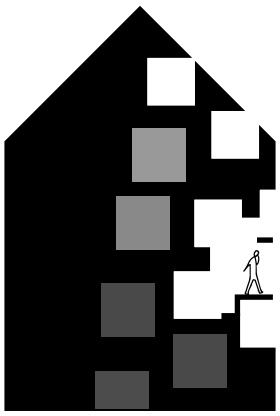

When life outlives memories
- Designing a dementia friendly nursing home

MSc04 ARC - Group 8
Architecture and Design, Civil Engineering
Aalborg University
May 2017

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When life outlives memories

Designing a dementia friendly nursing home.

Project title:	When life outlives memories - Designing a dementia friendly nursing home.
About:	Master Thesis, MSc04 ARC Department of Architecture, Design and Media Technology Aalborg University
Project period:	02.06.2017 - 05.18.2017
Copies:	7
Pages:	163
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Preface

This report is the compilation of our master thesis and culmination of our education at Architecture and Design at Aalborg University. The report is divided into five segments:

i) Prologue, introduces our project and our motivation behind it.

ii) Programmeme, establishes the theoretical foundation, on which the project is built.

ii) Presentation, contains our concrete proposal based on the theory.

iv) Design process, a representation of the process leading up to the final project.

v) Epilogue, establishes our conclusion and reflection of the pro ject and the process.

In the end of the report the list of references and illustrations can be found in alphabetical and chronological order respectively. The Harvard Style of Reference has been used as the standard system of reference throughout the report.

The theory behind the project is based on both scientific research, standards and guidelines but also from practical experience, gained from visiting the centres and people that spends their everyday life working in the environments, that we create, trying to help the same people as us. Therefore, we would like to express our thanks to the people for showing us hospitality and inviting us in to get a glimpse of the everyday life at various nursing homes and day care centres:

Birgitte Tollund Gert - Head of centre – Liselund
Karin Jensen – Activity manager, Lionsparken
Thomas Eggersen – Occupational therapist, Birkebo

Furthermore, we would like to express our graditude to our two supervisors, for asistance thoughout the project.

Lars Brorson Fich
Per Kvols Heiselberg

Abstract

The objective of this master thesis is to develop a modern dementia friendly nursing home and day care centre. The need for dementia specialised facilities is an increasing problematic as the illness is getting more and more widespread. In Denmark it is estimated that the current population with a dementia disorder is 84,000 and is expected to be nearly doubled by 2040. Today one in five of all people residing in a nursing home in Denmark is diagnosed with dementia, but only one in seven of the accommodations in the nursing homes have taken dementia into account in its design.

To be able to design a dementia friendly nursing home, the project is based on an extensive programme consisting of analyses of the illness, the people who gets it, existing nursing homes and day care centres as well as the context of the project site. The programme opens up the discussion on how dementia friendly design should be executed as there are multiple contradictory analyses on the matter.

The final suggestion for the new Dementia and Brain Centre Aarhus (DBC Aarhus) is based on three housing blocks each with a circular layout surrounding a central sheltered courtyard. The day care centre, the central element in the DBC Aarhus, is designed to house numerous different functions such as cultural activities, educational facilities and short term housing for the benefit of the residents as well as visitors. The entire complex is designed to be as stress free, easy to navigate and with a good indoor climate.

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Ill. 1 *The project made in collaboration with Aarhus municipality.*

Introduction

This report presents the final product of the master thesis developed by group 8 made up by Anders Brusen Jensen, Jonas Wittrup Laursen and Mathis Lauridsen Gerlich. The thesis is a part of the architecture programme at Architecture and Design, Civil Engineering at Aalborg University. The topic for the project is dementia friendly housing, where the specific project is made in coordination with the municipality of Aarhus, as a part of their overall plan to improve the everyday life for citizens suffering from dementia. The report is divided into five segments, prologue, programme, presentation, design process and epilogue each presenting different part of the project.

The prologue introduces the project, the motivation for selecting the specific topic and the methodology based on the Integrated Design Process (IDP).
The programmeme is divided into three parts. The first part describes dementia as a disease and how architectural considerations and design choices can influence a patient, the explanation of a nursing home and the daily routines of residents and personnel. The part ends up in a presentation of four different visits of nursing homes and day care centres.
Part two contains analyses of the project site and the context.
Part three defines the problem for the project with function diagrams, room programmeming, a vision and design parameters to use as guidelines throughout the design process.
The final design proposal is presented through diagrams, plan-, section- and façade drawings and visualizations, together with quantitative studies and results on the atmospheric and thermal comfort of chosen compartments, as well as a calculation on the energy frame for the whole complex.
The design process describes how the final design project have been deduced via gained knowledge from analyses and theoretical studies from the programmeme and through the use of sketches, physical and 3D modelling as well as classification and simulation tools to document the technical aspects.
The report ends with an epilogue containing a conclusion and reflection of the project and process, table of references and app. supporting the programmeme and presentation.

The project objective is to create a design proposal that can realistically meet the needs for a relevant problem. The goal is to create a complex that lives up to the demands of the Danish building class 2020, together with a focus on an optimal and stimulating indoor climate for the residents. This will be achieved by applying knowledge and skills acquired throughout the education.

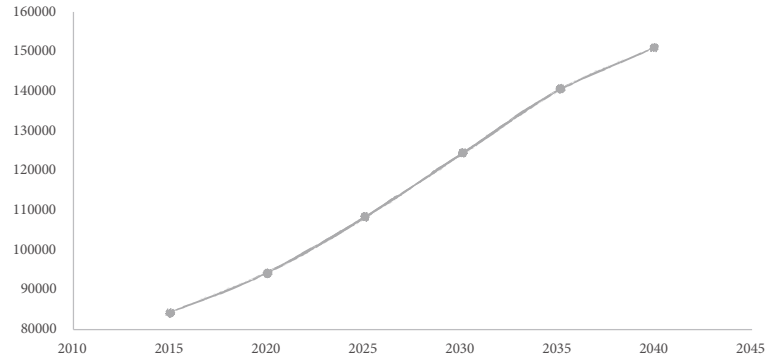
Motivation

Aalborg University implements two methodologies - problem based learning and the integrated design process – which use a problem as the fulcrum for a given project. This master thesis will focus on dementia friendly housing, which stands as a relevant community problem.

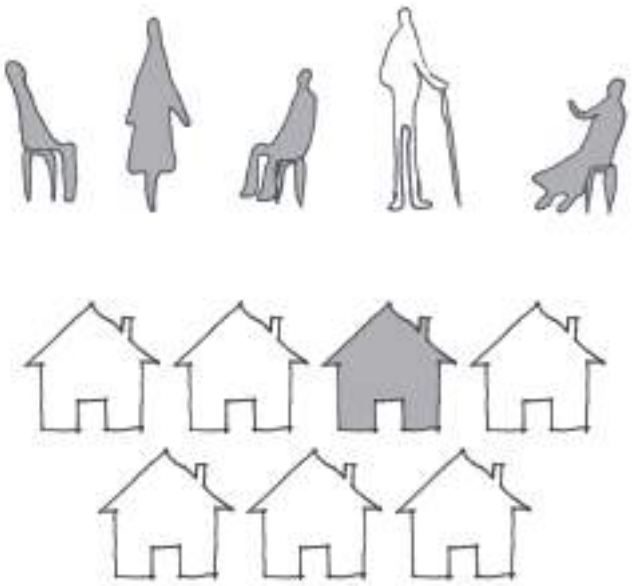
Dementia is a widely-spread disease. It is estimated that 80% of all institutionalized elderly have got some sort of dementia disorder (Kunnskapssenteret 2009). The risk of getting dementia increases with age. Combined with increased life expectancy, the number of dementia and therefore the magnitude of the problem is not getting smaller. Today, it is estimated that about 84,000 people suffers from dementia. By 2040 that number will increase by 80% equivalent to 150,000 people (National Videnscentre for Demens 2015).

This dramatic increase in dementia patients has gained attention in the political agenda. In December 2016, the Danish government issued yet another plan for improving the life of dementia patients, financed by half a billion Danish kroner. The aim is to guarantee that all municipalities become dementia friendly, get more patients diagnosed correctly and improve the care and treatment for the patients (Ministry of Health 2016).

As a consequence, the building sector has also been affected by the increased focus hence the lack of dementia friendly housing is significant. Four out of five people in nursing homes are suffering from dementia of some sort, while only one in seven housing units has taken dementia into account when designed (Danish Building Research Insititute 2015).



Ill. 2 *Expected increase in Danes suffering from dementia.*



Ill. 3 *Four of five inhabitants in nursery homes are demented, but only one in seven residences takes dementia into account.*

Methodology

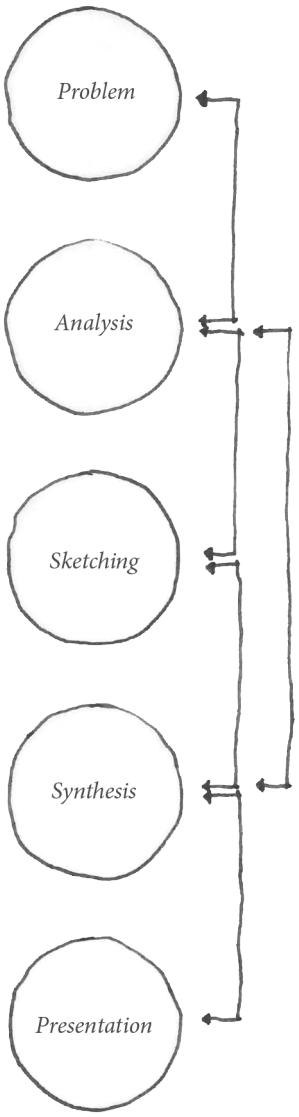
In the process of creating an architecture project, it has always been difficult to position the underlying methodology within a specific discipline. During the design process, the positivistic approach is often used as a staging point which is mainly associated with the traditional idea of science. Concurrently, however, there are also strong connections to the hermeneutic approach generally associated with social science (Bryman 2012). When describing the process in both architectural design and design in general, it could be described as a hybrid between the two approaches, both in terms of acquiring knowledge and one's perception of being. This means that a lot of different methods and tools are used in the process. The following section will give a brief overview of the methodology used in this specific project.

Architecture and Design approaches design through an Iterative Design Process (IDP). The fundamental idea behind the IDP is to make smarter and more efficient interdisciplinary solutions based on an iterative problem based process. The whole process starts with a problem which becomes the catalyst throughout the phases of the project, subdivided into analysis, sketching, synthesis and presentation (Knudstrup 2005). Using IDP, the aim is to unite aspects from multiple different disciplines i.e. engineering and architecture. This union of different aspects should be done through a solution-oriented process by working with both aesthetic, technical and functional characteristics (Knudstrup 2005). This idea of solution based process works well in parallel with the idea of problem based learning, which is one the core elements of Aalborg University.

The actual process of working with these different aspects unfolds in such a way, that the transitions between the different phases are blurred and difficult to pinpoint. The process is very closely related to the idea behind Kolb's learning cycle with its endless loops of investigation and reflection (Stice 1987). The basic thought behind the IDP is to include multiple aspects in the early phases and, in doing so, actively use those in the process as an aid for creating a better design, rather than being introduced at a later point, acting as an obstacle. In this way, the building components can be transformed multifunctionally in a broader perspective and synergize. This is for example seen in theory of tectonics where structure, space and aesthetics are working together to evolve from structures to meta-structures.

