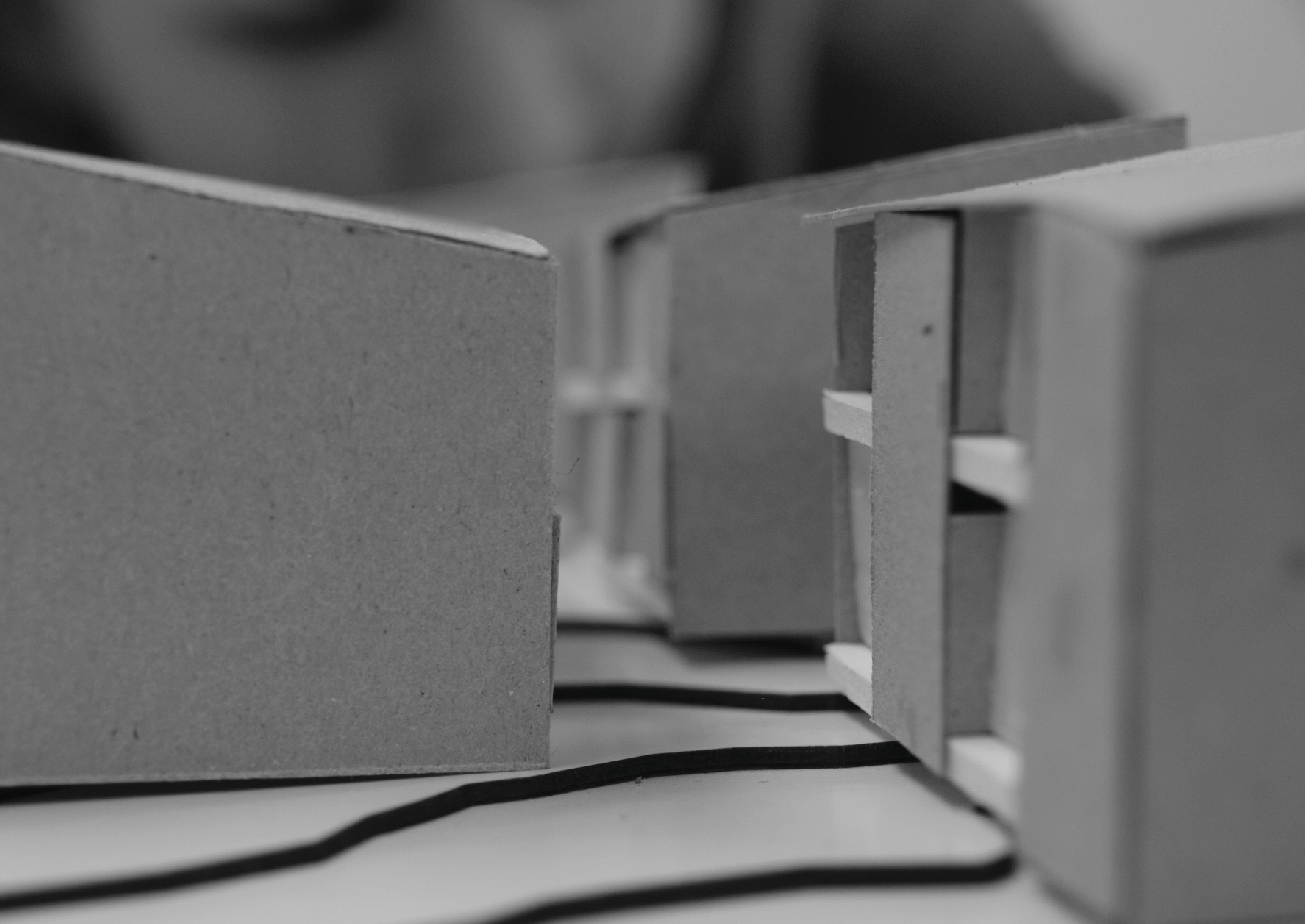
Ill. 9.19 Section A, 1:200

Ill. 9.20 South Elevation, 1:500

Ill. 9.21 West Elevation, 1:500

Ill. 9.22 Section B, 1:200

Ill. 9.23 Section C, 1:200



10 APPENDIX

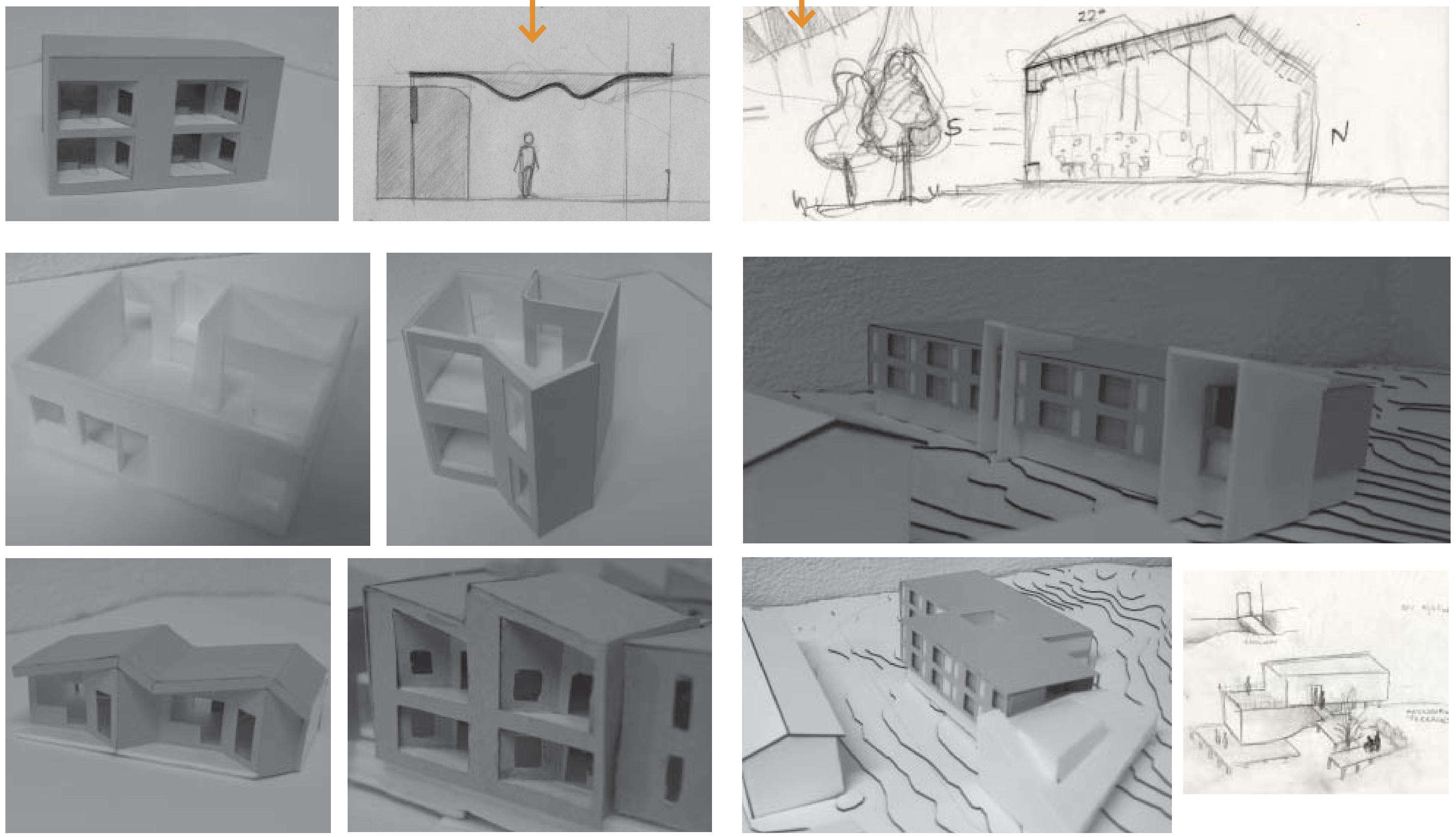
Appendix 1

Sketching

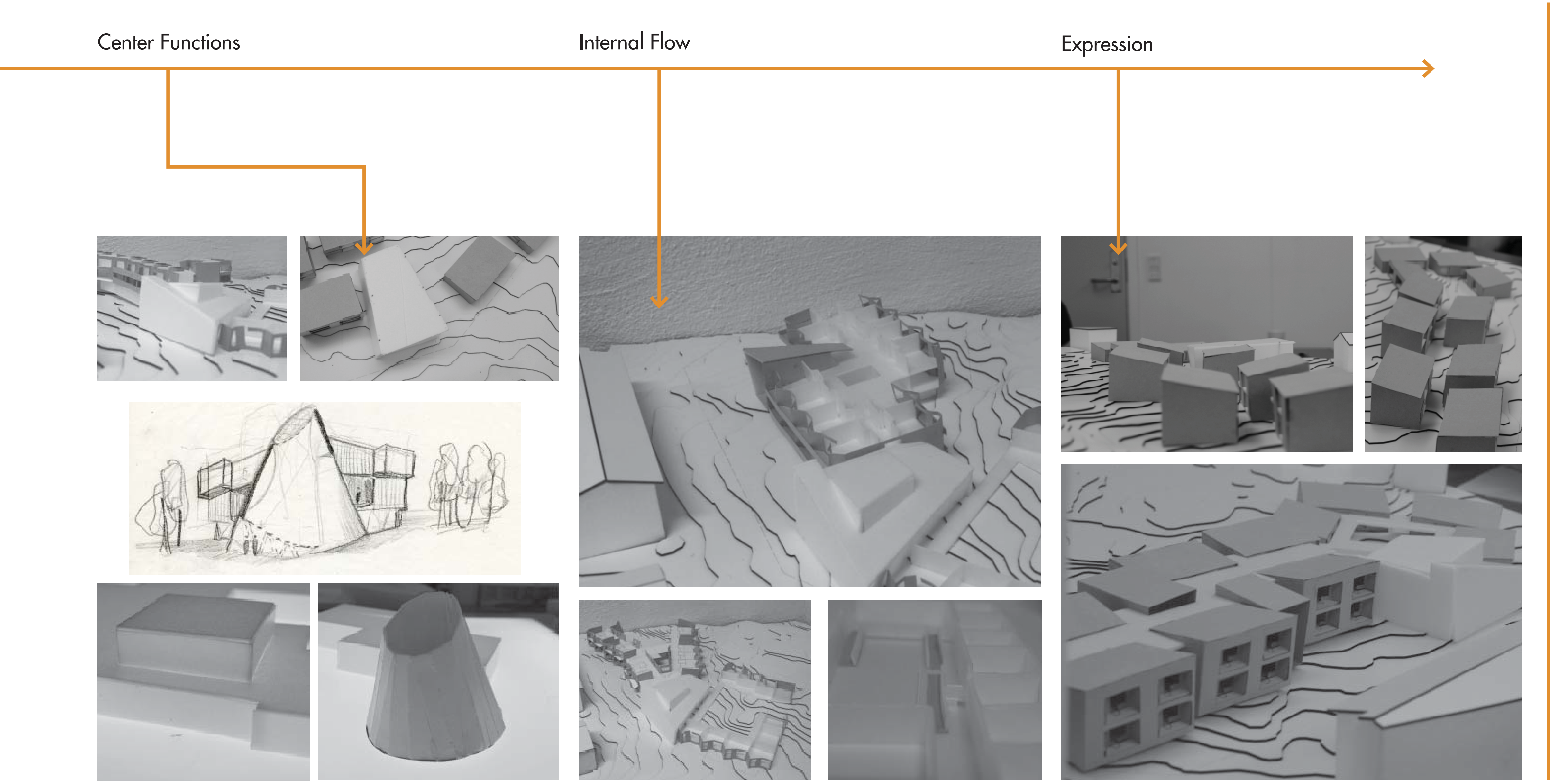
This appendix aims at giving an impression of the sketching phase. The sketching phase has been widely based on material evidence in the form of scale models, hand sketching and digital modelling. These pages focus mainly on the the two first methods, as they give an immidiate impression of both scale and space.