When analysing and acquiring knowledge, this project is relying both on inductive and deductive methods. It is important to note that cases with totalities are extremely rare and the two approaches is often combined in an abductive approach (Bryman 2012). For the programmeming, multiple different methodologies will be used. A vast amount of the knowledge acquired in the analysis is through literature studies i.e. professionals having reflected upon the specific empiricism – either through an inductive or deductive approach – then reflected upon again by the reader, thus resulting in application of double hermeneutics (Bryman 2012).

Investigations of the site has been dominated by literature studies and quantitative registrations. Phenomenology is used to make personal observations and registrations, using all senses to interpret the experiences and impressions had at the project site. These registrations can both be qualitative and quantitative and will most likely fall within the hermeneutic field (Bryman 2012). The design process mostly consists of visual oriented means of communication and exploration e.g. sketching and both modelling both digitally and physically. The advantage of using theses visually oriented tools benefits communication throughout the idea generation. Even more important is the advantage of idea generation, which happens because the onlooker is forced to relate to and reflect upon the suggestion. All suggestions should be accompanied by evaluation - both qualitative and quantitative - since every single iteration is essential for the overall progress of the project. These evaluations should ensure the project being developed in accordance with the design parameters and vision setup in the programme, which then answers the overall problem. The process should always be open for further iterations that allow for a revisit of the analysis phase to apply gathered knowledge and further improve the design,

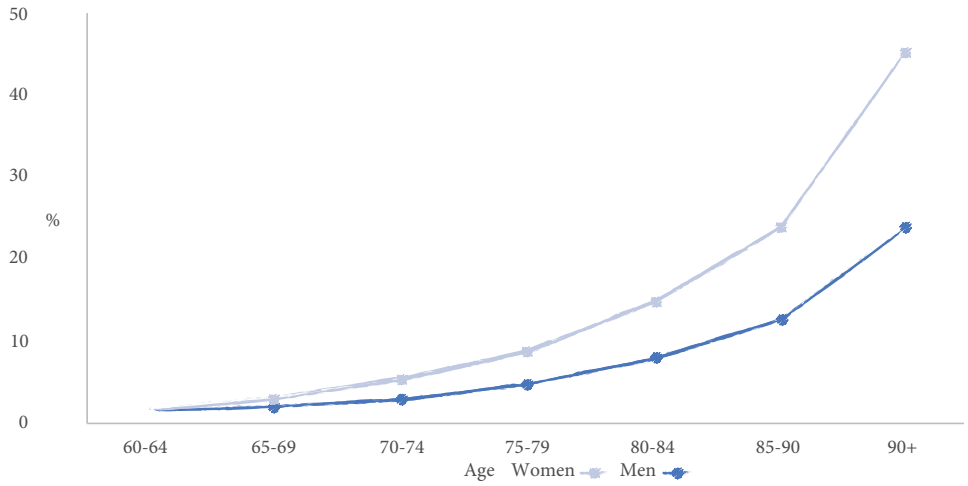


Ill. 4 *The five phases in the Integrated Design Process.*

Analyses of

The Illness and the Users

Dementia
Healing Architecture and Indoor Climate
Dementia Housing and Planning
Everyday Life at a Nursing Home
Visit at



Ill. 5 *The risk of getting dementia increases with age, and is higher amongst women.*

Dementia

In the following section, a brief explanation of the disease, the causes, consequences and affected will be clarified.

Dementia is one of the most widely spread diseases in the modern world. While many types of dementia exist, the common denominator is the deterioration of cognitive faculties resulting in loss of competencies one needs to make everyday life work (Heinig, Zens and Thiessen 2014). In most cases of dementia, the hippocampus is the first thing to get attacked. The hippocampus manages the spatial navigation, formation of memory and signals the rest of the brain under stressing circumstances by releasing the steroid hormone cortisol (Souza et al. 2013). The latter acts as a natural defence mechanism – a fight-or-flight response – where the rapidly increased level of cortisol helps improving short-term memory and adapting the physiology for the given situation (Institute for Memory Impairments and Neurological Disorders 2017).

One of the side effects, when physiological properties are optimized, is the downgrading of the immune system. When the hippocampus is deteriorating, it mainly happens because of amyloid beta peptides. Research show, that patients with increased cortisol levels also had dramatically high levels of amyloid beta peptides (Institute for Memory Impairments and Neurological Disorders 2017). This results in an ever continues spiral as people suffering from dementia have got increased risk of being stressed, which aggravates the illness.

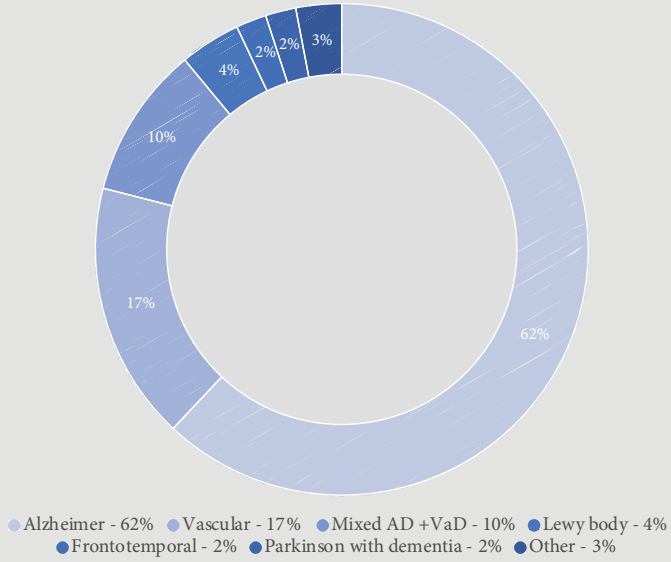
Dementia is not a stationary state but a slow continuous process. Some cases show the brain mass being reduced by more than 30% - from 1400 grams to less than 1000 grams (ed. Hof and Mobbs 2010). This deterioration of the mind is often divided into three stages (Clayton, Graham and Warner 2001):

- The early phase is characterized by language difficulties, lack of short term memory, depression, aggression and disorientation
- The second phase shows symptoms of severe forgetfulness, dependency on assistance for maintaining personal hygiene, toilet visits and bathing
- Third phase troubles the patient with eating difficulties, lack of bladder control and inability to recognize relatives, friends and familiar objects. Ultimately, the disease will lead to a fatal outcome

Due to slow development of the illness, signs of dementia often show a couple of years before both the affected and relatives notice. Where the surroundings can adapt accordingly and compensate for the initial signs, the mental faculties of the affected person will continue to decline. When differences between the affected and the surroundings become too big, the latter cannot compensate anymore and the slow degeneration appears as being sudden (Schmeider 2014).

Dementia does not only affect people who are diagnosed with the disorder, but just as much the people around them. Having a centre, which functions as a transition between living in a normal home and a nursing home is therefore of importance. Both for activating and rehabilitating the elderly in addition to socialising, creating awareness for the relatives and educate them on dementia and how to act.

Dementia is not a stationary state but a continuous deterioration of the mind and the design of a nursing home should therefore accommodate the different stages of the disease (Bascon 2010). The different cases of dementia are distributed as follows: Mild 55%, moderate 35% and severe 15% (Nationalt Videnscentre for Demens 2016). Adapting to the different degrees of dementia can be done through the design of a flexible housing unit, a series of units for temporary inhabitants and a centre to help people not residing in the nursing home. This centre can both create a smooth transition for future inhabitants and function as a social hub both for residents and visitors. To improve the life of the demented and delay the development of the disease, the facilities should be designed as stress relieving as possible.



Ill. 6 *The distribution of different dementia types is dominated by Alzheimer's Disease.*

Every type of dementia has its own characteristics and patients react differently, which makes it difficult to characterize the disease in general (National Videnscentre for Demens 2017 A).

Alzheimer's disease (62%):
Being the most common type of dementia, Alzheimer's disease results in apathy, depression and anxiety. In the initial phases the symptoms are minor, but as the cognitive abilities of the affected deteriorates, the effects of the disease increases.

Vascular dementia (17%):
The second most common type of dementia is known as vascular dementia that – like Alzheimer's disease – results in depression and apathy, but with a more recurrent and unpredictable frequency (Prince et al. 2016).

Mixed Alzheimer's disease and vascular dementia (10%):
Less frequent, a patient may suffer from a mix of both Alzheimer's disease and vascular dementia with above mentioned characteristics as a consequence.

Lewy body dementia (4%):
Characterized by sleep disorder and visual hallucinations.

Frontotemporal dementia (2%):
Severe neurodegenerative disease, that can result in impaired judgement towards physical consumption. The patients often get a tendency to eat, drink or smoke exaggerated and therefore require pedagogical help to control consumption (Prince et al. 2016).

The last 5% covers a variety of rare cases of dementia, with the majority being dementia as a consequence of Huntington's syndrome.

Ill. 7 *The four different indoor climate categories are: acoustic, thermal, visual and atmospheric.*

Healing Architecture and Indoor Climate

The senses are the primary contact we as humans have with our environment. When aging, some senses are changing because of the connection between the sensory organs and the nervous system weakens and environmental impressions reduces. This proves even greater for dementia patients, which calls for special demands for the design of housing facilities and the indoor climate (Hoof et al. 2010).

Healing architecture is a concept which supports the idea of architectural design playing an essential part in a person's well-being and the physical and mental healing process, through adequate daylighting conditions, sound, privacy, safety, etc. (Frandsen et al. 2009). The empiricism mostly focus on the health sectors – more precisely hospitals – but many design solutions can still relate to dementia friendly housing, and architecture in general as almost all architecture is build around humans and their well-being. In the following section, different examples will be presentet to how both the build environment and the indoor climate, can help to create a better architecture, that can contribute in synergy to improve the well-being of the occupants.

Lighting

Both natural and artificial lighting are important factors when designing dementia friendly homes. Studies show that lack of windows and natural daylight causes a weakening of patients' memory, the ability to orient themselves according to time and place and increase the number of hallucinations (Frandsen et al. 2009).

To accommodate for a steady circadian rhythm and improved quality of sleep – i.e. less movement and less interruptions - light intensity in common areas should be increased. If it is not possible to obtain high intensity daylight, artificial lighting can compensate for the lack thereof (Frandsen et al. 2009). A 75-year-old person requires thrice the light exposure as a 45-year-old in order to trigger the same circadian response (McNair 2014).

In relation to demented people, there is a connection between high activity levels and high intensity of daylight during the day and calmness during night time, this could also be accommodated by adapting the colour of the light during night to improve sleep patterns (Frandsen et al. 2009).

Daylight and sunlight also contributes to the relieve of experienced stress. This is supported by a study, where surgery patients experienced less stress in rooms facing west than similar patients in rooms facing east. The difference being 46% more light in the rooms facing west (Frandsen et al. 2009). A similar study were cardiac patients in identical wards who, beside their orientation, had varying mortality rates with the south-orienting wards being at 7,2% and the north-facing a rate of 11,6% (Beauchemin and Hays 1998)

These investigations only describe the importance of high intensity light indicated in LUX and touches upon the placement of the windows. In cases where windows are placed high in the room, does not offer a view or only let in an insignificant amount of daylight, a room without windows is considered equ-

al (Frandsen et al. 2009).
To design dementia friendly, considerations should include (McNair 2014; pp. 108):

- Increased light levels to twice the "normal" for an adequate visual response
- Use of daylight wherever possible
- Exposing people to the 24-hour cycle of light and dark for an adequate circadian rhythm
- Use sufficient "domestic style" fittings to help promote recognition of place

Sound
Various studies show, that sound and sound levels impacts a patients' physical and mental health. For demented people, the ability to hear sound can be crucially important whilst noise can prove harmful (Pollock 2014). Noise has been associated with distraction from activities, agitation and fear (Hoof et al. 2010).

Noise can - beside lighting – also be the main cause of sleep deprivation and affects the overall quality of sleep: length of a sleep period, number of awakenings, etc. (Frandsen et al. 2009). A shortening of reverberation time has an improving effect on patients' quality of sleep since otherwise high noise levels are reduced (Frandsen et al. 2009).

The hearing process can be described in three stages (Pollock 2014; pp. 110):

- Detection: Noticing there is a sound
- Resolution: Establishing where a sound is coming from
- Identification: Being able to understand and name the sound

Given that dementia is a disease affecting the brain, this process can be compromised and lead to hearing becoming confusing for the demented.

The correlation between stress and noise levels suggest that periods of time in silence has a positive effect on the physiological condition of the patient, since a noise reduction can lower feelings of anxiety, worry, excitability and lack of control. These feelings can also be caused by the lack of acoustical privacy in terms of sound irrelevant for the listener – for instance non-voluntary listening (Frandsen et al. 2009).

Established by the Dementia Services Development Centre at the University of Sterling, the five most significant acoustic issues are as follows (Pollock 2014; pp. 11-112):

- Reduction of noise: Paying attention to external sources of noise and creating a spatial layout that caters for internal noise levels
- Considering structure and construction: Taking absorption, transmission and insulation into account to reduce reverberation time and transmission of unwanted noise
- Considering reverberation time: Being aware of spatial dimensions in order to avoid a long reverberation time. When reflected sound reaches a listener more than 0.06 seconds after direct sound, it is heard as an echo (Pollock 2014)
- Improving visibility: People with compromised hearing rely more on visual clues such as lip reading. Smaller spaces allow easier visibility and face to face contact which is important for a better understanding
- Using assistive technology: Minimizing the use of assistive technology since audible alarms can cause anxiety distress for demented people

Thermal Comfort
Lack of possibilities to control ambient temperatures can lead to both irritation and discomfort and can lead to stress: Systems programmemed according to season rather than weather, problems regarding overheating in south- or west-facing rooms, lack of individual control over temperatures, etc. (Frandsen et al. 2009).

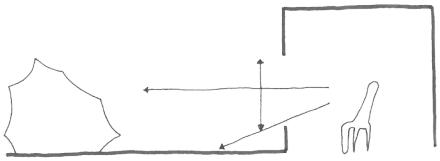
Atmospheric Comfort
Atmospheric comfort deals with the indoor air quality, and how it influences our health and well-being. The air quality is related to moisture, smell, bacteria and CO2 levels from building materials, ventilation and residential activities. The olfactory bulb in the brain is linked to the Thalamus-cortical region and the Limbic system which is a part of the brain that is affected by dementia. The Limbic system affects the behaviour and the Thalamus-cortical the olfactory sense which in dementia cases can cause abnormal behaviour, personality changes and aggression (Hoof et al. 2010). To reduce abnormal behaviour and aggression it is important to maintain a good atmospheric comfort through adequate ventilation.

Conclusion
It has become a well-accepted fact that the build environment affects the human well-being and health. All the four types of indoor climate have effect on both the physical health of the inhabitant, but also psychological. Making the natural circadian rhythm apparent for the inhabitants at the nursing homes is crucial for the sense of time and place thus resulting in better sleep patterns and health. This also goes for the change of season. Carefully designing the correspondence between indoor and outdoor both physically and visually can help relieve stress. Visual overview in a social space is also important to avoid exclusion of any of the residents. Small niches and different forms of seating should also be an opportunity. When discussing indoor comfort the debate can often become a one-sided endeavour for a climate with as little variation as possible, meaning a quantitatively stable indoor climate equals a good indoor environment. Generally, when designing for elderly the guidelines in DS/EN 15251 says that a category I is favourable, though going far beyond the regulations. Instead of doing this, the goal will be to design a less monotone indoor climate and use the wider window of operation to create a more stimulating indoor climate, where the occupants can sense the time of day and year. This should of course be done whilst still answering to all relevant regulations.

Dementia Housing and Planning

As research states, the physical environment can have a therapeutic effect on a person's well-being. In regards of dementia patients, it can also help to improve and preserve their behaviour, independence and functionality (Marquardt, Büter and Motzek 2014).
People with dementia have lesser capacity to regulate their environment, which makes it important to design in a way so it accommodates their needs. When people with dementia cannot regulate the environment, they can have difficulties in their abilities to orient themselves (Marquardt and Schmieg 2009). Here, studies point towards general initiatives on the physical environment:

Ill. 8 *A homely, non-institutionalized atmosphere*



Ill. 9 *Windows have more function tahn letting light in.*

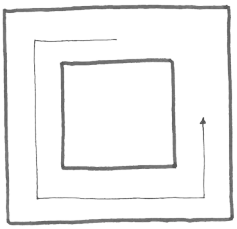
A homely, non-institutionalized atmosphere

Even though loss of memory is one of the effects of dementia, the emotional memory seems to persist, since patients, while not remembering the exact experience, still remember the emotional impact of it. Studies show that sensitivity to atmosphere increases concurrently with the decrease of cognition. This issue demands towards the planning and architectural design in regards of creating different environments for a patient when walking from one room to another.
The fundamentals of creating a good atmosphere for the residents is to create residences which are recognizable and reflects their life story, by having enough space to contain personal belongings and furniture. In continuation of this, it is important also to liberate the architectural design from any institutionalized atmospheres (Sigbrand et al 2016).

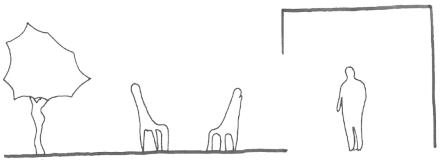
According to current legislations, a residence must include a living area as well as toilet and kitchen facilities. The private residence should be comprehensible for the resident, for which it should be arranged as one combined room with space enough for both a sleeping and a living area, with the ability of division if desired.
The residence should have the possibility of being furnished in different ways, depending on the resident's preferences and own belongings to meet a homely atmosphere. The residence should also contain enough space to maneuver with any wheelchair and for personnel to aid the resident if needed.
The sleeping area should contain enough space for the bed to be arranged in different ways according to the residents' preference or dependence on help from personnel.

Good lighting conditions, which stimulates the patient's circadian rhythm and orientation ability

Not only are dementia patients experiencing a loss of orientation but also time, wherefore lighting is of great importance for them to follow a steady circadian rhythm.
In the architectural design, it is important to secure good lighting conditions not only to stimulate the circadian rhythm but also for the resident to see and understand the environment. The therapeutic impact gained from good light exposure results in dementia patients being more active during the day and calmer at night, which contributes to a greater well-being and a calmer behavior (Sigbrand et al 2016).
Large windows can proove beneficial to let in a lot of daylight but also to create views to the surroundings. It is also important to consider the dimensioning and placement of the windows. Wide frames can create a clear transition from inside to outside and a low wall can make it possible for resident to look out from any given position.



Ill. 10 *Plans can should oblige to wandering and wayfinding.*



Ill. 11 *Conections to outdoor areas are important*

Small, manageable environments in which the patient can easily orient oneself

To relieve the stress level for people suffering from dementia, it is very important to accommodate easy wayfinding. To feel independent is essential for prosperity and quality of life, which is why the housing units should be arranged for easy orientation. Alzheimer's disease affects the cognitive map by weakening the sense of place, ultimately complicating the wayfinding ability. Research show, however, that patients suffering from mild dementia rarely experience difficulties orienting themselves, while severely demented are having problems.
Some patients experience purposeless wandering because of disorientation and trouble with wayfinding. Others tend to wander because of a natural energy discharge or physical or psychological restlessness (Sigbrand et al 2016).
Results from studies show, that straight circulation within the living unit affected dementia patients positively, since they can find their way better than in any layouts with numerous decision points. Orientation would be further enhanced with the whole corridor being visible from any given point of the living unit (Marquardt and Schmieg 2009).

Secure possibilities of contact with day- and sunlight, nature, wind and weather

A close relation to nature points to health-related attributes like improved well-being and mood, fewer cases of problematic behavior less use of medical prescriptions, etc. Studies conclude, that outdoors horticultural activities benefits the patients the most, since it contributes with more varied sensorial stimuli and the possibility for physical expansion and taking a break from the indoor environment (Sigbrand et al 2016).
In terms of architectural design, studies recommend that a good connection between in- and outdoors must be established, allowing the residents to have good views and to venture outside unsupervised in an enclosed environment. Furthermore, the outdoor areas should include various experiences and tempi to enhance independence and well-being.

Conclusion

Read-throughs of various articles has set the base point for the development of the housing units. Even though many agree on aspects of sensorial stimuli, i.e. how atmosphere and lighting pay a crucial part in the resident's well-being and behavior, lots of studies contradicts each other in terms of plan layout and the ability of easy wayfinding consequently. Qualitative studies have proven that number of viewpoints and references minimizes troubles in wayfinding sufficiently.
The conclusion upon investigating the matter is that no design is without flaws. This issue demands upon the architect to sort out arguments for the given design choice to make the best possible design which incorporates the above-mentioned initiatives in the best way possible.

What is a Nursing Home

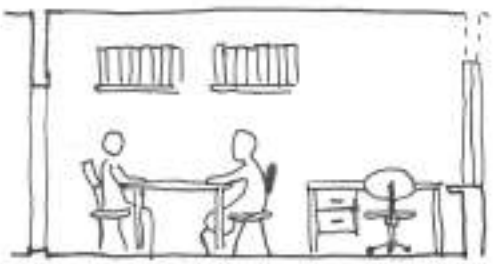
A nursing home consists of subdivisions and arrangements to promote a person-focused cultivation and care. As mentioned, it is important to create enclosed and manageable environments in order to enhance manageability and reduce stress. The different subdivisions are as follows and will be referred to for the rest of the report:

The organizational unit
The organizatinal unit is shared between housing units and contains a variety of commons facilities, which are used by the personnel across. The organizational unit is also consisting of rooms reserved for administrative work. The organisational unit should be an integrated part in the housing unit with a homely and safe expression.

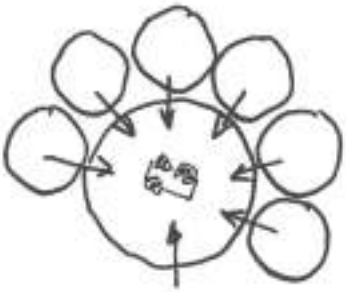
The housing unit
The housing unit consist of residences and common areas. The number of residences varies depending on the resident diagnosis and the arrangement of the personnel, but housing units usually consists of 6-12 residents.
To create security for the residents, all daily activities should be able to be carried out in the housing unit, sealed off from other housing units and nursing home facilities to create an enclosed environment. The facilities should include kitchen, dining area, living room and service facilities. These can be shared with another housing unit.

The residence
The private residence should express a sense of homeliness and allow for a personal touch depending on the residents' lifestyle, cultural background and individual preferences. As mentioned, the residence must consist of a living area alongside a kitchen and a bathroom including bathing facilities. These facilities should live up to recommendations regarding personnel and use of aides in sleeping and living area alongside bathroom (Sigbrand et al).

Day care centre
The day care centre is comprised of common facilities in connection to the housing units. The different facilities include both rooms for personnel and for the residents of the nursing home as well as relatives and elderly living at home, who can participate in activities at the day care (Sigbrand et al 2016).
The common facilities could include cultural programmeming such as a music room, hobby room, wellness and a café which could create connecting link between aforementioned user groups.