Apartment Plans & Roofs

Organization



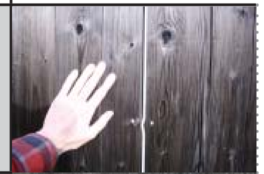
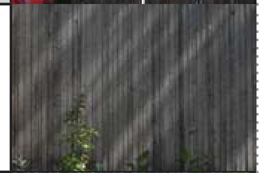
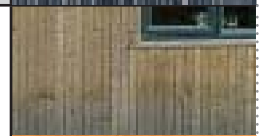
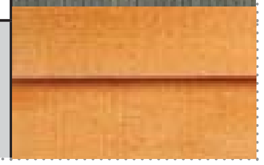
Ill. 10.1.1 Sketching Phase


Center Functions
Internal Flow
Expression

Appendix 2

Wood Types

Due to considerations regarding minimization of the environmental impact of the building (renewable sources, short transportation routes) this project considers local wood types only. The types are listed below, along with their material properties and photo references.

Name & Tree Type	Picture Reference	Appearance	Average Density kg/m3	Surface Treatment	Natural Durability (DS/EN 350-2)	Moisture Stability T/R	Special Regards	Patinated Appearance Example
Pine (Confiner)		Heartwood is dark brown, sapwood is yellow-white	490	Easy The wood contains much resin	3-4	1.93	Knots often break through the surface. Must be impregnated if the wood is in contact with soil.	
Siberian Larch (Conifer)		Grey-brown	640	Easy, but acid contents make treatment with water based products hard	3-4	2.42	The construction must provide for larchwood's tendency to twist and to develop cracks	
Oak (Hardwood)		Heartwood light grey to brown, sapwood is yellow-white	650	Easy, but stains appear regularly	2	2.00	Tannin creates brown stains. Stains from iron.	
Spruce (Conifer)		Yellow-white. Spotted with small knots.	430	Easy	3-4	2.10	Less resin than pine. Knots are hard and make to wood hard to process.	
European Thuja (Conifer)		Grey-brown	340	Easy, but stains appear regularly	3		-	

*Durability classes for untreated heartwood in contact with soil according to DS-EN 350-2:
1-very durable 2-durable 3-moderate 2-less durable 1-not durable.

(Lund Johansen 2008, Morsing 2001, vot.teknologisk.dk) 24.04.2012))

Appendix 3

Ventilation

This appendix documents the required ventilation rate applied to both B-sim and Be-10.

Ventilation Strategy

As mentioned earlier, the ventilation strategy of the nursing home complex is to use mechanical ventilation during the heating period and support it by natural ventilation during summer (May - August).

Air Quality Design Criteria

The chosen indoor air quality standard for the private dwelling units is category A, which implies that the CO2 concentration must not exceed the outdoor level with more than 460 ppm and that the indoor air quality must be no higher than 1,0 decipol in order to achieve a maximum of 15 percent dissatisfied. In order to dimension the ventilation system in accordance with this demand a basic air change rate must be found for each room. In CR1752 two calculation methods are presented in order to find the required ventilation rate in regard to health (chemical pollution) and comfort (experienced air quality) respectively. As the nursing home is a residential building it will not be necessary to calculate the required ventilation rate in regard to health as the comfort scenario will be the dominant one. As such the required ventilation rate of the two different dwelling types are calculated in the following. Common assumptions are that there is one resident with a low activity level (1-1.2 met) occupying the dwelling 24 hours a day.

The required ventilation rate are in both cases calculated according to the folliwing formula $Q_c = 10 \cdot (G_c / C_{c,i} - C_{c,0}) \cdot (1/\varepsilon_v)$

Q_c is the ventilation rate for comfort [l/s]

$C_{c,i}$ is the desired perceived indoor air quality [dp]
$C_{c,i}$ = 1.0dp (category A)
$C_{c,i}$ = 1.4dp (category B)
$C_{c,i}$ = 2.5dp (category C)
(CR1752, figure A.5)

$C_{c,o}$ is perceived outdoor air quality at intake [dp]
$C_{c,o}$ = 0.1dp
(CR1752, figure A.9, city)

ε_v is the ventilation effectiveness [-]
ε_v = 1 (general assumption)

G_c is the sensory pollution load [olf]
G_c = S·po + bo

S is the servicelife of the building [%]

b_o is the pollution load from the building
$b_{o,a}$ = 0.03olf/m²

p_o is the pollution load from the occupants
p_o = 1olf/p
(CR1752, table A.6, sedentary, 1-1.2 met)

Dwelling Type	A	B
Netto area (A_1):	37 m²	35 m²
Volume (V_1):	92 m³	87.5 m³
Number of occupants (P_1):	1 person	1 person
Activity level (M_1):	1.0 met	1.0 met
Service life (S_1):	100 %	100 %

Calculation 1: Apartment type A

Sensory pollution load, G_c

Occupants:	(1p·1olf/p)	= 1.00 olf
Building:	0,03olf/m²·37m²	= 1.11 olf
Total, G_c		= 2.11 olf

Required air change rate
$Q_{c,a}$ = 10·(2.11olf/ (1,0dp-0,1dp)) · (1/1) = **23.44 l/s**

Calculation 2: Apartment type B

Sensory pollution load, G_c

Occupants:	(1p·1olf/p)	= 1.00 olf
Building:	0.03olf/m²·35m²	= 1.05 olf
Total, G_c		= 2.05 olf

Required air change rate
$Q_{c,a}$ = 10·(2.05olf/ (1.0dp-0.1dp)) · (1/1) = **22.78 l/s**

The results from these calculations will be brought forward to other calculations and simulations conducted in connection to the project. In addition the required ventilation rates for the other quality categories are calculated in the scheme on the next spread in order to find out what the consequences of the choice of category A are compared to category B and C. Note that the required ventilation rate for category B and C are significantly lower than for category A.
The second chart on the next spread presents a calculation of the total air flow rate of the building when prescribing category A to the private dwelling units and category B to the additional building parts.

Air Quality Design Criteria	IAQ Category	Perceived Air Quality	Perceived Air Quality	Number of Occupants	Pollution Load Occupants	Floor Area	Volume	Pollution Load Building	Sensory Pollution	Percieved Outdoor Air	Required Air Change
Symbol		-	Cc,i	P	P_o	A	V	b_o	G_c	$G_{c,o}$	Q_c
Unit		[%]	[dp]	[p]	[olf/p]	[m^2]	[m^3]	[olf/m^2]	[olf]	[dp]	[l/s]
Dwelling Unit A, non-demented	A	15	1	1	1	37	92	0.03	2.1	0.1	23.44
Dwelling Unit A, non-demented	B	20	1.4	1	1	37	92	0.03	2.1	0.1	16.23
Dwelling Unit A, non-demented	C	30	2.5	1	1	37	92	0.03	2.1	0.1	8.79
Dwelling Unit B, demented	A	15	1	1	1	35	87.55	0.03	2.1	0.1	22.78
Dwelling Unit B, demented	B	20	1.4	1	1	35	87.55	0.03	2.1	0.1	15.77
Dwelling Unit B, demented	C	30	2.5	1	1	35	87.55	0.03	2.1	0.1	8.54
Source: CR1752											

Ill. 10.3.1 Air Quality Design Criteria, evaluation of categories

Air Quality Design Criteria	IAQ Category	Perceived Air Quality	Perceived Air Quality	Number of Occupants	Pollution Load Occupants	Floor Area	Volume	Pollution Load Building	Sensory Pollution	Percieved Outdoor Air	Required Air Change
Symbol		-	Cc,i	P	P_o	A	V	b_o	G_c	$G_{c,o}$	Q_c
Unit		[%]	[dp]	[p]	[olf/p]	[m^2]	[m^3]	[olf/m^2]	[olf]	[dp]	[l/s]
Dwelling Unit A, non-demented	A	15	1	24	1	888	2208	0.03	50.6	0.1	562.67
Dwelling Unit B, demented	A	15	1	8	1	280	708	0.03	16.4	0.1	182.22
Additional Building	B	20	1.4	10	4	2332	5830	0.03	110.0	0.1	845.85
total											1590.74

Ill. 10.3.2 Air Quality Design Criteria, whole building complex

Natural Ventilation Capacity

A rough estimate of the natural ventilation capacity of a dwelling was made using a spreadsheet in the Passive House Planning Package (PHPP-SummVent).