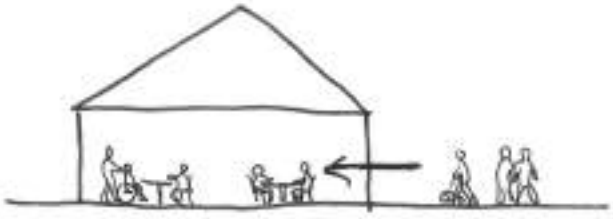


Ill. 12 *Meetining room in the organizational unit*

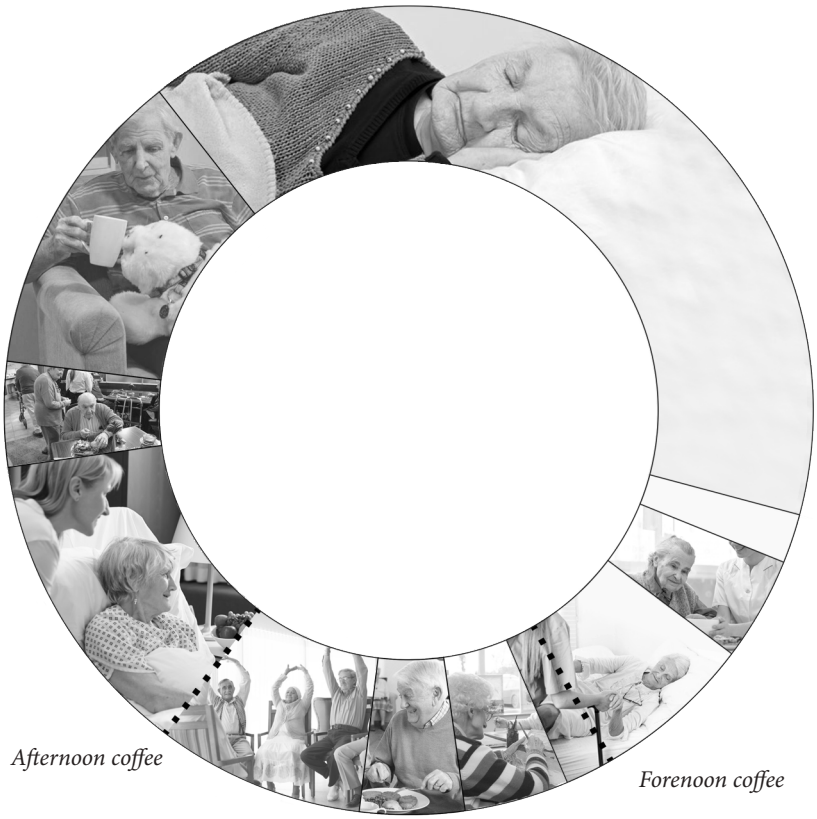


Ill. 13 *Housing unit with appertaining courtyard*

Ill. 14 *Flexible residence catering different needs*



Ill. 15 *Day care centre as the gathering point for residents and visitors*



Ill. 16 *24 hours in the life of a resident.*

Everyday Life at a Nursing Home

Introduction

The following section describes the circadian rhythm of both staff and residents of a prevalent nursing home. The purpose of the descriptions is to give an overview of various users of the complex, and in doing so take each individual need into account and incorporate these in the design process. This will ensure good living conditions for the residents and a problem-free work environment for the staff.

Everyday Life of a Resident

Morning:
Residents primarily get awakened by personnel if they are not themselves capable of getting up in the morning. Many feel the need for assistance when doing morning routines such as going to the toilet, taking a bath and getting dressed. Some residents also require medicine first thing in the morning (Kuben Management 2016).

Breakfast:
Depending on needs of the individual resident, breakfast can be consumed either in the apartment or in the common dining facility. Some residents may require one-on-one support from personnel (Kuben Management 2016).

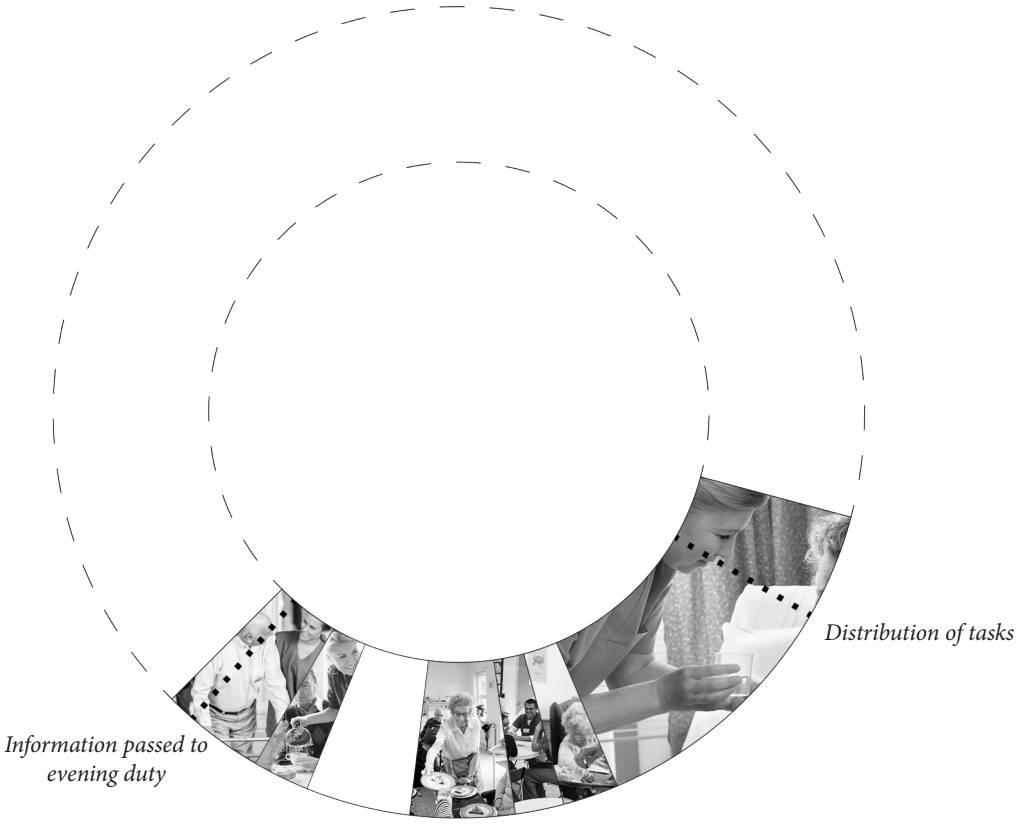
Lunch:
Lunch is served at 12 o'clock under same procedure as breakfast.

Dinner:
Dinner is served from 17:30 and the level of activity is afterwards reduced (Kuben Management 2016).

Night:
Come bedtime, the residents may require assistance with getting to bed (Kuben Management 2016).

Activities:
Activities of different activity levels are scattered throughout the day.

In the forenoon, a variety of smaller activities are arranged by therapist or personnel. This could include singing, walking, bicycling, etc. (Kuben Management 2016).
In the afternoon, residents are able to take a nap or participate in calmer activities. Coffee is served mid-afternoon and family and/or friends pay a visit around this time (Kuben Management 2016).



Ill. 17 *24 hours in the life of an employee.*

Everyday Life of the Staff

Personnel:
One personnel member has full responsibility for personal care of 4-5 residents per day; More in the afternoon and evening. The personnel are also focused on distribution and nutrition administration (Kuben Management 2016).

Therapists:
The forenoon is differentiated between personnel and residents, which sometimes leaves out time for documentation. Often therapists are acting as counsellors for the residents. (Kuben Management 2016).
The occupational therapist gathers information on the individual resident by participating in daily activities such breakfast and overall morning routines and observing possible difficulties. Occupational therapists are also participating during weekends where daily activities and individual training are the main focus points (Kuben Management 2016).

Conclusion

The circadian rhythm of the residents differs individually in terms of the need for assistance and the participation of various activities. It is important to ensure common facilities which encourage both social interaction and privacy. The residences should be flexible in a way, so the possibility of assistance is catered if needed.

The staff plays a substantial role in the everyday life of the residents in terms of assistance and rehabilitation. The staff have different needs in regards of logistics and office space which should be considered in the design.

Visit at

As part of the analyses of the everyday users, we have been visiting various different day care centres and nursing homes. On our visits we have been talking to the different staff members and users of the centres, to learn from their experience and their challenges in everyday life.

Lions Parken
Architect: KPF Arkitekter
Location: Lions Parken 4, Nørresundby
Year: 2005

With the focus on gathering information on a functioning day care centre, a visit to Lions Parken in Nørresundby was planned. The entire complex includes both a nursing home, senior housing and the day care centre. The day care centre receives visitors from all over Aalborg, including the senior housing and nursing home. However, a majority of the users are from outside the centre. It should be noted that the centre is not specifically focused on dementia, as it was built before the awareness on the illness had begun. However, a lot of the users have got some sort of dementia diagnostic which has characterised the centre over the years and the whole complex is planned to be renovated into a dementia friendly complex as a part of the plan of the municipality.

One of the major attractions in the day care centre is the café, which is open for everyone. Residents and visitors can get commissioned a certain number of meals a day to ease their daily life, while others can buy a meal. The café also works as the gathering room, and hosts bigger events such as community singing, visits from the local kindergarten and church services. The menu in the café is decided by a tenant council, who is also included in the process of planning activities, decorations, trips etc. The trips from the centre can be everything from a trip to the local supermarket or bowling centre, to a big picnic or trip to the beach. A request from the day care centre would be to share the means, both finance and transport, with the nursing home, as it opens up for more effective use of vehicles and parking. The centre also have a series of bikes at their disposal, all being electric, they are a huge success in the summer months. It is however important to consider that bikes where personnel can assist, such as tandems and rickshaws, are far more popular than individual bikes. Here it is also important to ensure possibilities to charge them while parked.

> *"[…] our citizens sit with quivering lower lips and tears in their eyes, when we have children over for Shrovetide or Saint Lucia parade, from pure joy."*
> Karin Jensen – Activity Manager

A successful concept at the day care centre is the blend of very bespoke rooms and rooms with a broader range of possible functions. An example of a bespoke room is the sun lounge, which is carefully arranged to give a sense of homeliness, with personal furniture, greenery in flowerpots and a fireplace. The more multifunctional rooms can be a simple training kitchen that is simple in its arrangement, and is mainly used for baking and making self distilled schnapps, while proper meals are made in the café. The hobby room or workshop is another example hereof. The room is under heavy influence of the users, and the reason for its success is the amount of influence they have been allowed to have on it. There has been installed an oven for burning of porcelain and clay, while it is also used for pathchwork, painting and so forth. The kitchen is also arranged to support a small computer workshop, to help the citizens with everything from banking, taxes and general communication with public authorities. The computers are also used for workshops on general computer skills, ancestry research etc.

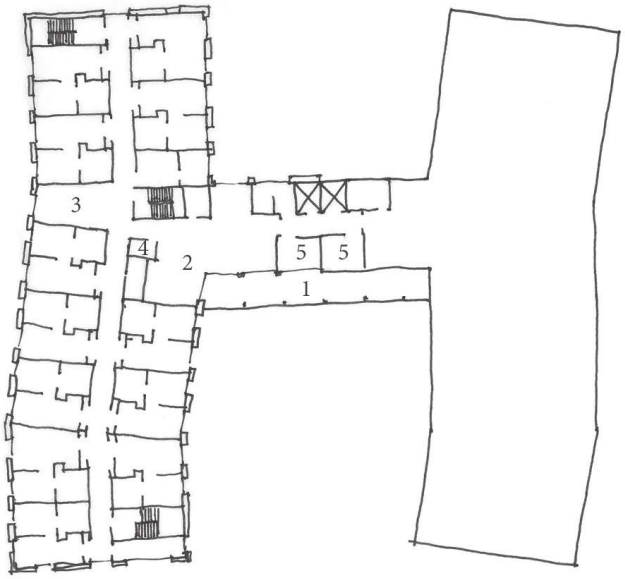
The last room which is often used is the exercise room, which is both open to the users for free training, scheduled teams and for the staff to use. The most popular activities include spinning and exercise on chairs, while machines for training is never used. The activities is held both by staff at the centre as well as by external professional instructors. The physical level is at a very low intensity so no dressing rooms or showers is needed, as the training functions more as means of keeping the body going rather than cardio exercise. The common garden, shared with the nursing home, has recently undergone a rearrangement to a bespoke dementia friendly garden, with the goal of stimulating the residents and visitors on both their sense and memory. The garden includes various themed sections such as forest and beach, greenhouse, pavilion and a memory garden, where the residents themselves can bring the plants and trees they have had in their previous home. In extension to this the centre also has a weekly garden activity, were the users can help out in the garden.