A ventilation area of 2 m² - corresponding to the terrace door - was defined as total ventilation opening. In addition the temperature difference (inside - outside) was set to 4 degrees and the wind velocity to 1 m/s, which are both recommended settings in PHPP when performing the estimation. Different scenarios were composed representing different hours of applying natural ventilation.
Subsequently the data output was processed by arranging it in tabular form and compare the air quality category associated with each scenario.

Passive House Planning

SUMMER VENTILATION

Building: Linköping Nursing Home
Location: Europe-N
Building Type/Use:
Building Volume 92 m³

Description	1 hour	2 hours	3 hours	4 hours	6 hours	always	
Fraction of Opening Duration	4%	8%	13%	17%	25%	100%	
Climate Boundary Conditions							
Temperature Diff Interior - Exterior	4	4	4	4	4	4	K
Wind Velocity	1	1	1	1	1	1	m/s
Window Group 1							
Quantity	1	1	1	1	1	1	
Clear Width	1.00	1.00	1.00	1.00	1.00	1.00	m
Clear Height	2.00	2.00	2.00	2.00	2.00	2.00	m
Tilting Windows?							
Opening Width (for tilting windows)							m
Window Group 2 (Cross Ventilation)							
Quantity							
Clear Width							m
Clear Height							m
Tilting Windows?							
Opening Width (for Tilting Windows)							m
Difference in Height to Window 1							m
Single-Sided Ventilation 1 - Airflow Volume	765	765	765	765	765	765	m³/h
Single-Sided Ventilation 2 - Airflow Volume	0	0	0	0	0	0	m³/h
Cross Ventilation Airflow Volume	765	765	765	765	765	765	m³/h
Contribution to Air Change Rate	0.35	0.69	1.04	1.39	2.08	8.31	1/h

Ill. 10.3.3 PHPP Spreadsheet, SummVent

Nat. Vent. Capacity	Duration	Temp. Diff.	Wind Velocity	Width	Height	Mean Air Flow Rate	Mean Air Flow Rate	Mean Air Change Rate	Air Quality Category
Hours a Day	[%]	[◦C]	[m/s]	[m]	[m]	[m³/s]	[l/s]	[h-1]	
1	4	4	1	1	2	31	9	0.35	C
2	8	4	1	1	2	64	18	0.69	B
3	13	4	1	1	2	96	27	1.04	A
4	17	4	1	1	2	128	36	1.39	A
6	25	4	1	1	2	191	53	2.08	A
12	100	4	1	1	2	765	212	8.31	A

Ill. 10.3.4 Natural Ventilation Capacity

Appendix 4

BSim

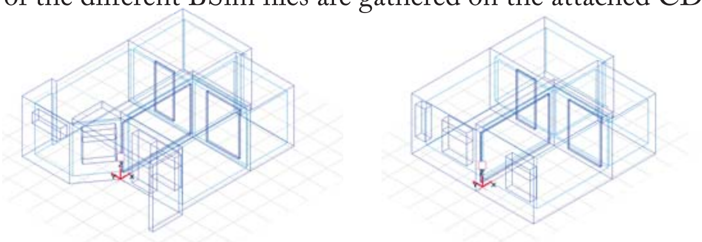
This appendix clarifies the use of BSim.

Clarification of Input Data and Settings

In this project BSim is used to identify whether an acceptable thermal environment can be obtained in the two different dwelling types. For this reason a worst case scenario is simulated for both. For the cognitively healthy residents a west orientated dwelling is used as simulation basis as it will have a greater risk of overheat that than the east orientated ones. Similarly a south-west orientated dwelling is used as simulation basis for the demented residents.

The input data inserted in BSim is approximately the same for the two dwellings types as the worst case scenario is rather similar. Hence, the worst case scenario is estimated to be a bed-bound resident with 6 hours of daily care distributed over the course of the day.

The applied settings for both dwelling types are explained to the right and an example of the result sheet used for evaluation is presented in illustration 10.3.6. Note that a collection of the different BSim files are gathered on the attached CD.



Ill. 10.4.1 Bsim Models (left: type A, right: type B)

average air change rate →

Co^2 concentration →

overheat →

termisk zone	Sum/Mean	1 (31 days)	2 (29 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	709.62	149.51	112.55	88.36	35.58	1.36	0.00	0.00	0.00	11.37	61.56	107.90	141.43
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-428.50	-58.65	-48.86	-49.54	-38.87	-25.33	-19.31	-14.92	-16.30	-23.11	-34.11	-44.80	-54.71
qVenting	-195.48	0.00	0.00	0.00	0.00	-28.21	-41.54	-80.96	-44.78	0.00	0.00	0.00	0.00
qSunRad	851.19	10.13	27.68	67.18	112.57	131.78	124.08	131.99	99.43	74.82	46.55	18.05	6.94
qPeople	1098.00	93.00	87.00	93.00	90.00	93.00	90.00	93.00	93.00	90.00	93.00	90.00	93.00
qEquipment	384.30	32.55	30.45	32.55	31.50	32.55	31.50	32.55	32.55	31.50	32.55	31.50	32.55
qLighting	277.72	22.32	20.88	22.32	21.60	20.77	25.50	25.77	30.72	21.60	22.32	21.60	22.32
qTransmission	-892.80	-102.11	-92.38	-105.21	-105.79	-63.52	-46.66	-35.33	-33.86	-56.51	-74.15	-82.42	-94.84
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	-1801.18	-146.74	-137.29	-148.16	-145.91	-162.15	-163.43	-151.89	-160.53	-149.17	-147.41	-141.82	-146.68
Sum	2.87	0.00	0.03	0.50	0.69	0.24	0.15	0.21	0.23	0.50	0.31	0.01	0.00
tOutdoor mean	6.4	-3.6	-0.9	0.3	4.4	11.7	14.5	17.0	16.0	11.3	6.7	1.6	-1.9
tOp mean	21.7	21.0	21.0	21.1	21.3	22.4	22.9	23.4	22.9	21.4	21.1	21.0	21.0
AirChange/h	1.5	1.3	1.3	1.3	1.3	1.7	2.1	2.3	1.8	1.3	1.3	1.3	1.3
Rel. Moisture(%)	35.7	24.9	25.5	28.0	27.4	35.4	42.1	50.3	48.6	47.0	39.9	32.5	26.6
Co2(ppm)	533.9	546.6	546.6	546.5	546.4	527.6	508.2	487.1	512.1	546.0	546.3	546.5	546.6
PAQ	0.5	0.6	0.6	0.6	0.6	0.4	0.3	0.1	0.2	0.3	0.4	0.5	0.6
Hours > 25	87	0	0	0	0	14	61	12	0	0	0	0	0
Hours > 26	18	0	0	0	0	0	18	0	0	0	0	0	0
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 20	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	176.06	14.44	13.51	14.44	13.98	15.40	17.79	15.22	14.44	13.98	14.44	13.98	14.44
HtRec	3343.59	539.97	445.73	449.34	326.10	146.17	79.95	27.40	33.79	130.11	268.28	393.53	503.23
ClRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	100.39	34.23	16.79	10.22	3.36	0.00	0.00	0.00	0.00	0.00	0.15	13.59	22.04
ClCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	473.08	99.67	75.03	58.92	23.80	0.91	0.00	0.00	0.00	7.52	41.03	71.91	94.30
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HeatPump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HeatPumpElCons	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ill. 10.4.2 Key Figure, type A, iteration 3a

Infiltration:
0.1 h^{-1} (air tight building)

Equipment:
100 W
(regulated according to day-profile)

People Load:

10 p.m. - 2 a.m.	1 person
3 a.m.	2 persons
4 a.m. - 7 a.m.	1 persons
8 a.m. - 9 a.m.	2 persons
10 a.m. - 12 a.m.	1 persons
1 p.m. - 2 p.m.	2 persons
3 p.m. - 8 p.m.	1 persons
9 p.m.	2 persons

Lighting:
(Standard values)

Ventilation:
The ventilation rate was calculated according to comfort to ~ 25 l/s.
This value was adjusted to take into account the additional need when the nursing assistant is present. Heat recovery was set to 75%

Venting:
Natural ventilation is only applied from May-August and activated at 23 degree.
In addition it can only be activated from a.m. to 8 p.m.