Ill. 18 *Greenhouse located in the sensory garden.*

Ill. 19 *Garden of memories lets the residents bring their plants with them to the nursing home.*

Ill. 20 *One of the more popular teams in the gym is "slow spinning".*

Ill. 21 *Drying racks are mounted both in normal height and in wheel-chair height so the residences can help with the daily deeds.*



Ill. 22 *2nd floor of Marienlund nursing home. The housing units are arranged in parallel, divided by an organizational unit, vertical transportation etc. Each unit is arranged with residences on each side of a hallway.*

1) Common terrace, 2) Kitchen and dinning area, 3) Lounge/Living room, 4) Cleaning room, 5) Wellness room.

Marienlund
Architect: Entasis
Location: Sanatorievej 40, Silkeborg
Year: 2017

The visit at the brand new Marienlund nursing home in Silkeborg, aimed at learning how a super modern dementia friendly housing unit and residence can be designed. The complex includes both a day care centre and a nursing home. The centre is open to everyone and the nursing home houses 120 residences. It is also a study on how a very large amount of residences can be arranged in multiple storeys, as the nursing homes is five storeys tall, thus resulting in a number of challenges in regards to outdoor access and wayfinding.

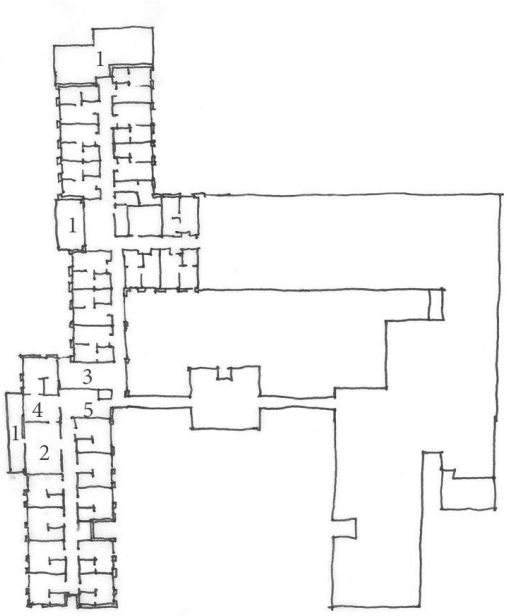
Each housing unit houses 18 residences, centreed around the common rooms in that given unit. The common areas include a living room, kitchen, wellness and dining area. All the areas are arranged in an open layout, with no possibility of sealing the sections off from one another.

The whole complex is very technologically advanced, each resident has his own bracelet that both works as a key for their home and as a call system if help is needed, thus making switches hung from the ceiling unnecessary. Furthermore, the entire complex is installed with circadian dependant lightning, enabling intelligent control of the lightning so the residents have an easier time staying awake in blueish light during daytime. During night time the light can change to a more reddish tone, making it easier for the occupants to fall asleep after a trip to the toilet at night for example.

Each residence is organized with a small kitchenette, living area, sleeping area and toilet. There are only permanent walls around the toilet, while the rest of the residence is fitted with demountable walls, so the residence can be adjusted to personal wishes and care needs, without moving the resident to another room. The ceiling lift in the residence is integrated in the ceiling of the unit so it can cover both the sleeping area and the toilet, by passing through the wall. When not used the lift can be stored in the wall. Furthermore, all the permanent installations and furniture in the bathroom is mounted in a movable system so everything from the sink to the toilet can be adjusted to fit the resident.

Ill. 23 *The lift is parked in a double sided closet accessible from both the toilet and bedroom.*

Ill. 24 *All interior in the toilet is installed on flexible mounts for adjustment to the user.*



Ill. 25 *1st floor of Birkebo nursing home. The housing unit with 24 residences, area laid out shifting hallways. The challenge lies in the many hallways, that are creating difficulties in wayfinding.*

1) Common terrace, 2) Kitchen and dinning area, 3) Lounge/Living room, 4) Cleaning room, 5) Parking fro wheelchairs.

Birkebo
Architect: Arkitektfirmaet Nord
Location: Forchhammersvej 23, Aalborg
Year: 2017

The visit at Birkebo was a study of a dense nursing home with 105 residences on a site two thirds of the project site - day care centre not included. The new building is an extension of an existing nursing home, and is built with residences in two storeys and common areas on the third. The densely build structure means that only little areas are available for making usable outdoor spaces. As a contrast to Marienlund, having residences in two storeys, all housing units have access to a roof terrace as compensation for their lack of access to the terrain. A visual connection is also made in the main area of vertical transport, where a double high room has been placed, while the connecting staircase also has been made more spacious, altogether making the relation between the floors very clear.

The common rooms in the nursing home includes a physical room, a creative room, training kitchen, meeting room, wellness and a large assembly room. Some of the rooms are used a lot, while others are rarely used at all. The staff requests more flexibility between the rooms that are placed next to each other to make it easier to host big groups of people for community singing and church services. At Birkebo they are also having great success with having children over from various institutions. Furthermore, a very popular event is visiting-animals - dogs and even ponies.

In the section from 2005, a housing unit of ten residences is specially renovated for severely demented residents. The contrast between the institutionalized design of Marienlund to the homeliness of Birkebo was very clear in this department. By only making the housing unit for ten residents, it eases the stress they are put under from social relations and wayfinding.

> *"[…] we use an immense amount of time on helping our residents finding their way around, they simply can't find their way in these housing units. Before we had a plant at the end of this hallway that helped a lot, but now someone moved it so they get lost again."*
> Thomas Eggersen – Occupational Therapist

Ill. 26 *The door connecting the severely demented to the rest of the nursing home is camouflaged.*

Ill. 27 *The typology allows for roof terraces, but little outdoor space which is sealed of with "dementia fence".*

Liselund
Architect: gpp Arkitekter
Location: Liseborg Hegn 10, Viborg
Year: 2009

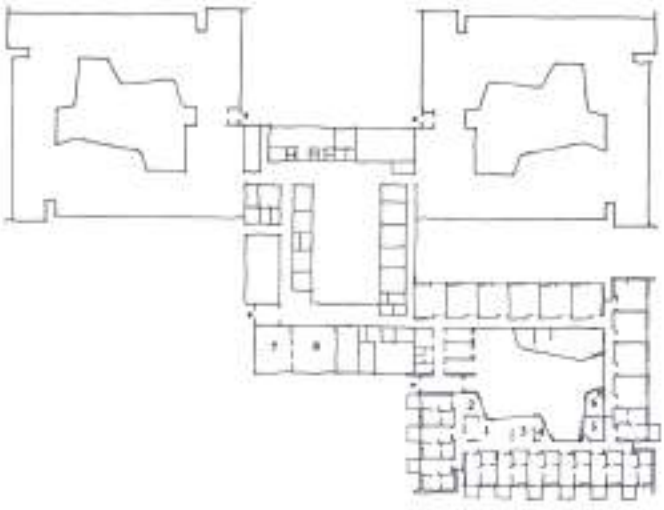
Liselund is a dementia specialised nursing home, made up of three housing blocks and a main building. Each block houses 20 residents making a total of 60, 50 of while are normal dementia housing, while the remaining 10 are four short term units and six residences for severely demented. In extension to the 60 residences, there are two visitor residences for relatives.

The main building of the centre includes administration, main kitchen, orangery, wellness, fitness and a joined café and classroom. The educational facilities are used a lot and celebrated for its flexibility with the café in the shape of a folding wall. In extension to education the classroom is also used for dancing and other activities with the residents. The café however, is isolated from the rest of the build and have not become the open gathering point it could have been. It is used mostly for common events and parties. The fitness room is supplemented by the courtyard which is designed in collaboration with occupational- and physiotherapists. Unlike the conventional outdoor training machines, the courtyard at Liselund is fitted with more simple effects like two way stairs with a good railing, steppingstones and musical instruments. The wellness room is fitted with a hairdressers stand, which works well as a part of the overall salon atmosphere. Howver, an issue with the room is its need for shading when placed on the ground floor due to a lack of privacy. An unheated orangery with big glass areas is used to stimulate the residents through fluctuating temperatures over the year.. The room is used for flower arranging, playing games, having dinner etc.

The three housing blocks in the structure are all made up from one organizational unit, housing the main administrative functions and two housing units, each housing 10 residences a common kitchen, dining room and living area. In each block the two housing units are arranged in an L-shape, together forming an enclosed courtyard. In one corner, each block connects to the main building through the organizational unit. The common area in each housing unit is made up from a lot of niches arranged in an open plan. The noise transference has however presented itself as an issue especially between the TV-room and dining area. Furthermore, the kitchen is placed centrally, giving it good visual contact with the common area. However, over the past year walls have had to be installed to enable separation to keep unpredictable and perhaps violent residents from entering and getting hold of knifes etc.
In terms of wayfinding the two merged housing units does not create any problems, but allow circulation and a larger safe outdoor area in the centre, compared to just one housing unit. Challenges do however occur when entering the block as you enter the organizational unit, which is not visually connected to the garden, that is otherwise the main navigational element in the unit. Administratively the double unit layout is an advantage, as the staff can easily support each other and only two people are needed for each housing unit and only one person during night. There is however a need for a specific room for the staff, and a room otherwise intended for the residents have had to be converted into an office.

All residents have their own private terrace. They have however been fitted with hasps to keep the residents from letting uninvited people inside. The residences all have a small niche in front of their door. However, it is not wide enough to place anything if it cannot be hung on the wall. Lastly, a general problem is a lack of storage space, in relation to the residence. This is such an issue that a common area in one of the blocks is being used as a storage instead.

All hallways are open, and everyone can stroll around, and according to the staff they are experiencing few issues with residents getting lost, after a few months living at the nursing home. Originally colour-coding was used as a strategy for wayfinding, with for instance all toilet doors painted red. This did not prove itself very effective. The users could not relate to the colours and some even got more depressed from the institutionalized use of colours. Today, more success is had with using simple signs, but with an informal and cosy font, as a contrast to clean fonts often used in traffic and transportation hubs. The hallways in the centre is fitted with “memory boxes” on the walls and other artefacts that both help starting a conversation and stimulate memory. The surrounding area is included in the nursing home and because of the open layout ,the residents can go for a walk, most often unaccompanied by a staff member and the context is used as an extension to the nursing home, as it is both a scale and typology many of the residents can relate to from their earlier life. This also goes the other way around as the neighbours are invited over, and the nursing home is always open for anyone.



Ill. 28 *Ground floor of Liselund nursing home. The three blocks are organised around the main building. They are all connected through the organizational unit, joining two housing units in a circular plan layout.*

1) Kitchen and dining area, 2) TV-room, 3) Activity zone, 4) Niche, 5) Improvised personnel room, 6) Quiet room 7) Class room 8) Café (3 and 4 are in one case converted into storage space).