Heating:
Heating is defined as floor heat set to activate at 22 degree.

Constructions:
Constructions comply with the chosen element types of the project.
Hence this enables the simulation to take heat storage into account.

Ill. 10.4.3 Data input, BSim

Appendix 5

Be10

This appendix clarifies the use of Be10.

Calculation Model

As the energy strategy of the project was to fulfill the low energy class 2015 energy calculations were conducted in Be10 and used for both optimization and documentation purposes. The calculation bases on the entire building complex as a section of the building is not considered to present a true picture.

As the building is rather complex simplifications to the calculation were considered beneficial. This means that the picture is not as accurate as it would have to be if it was going to be approved. Still the accuracy is considered appropiate considereing the scope of the project.

Both a Be10 model document and a result document is placed on the attached CD together with a Be10 file of the final iteration. Recall that the report (re chapter Energy Optimization) presents 4 iterations involving both the introduction of active energy measures and minimization of window area.

Clarification of Input Data

Building Envelope

The building envelope is typed in according to a completed revit model of the building and the U-values are corresponding to those chosen for the project.

Thermal bridges

Thermal bridges are roughly estimated. For instance are linear thermal transmittances of the installation of windows estimated by means of taking the entire window area and define a reference window of 2 m^2 and calculate what the length of the window installation would be if all windows were that size.

Windows

As concerns data input of windows they are all given the same U-value regardless of whether they can be open or not, which will affect the U-value. In addition the glass percentage is also defined as an identical value (0.8) as an accurate calculation would be too time consuming.

Shading

The shading conditions are tried defined rather thorough but some simplifications have naturally been applied and groups of windows are thus considered one imaginary window and given an identical shading condition.

Ventilation

Ventilation is assigned according to the ventilation need calculated in appendix 3 - Ventilation.

Heat Supply

The heat supply is dived into two groups - one representing the supply of the residents and on representing the staff.

Technical Data

Most of the technical data are based on SBI-Anvisning 213 providing guidance and general assumptions.

Heat Pump

A heat pump is assigned as part of the optimization iterations. It is set to cover the need of the domestic hot water only.

Solar Cells

Solar cells are also assigned in connection with the energy optimization. It is divided into two groups as they have different settings. The one placed on the assembly hall is 68 m^2 orientated south, sloped 10 degrees and assumed to have a peak power of 0.1 kW/m^2 and a system efficiency of 0.75. The other group of solar cells are placed on top of the center functions and covers an area of 146m^2. The orientation is south, the slope 5 degrees (due to maintenance) and the peak power and system efficiency is assigned the same values as the first group of solar cells.

Energy frame in BR 2010

Without supplement	Supplement for special conditions	Total energy frame
52.9	0.0	52.9
Total energy requirement		31.2

Energy frame low energy buildings 2015

Without supplement	Supplement for special conditions	Total energy frame
30.3	0.0	30.3
Total energy requirement		30.2

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20.0	0.0	20.0
Total energy requirement		24.1

Contribution to energy requirement		Net requirement	
Heat	4.8	Room heating	4.6
El. for operation of bulding	11.7	Domestic hot water	11.1
Excessive in rooms	8.0	Cooling	0.0

Selected electricity requirements		Heat loss from installations	
Lighting	0.0	Room heating	0.1
Heating of rooms	0.0	Domestic hot water	2.7
Heating of DHW	0.1	**Output from special sources**	
Heat pump	3.4	Solar heat	0.0
Ventilators	8.1	Heat pump	11.1
Pumps	0.1	Solar cells	4.3
Cooling	0.0	Wind mills	0.0
Total el. consumption	42.3		

Ill. 10.5.1 Key Figure, last iteration, Be10

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