Ill. 29 *"Menmory box" retrofitted to the walls in the hallways.*

Ill. 30 *The distance between housing units is 10 m, and fitted with plastic animals to provoke conversation.*

Ill. 31 *The courtyard in the main building is simple means of exercise, for example a staircase with varying inclinations.*

Ill. 32 *On all north oriented residences a south oriented skylight is mounted on the otherwise flat roof.*

Partial Conclusion

Dementia is not a condition with a singular facet nor is it stationary. It is an illness which affects patients in various ways depending on the specific type of dementia and progresses over time. In terms of architectural design, theoretical guidelines and studies point in an overall direction of how to create a facility which meets the patients' need in terms of well-being and improvement. The examined empiricism explains how aspects such as daylight, noise nuisance and variations of comfort plays an integral part in this way.

On top of this, the empiricism also points to the patients' sensitivity in terms of atmosphere and sense impressions, where personal inventory and spatial qualities are appreciable aspects to enhance well-being.

Residents of the nursing homes are very dependent on the personnel, as some are having trouble executing otherwise simple, daily routines, which is both supported by guidelines and interviews. The presence of personnel also offers the residents a sense of calm and security. It is therefore important to create a good connection between subdivisions of the complex in order to create a sufficient and flexible work environment.

Visits around different dementia nursing homes provides a basis for the design process, since impressions have been gathered and empiricism could be compared to physical cases and then be reflected upon. Here, the most noticeable aspect was the sensory impression that institutionalized design choices brought about in regards of a patient's well-being. Interviews for instance clarified that use of colours as a highlighting element in wayfinding gave the resident the impression of a hospital, resulting in depression.

As already discussed, lots of theoretical studies are conflicting, and when applied, they might not work as intended - as some visits around various nursing homes suggest. It is therefore important to take a critical stance and reflect upon design choices when a problem arise, since given guidelines might not be the definitive answer.

Analysis of

The Site and the Context

Location in the City of Aarhus
Introduction to the Site
Vegitation
A Phenomenological Approach
Windscape
Soundscape
Lightscape

Ill. 33 *The site is located in the north of Aarhus, here shown in relation to other key locations in Aarhus.*

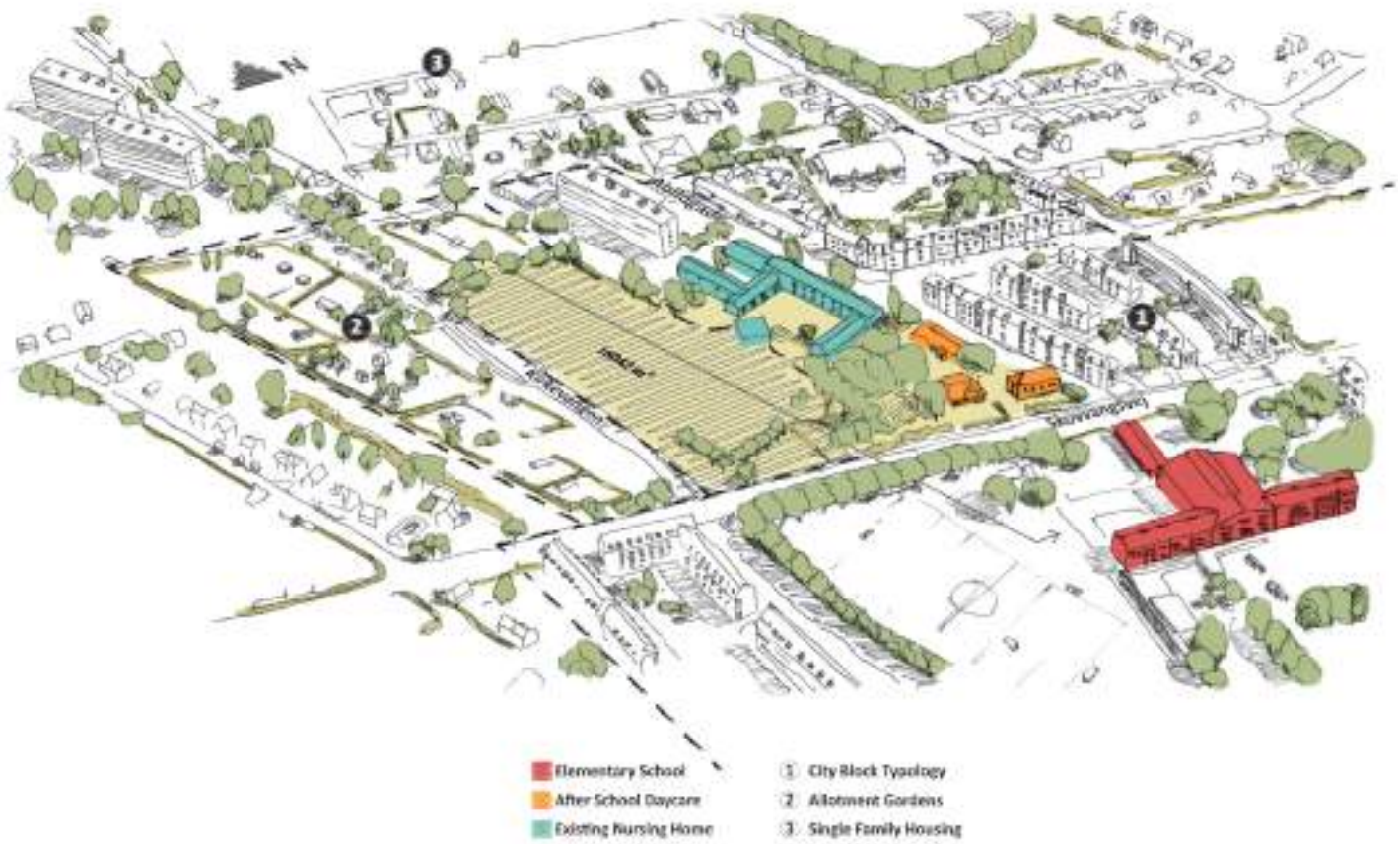
Location in the City of Aarhus

The location of the project site has been picked in correspondence with the municipality of Aarhus, who have chosen a site to be subject for development. The project is a part of the overall dementia plan by the municipality. The new project is going to be called Dementia and Brain Centrum Aarhus (DBC Aarhus).

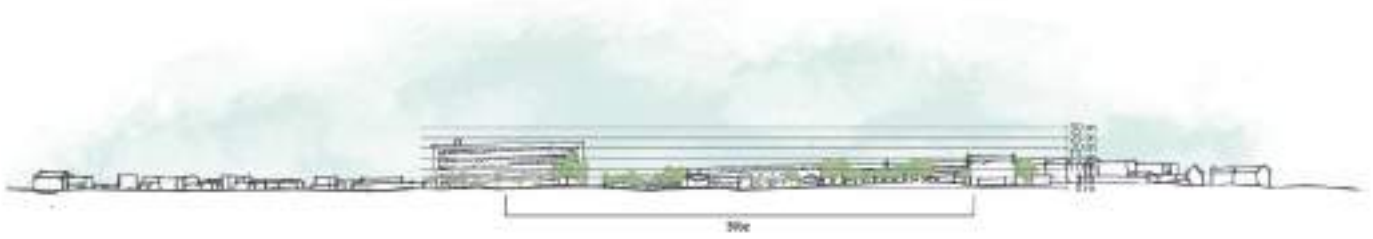
The site is located on the two addresses Skovvangsvej 97 and 99 in the district of Christiansbjerg situated in the northern part of Aarhus. From the beginning of the 20th century up until the 1970s the area developed into its own small community. It was characterised by low open typologies and functioned as a suburb to Aarhus. In the beginning of the 1970s the university marked the edge of the city of Aarhus, but during the decade, the city expanded and Christiansbjerg became part of it. During this expansion, the area became characterised by a mix of both functions and typologies. The same can be said about the area today as it is characterised by everything from single-family housing and larger city blocks to a few allotment gardens (Lundskov 2012).

Over the past year, the development of Aarhus has mainly taken place in the southern part of central Aarhus and the harbour area with both educational and public-functions as well as Aarhus Ø. However, the outer district like Fredriksbjerg and Christiansbjerg, are now getting into the picture as well. Christianbjerg is undergoing more and more development especially from public institutions such as educational and care facilities. Part of this development is the DBC Aarhus facility.

During the next section, the site and near context will be subject to more detailed analyses. The analyses will cover both climatic, phenomenological, geographical and aesthetic characteristics.



Ill. 34 *The near context around the site is made up of a mix of typologies and functions, both city blocks, single family housing and an allotment garden.*



Ill. 35 *The height of the neighbouring buildings vary from 5 metres to 23 meters. The local threes varies from 8 to about 20 metres.*

Introduction to the Site

The project location is in the middle of a very diverse area both in the sense of typologies and functions. It lies just in the bordering lands between the big city block structures of the central city to the south and the open single family housing areas to the north. The dense structures of the city are generally four to five storeys tall, with the exception of the large housing complex neighbouring the north-eastern part of the site which is seven storeys tall. As a contrast to the big housing blocks, small allotment garden association lies with 58 small houses located west of the project site. The context to the north and west of the site is mainly a low open typology made up of single family housing.

Abildgaarden, the neighbouring building to the east of the site, houses the current nursing home that will be expanded. The nursing home is a three and two story buildings. The new DBC Aarhus should be an extention of the existing nursing home, but with the option of rebuilding the it. South of the nursing home an afterschool day care is situated, housing children from 0th to 4th grade. Across the road Skovvangsvej is "Skovvangskolen" an elementary school with about 600 pupils enrolled.

The site of 16042 m^2 is characterised by a relatively even slope towards the south-eastern corner from north west. The total decline of the site makes up a total height difference of about four to five meters.

Many aspects are to be taken into account when considering the site and its surroundings. These include the many different typologies located around the site, as well as the many different functions in its very proximity. These could be used together in synergy with the nursing home to make even better conditions for both parties. However this should be done under careful considerations of what affects it might have, both positive and negative.

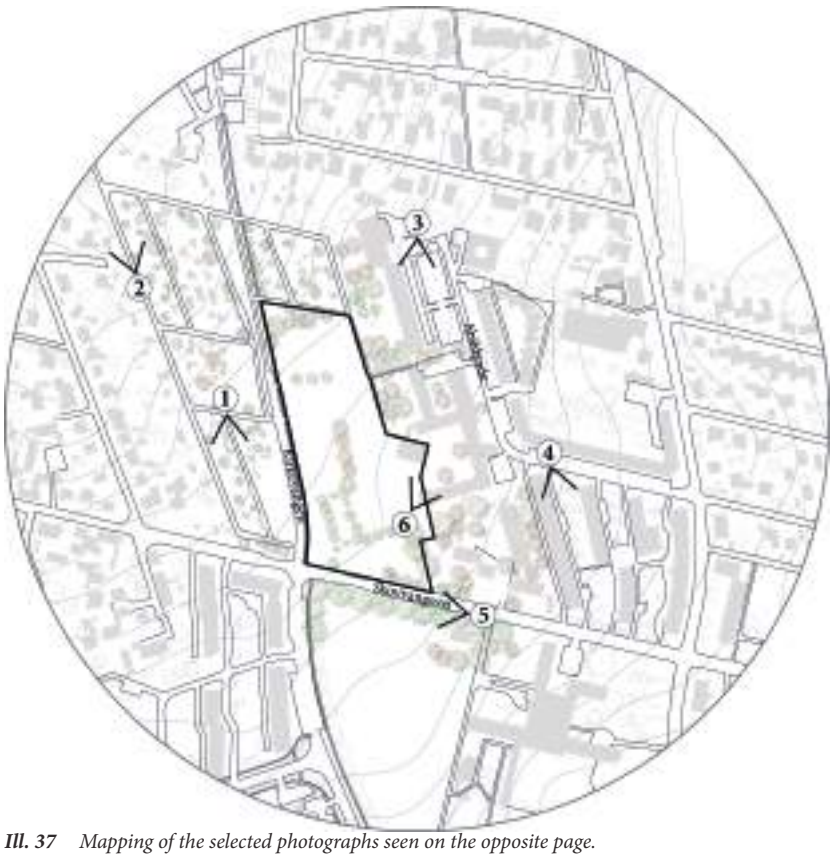
Ill. 36 *Mapping of the surrounding vegetation is varying with the typologies.*

Vegetation

The vegetation in the area is mainly floriferous in all directions. To the south the school and sports field is defined by straight lines of tall trees creating an almost avenue-like feeling. In the eastern direction of the after-school care and the tall building blocks, the vegetation is also characterised by the same tall solid threes, but arranged in clusters, creating zones with both dense and open greenery. In the north-western direction in the allotment garden area, the vegetation gets more open like the typology, and is characterised by lower and more diverse greenery.

Since it is floriferous vegetation, their shading properties change over the duration of the year, during summer they function as solar shading to prevent overheating. During wintertime, their leaves will fall off and they will allow more sun to pass through and contribute with passive heating.

Vegetation or green elements in the urban environment is also a positive factor in terms of life quality. Studies show that people living in close proximity to green areas consider themselves having a better quality of life than people further away. Furthermore, people living within 300 meters of green areas have stress levels 12% lower than people living more than one kilometre away (Stigsdotter et al. 2011). Vegetation can stimulate the human senses as it reflects the seasons and weather, through seeing hearing and smelling. For the observer, this creates a sense of having a greater contact and interaction with both time, period and being (Stigsdotter et al. 2011).



Ill. 37 *Mapping of the selected photographs seen on the opposite page.*

A Phenomenological Approach

The following analysis is based on a phenomenological approach to investigate the site, with the aim of capturing the atmosphere of the site and the surroundings. The view map and photographic documentation is used to illustrate the local conditions. The numbers in the text refer to a picture and location in the view map.

Walking east along Skovvangsvej towards the site, the many single family houses from the neoclassicism set the tone. In the early morning and the afternoon, the pedestrians, cyclists and a few cars create a hectic atmosphere of the many children going to school. While getting closer to the site, the surroundings change with larger, classic apartment blocks shooting up from east with vast green areas between them. Northern, leaving the bigger road into the allotment garden, the complete contrast is very apparent with very small, colourful houses catching the sight (1). Further north, 60's modernist building blocks can be seen rising in an area otherwise dominated by villas.

Walking on the small gravel paths between the allotment sheds all sense are stimulated as you can both see and smell the gardens, hear people going about with their gardening only interrupted by the crunching beneath your feet and the bird singing around you as you walk along (2). Exiting the allotment garden out on Abildgade, the wind can be felt again in the open area dominated by modernistic buildings (3). Walking on the paths between the apartment blocks in the area between Abildgade and Skovvangsvej, the latter can vaguely be heard again with the occasional car passing by. The buildings are characterized by added balconies with walking frames and lawn furniture and towers for elevators - easing the life for the elderly residents (4).

Going back onto Skovvangsvej, the sound of playing kids fill the air, both from the school and after school day care. After the school day has ended, the roads are very quiet and the soundscape is dominated by the children in the area. The huge old trees along Skovvangsvej and the sports field identifies the area and frames the entire road (5). Walking in between the dense vegetation on the other site, you get the feeling of a dense forest with the moist ground with twigs and leaves giving away underneath your feet and the sound from the roads slowly dying away only to reveal the sound of playing children again. As you clear the dense vegetation you enter the area of the existing nursery home build in two to three storeys in yellow bricks - the characteristic material of Aarhus. In the open courtyards of the nursery home, the wind dies away and can only be heard in the tall trees, while leaving the green areas unaffected. Centrally in the courtyard the soundscape is overshadowed by the voice of many people joint in common song coming from the assembly hall (6).

Ill. 38 *Low hedges and colourful houses.*

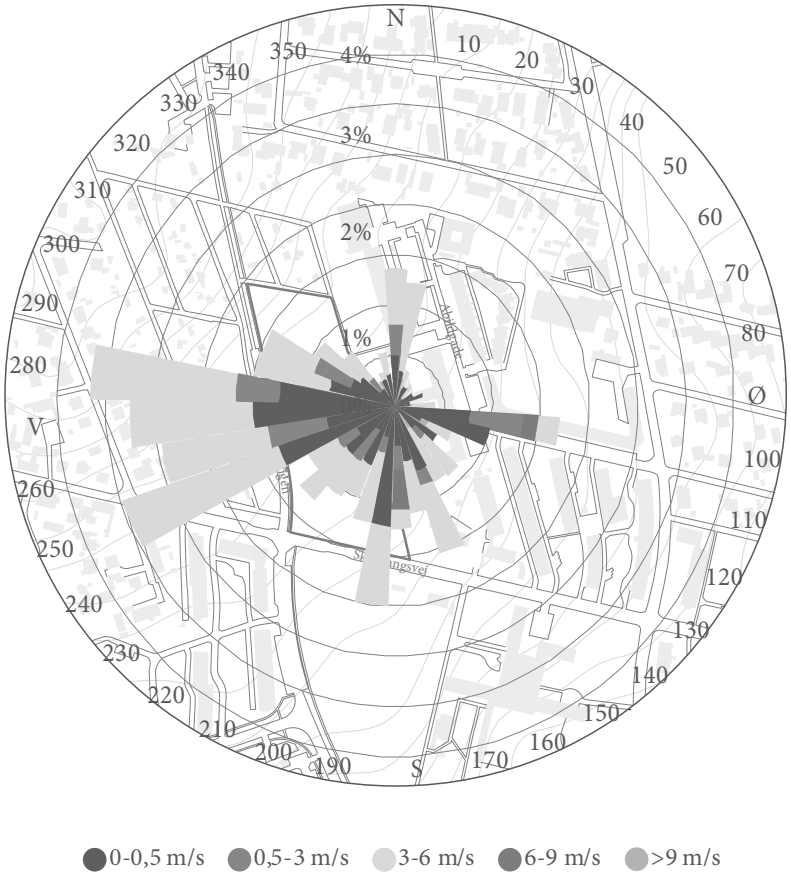
Ill. 39 *Low allotment gardens and tall city blocks.*

Ill. 40 *Minimalistic housing unit.*

Ill. 41 *Renovated elder housing.*

Ill. 42 *Tall trees borderlining the sports field.*

Ill. 43 *Interior courtyard in the existing nursing home.*



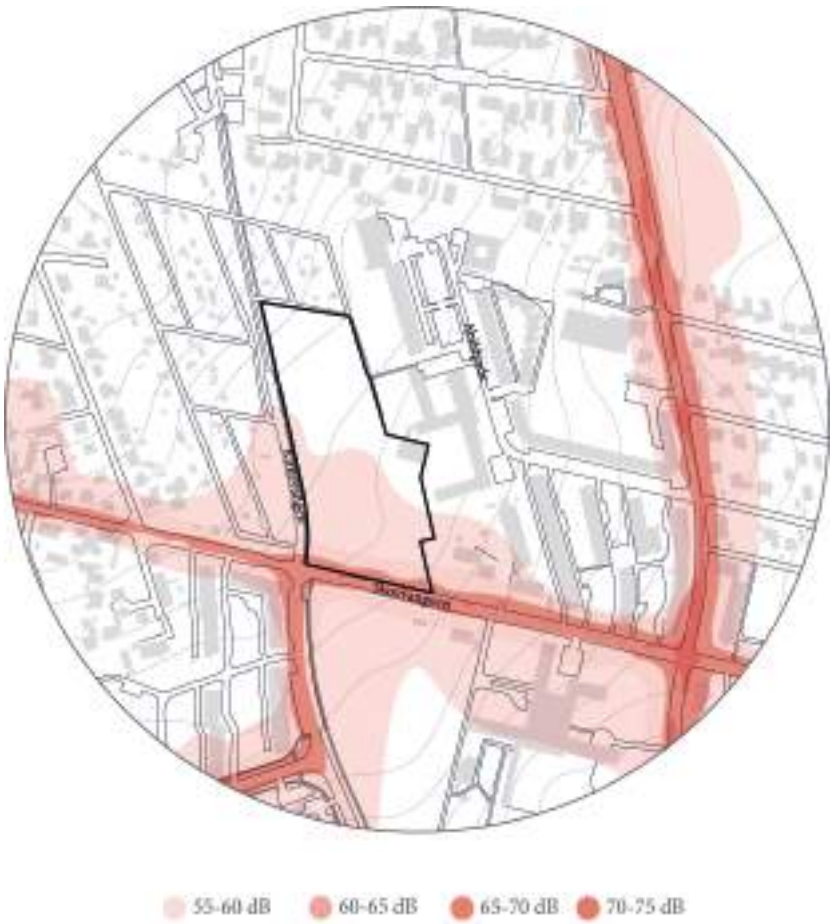
Ill. 44 *Regional wind analysis plotted in a wind rose showing wind speed, direction and frequency.*

Windscape

To analyse the local wind conditions on the site the regional wind data has been plotted into a wind rose to examine the direction, speed and frequency of the wind. For the analysis, the winter period was excluded as the wind properties is more relevant during the time periods that accommodates people staying in the outdoor spaces and wind as a natural driving force for ventilation.

Walking around the surrounding area it is very clear how much the area is shielded from winds, and especially how important the low dense vegetation is in shielding it off. The same goes for the existing nursery home, that can create a completely protected area, within its two courtyards, whilst in between the larger building volumes the winds prevails when shifting to a parallel alignment.

When designing the building and especially the outdoor spaces the local wind conditions should be considered. In this project specifically there is a good supply and access to wind coming from the west. This is due to the low context in that direction, and the area being the dominant wind direction. From the south and east the larger masses in the context creates a more shielded environment.



Ill. 45 *Noise mapping in the area conducted by the Danish Environmental Protection Agency*

'Sight isolates, whereas sound incorporates; vision is directional, whereas sound is omni-directional. The sense of sight implies exteriority, but sound creates and experience of interiority. I regard an object, but sound approaches me; the eye reaches, but the ear receives.'
(Pallasmaa 2012)

Soundscape

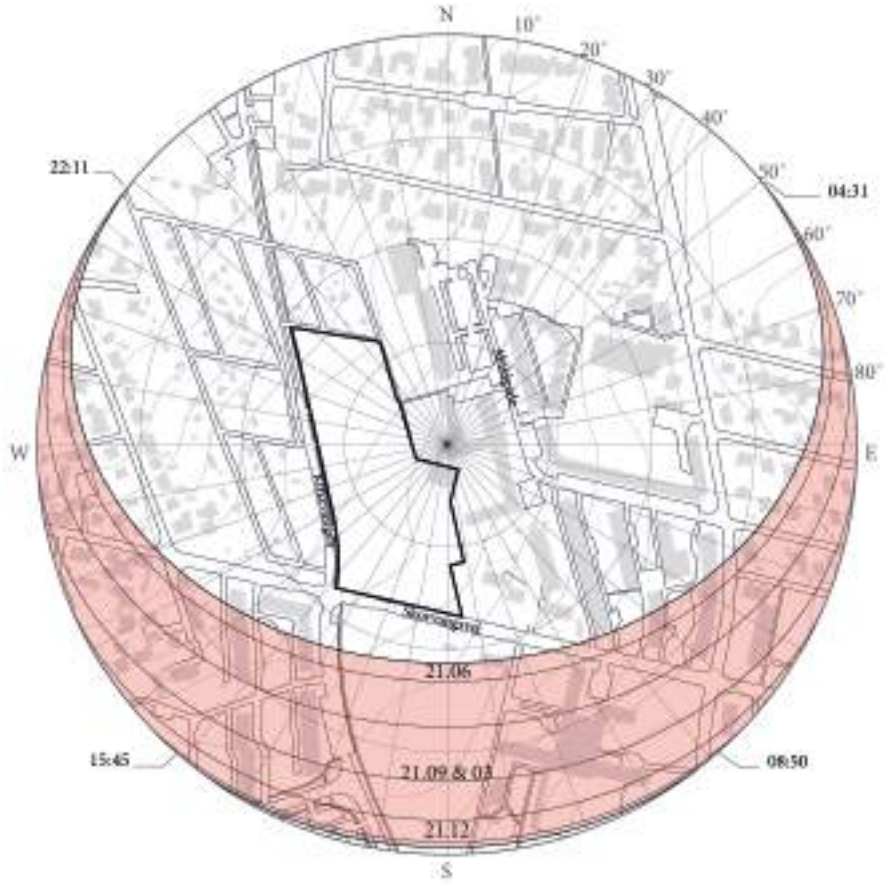
Pallasmaa describes how sound differs from many other senses, and how sound indulges all impressions, whereas sight for example is very directional and narrow in this regard.

When considering city planning through the 90s and 00s the soundscape has often been a neglected element in the considerations during the design. City planning in that period was highly focused around visual aspects in our surroundings. Sound is a very important element in our daily life both in the way that we experience our surrounding and for our mental and physical health. Research shows that excessive noise can harm the human health by causing headaches, increasing stress, increasing the risk of getting diseases and many other consequences (ed. Braubach, Jacobs and Ormandy 2011).

A lot of urban planning today is based on the ideals of the 70s which had a rather conservative approach to design. An example is Jan Gehl, who was developing theories based on totalities, either something is good or bad for you: Seating is good; no seating is bad, long sightlines are good; short once are bad, silence is good; noise is bad. However, city planner Lise Rask argues that sound should be cultivated and used in its contrasts rather than avoided (Rask 2016). An example of this could be Ørestad Bypark, which is a very vast open green space surrounded by big volumes. It is a space with a very long and wide acoustical horizon. It is characterised by very little intimacy and every sound becomes very strong. Even though the background noise from the highway is very low since it is far away, it becomes very clear.

The mapping illustrates the average noise level during daytime, measured by the Danish Environmental Protection Agency (Geodatastyrelsen 2012). The measurements are characterised by very little amount of noise coming from traffic nearby. With the noise level ranging between 55 and 60dB in the exposed areas of the site, it is a low exposure. Only at the very border to Skovvangsvej the noise level rises up to 70dB, and should be considered in the design.

In the process of working with architecture and urban design, the sound should be integrated in the process. Exposure to excessive noise should be avoided and integrating sound to activate the senses reinforces both place and space. The deliberate use of acoustic contrasts can help make the acoustical landscape a soundscape worth exploring.



Ill. 46 *The global sun analysis shows the shortest day is less than five hours, while the longest is almost 16 hours.*

Lightscape

The conditions for sunlight should be considered in two different scales, both globally and locally. The global properties are defined by the latitudinal position of the site and can be used to generally define the solar angles both altitudinal and azimuthal, which is characterised by a high altitudinal angle during the summer months and oppositely low angle during the winter period. The east-western width of the span of the sun is described through the azimuthal angle. During summer the span is very wide and even includes northern sun, while in the winter periods it is narrowed down to nearly only including a southern direction.

The local properties of the context influences how solar access is at the site. For this, solar simulations has been made to calculate the number of hours with direct sunlight during summer, winter, fall and spring (see app. 1).

Sunlight is an important factor both in the terms of energy and well-being of the inhabitants.The weather dynamically changing across the seasons creating an expression of time. Here in the northern region the light is remarkable but unreliable particularly during winter. Daylight is vital for any human being, research shows that lack of daylight causes irregularities and dysfunctions in the hormonal balance and the risk of getting a depression is dramatically increased (Henning Larsen Architects 2012).

Daylight is very important in the design of buildings, both in regards of the indoor and outdoor environment and should be carefully considered throughout the design process. The sunlight conditions are affected both by the local and global properties. Looking at the daylight analysis (app. 1), summer solstice will contain most sunlight hours while winter solstice will be the day with less. The surrounding context is relatively low and will not have any influence on the site. The surrounding buildings will have very little influence on the daylight access on the site, and only the new DBC Aarhus will be affecting the conditions.

Partial Conclusion

The elements investigated in this section of the analysis sets the foundation for the overall design in relation to the site and surroundings. This being the contextual and environmental properties of the site, both local and regional. The outcome of the analysis creates the fundamental understanding of the context used in the design process.

The location of the new DBC Aarhus is in direct physical connection with the existing nursing home, Abildgaarden, which is potentially going to be rebuild. The context is made up from a mixture of various typologies and functions. The many typologies raise the question whether to match a certain style in the area or to design an alien object to add to the mix of styles and typologies. The transit in the area is heavily influenced by the many institutions in the neighbourhood, with people and kids walking along the path next to the site and more traffic along Skovvangsvej. This flow of people is an effective indicator of the daily life, by revealing the time of day and day of the week. The allotment garden is a very quiet and peaceful neighbour which can provide stimulation for the residents. All the elder housing in the area will provide the basis for a lot of users of the future day care centre. Furthermore, by positioning the DBC in an area like this, the day care centre can provide a graduate transition for those who will eventually live at the nursery as it will form a common space for everyone.

Sound can be used as an effective stimulant for the elderly, but it should carefully be separated from noise, as it can worsen their state. The area is relatively quiet compared to its central location with only little sound entering the site. Compared to the surrounding typologies, the sound can relatively easily be dampened. The sound scape should be considered so acoustical horizons that are too vast is not created. The green element in the area is a strong presence, and can be used as a characteristic factor for the project, and work with the possibilities that are already present. The local climate in general is an important factor in the architectural design, as it both has a physical and psychological influence on the users of the new DBC Aarhus. The design of the building should ensure good amounts of daylight both inside and outside. The wind should be considered when designing the outdoor environment.

Definition of the Problem

Energy Frame
Functions
Room Programme
Vision
Design Parameters

Energy Frame BR15 Building Class 2020

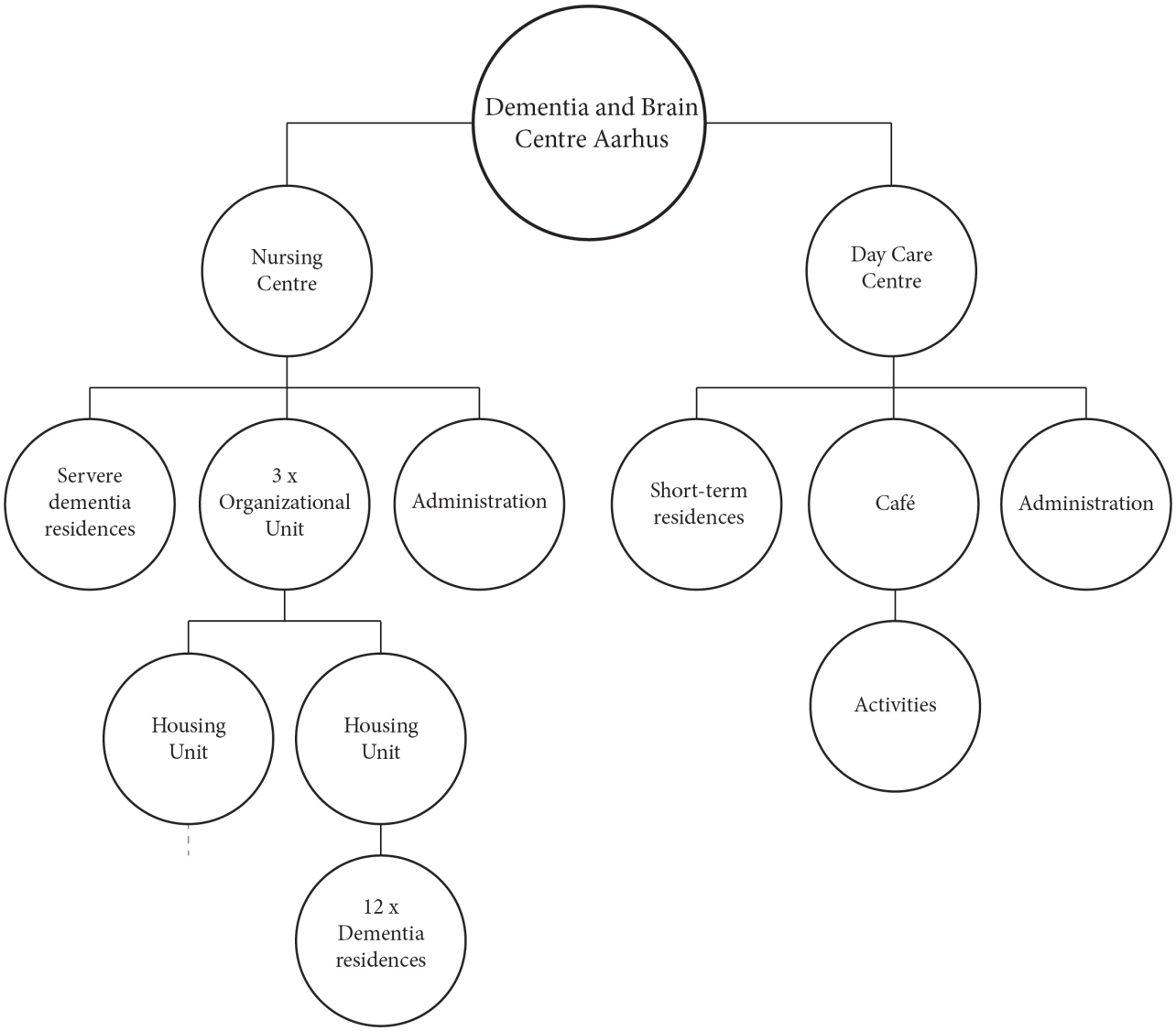
For the new dementia friendly centre in Aarhus to adapt to future requirements, the building must be designing to comply to the Building Regulations 2015 building class 2020, appertaining requirements to indoor climate, fire conditions, energy use etc.
The energy frame for building class 2020 involves both common and specific regulations for both housing and various, individual institutions. Since the design comprises of both housing and a dementia centre with administrative programmeming, both regulations need to be fulfilled (Bygningsreglementet 2017).

Some of the common requirements is the maximum infiltration maximum transmissions loss through the building envelope. The maximum infiltration at 50 Pa is 0.5 l/s per m^2 and the maximum transmission loss is 3.7 W/m^2 through the building envelope for one floor and 4.7 W/m^2 for two floors. Other requirements include maximum U-value for exterior doors and use of heat recovery in the ventilation system. For exterior doors, the maximum U-value should be 0.8 W/m^2K (1.0 W/m^2K). The heat recovery for ventilation must be minimum 85% (Bygningsreglementet 2017).

For the energy frame of building class 2020, the differences in requirements for housing and institutions are the maximum electricity use for air transport (SEL) and indoor temperatures. Differences can be seen on ill. 47-48.

Ill. 47 *Requirements for building class 2020 specific for housing.*

Ill. 48 *Requirements for building class 2020 specifically for "other".*

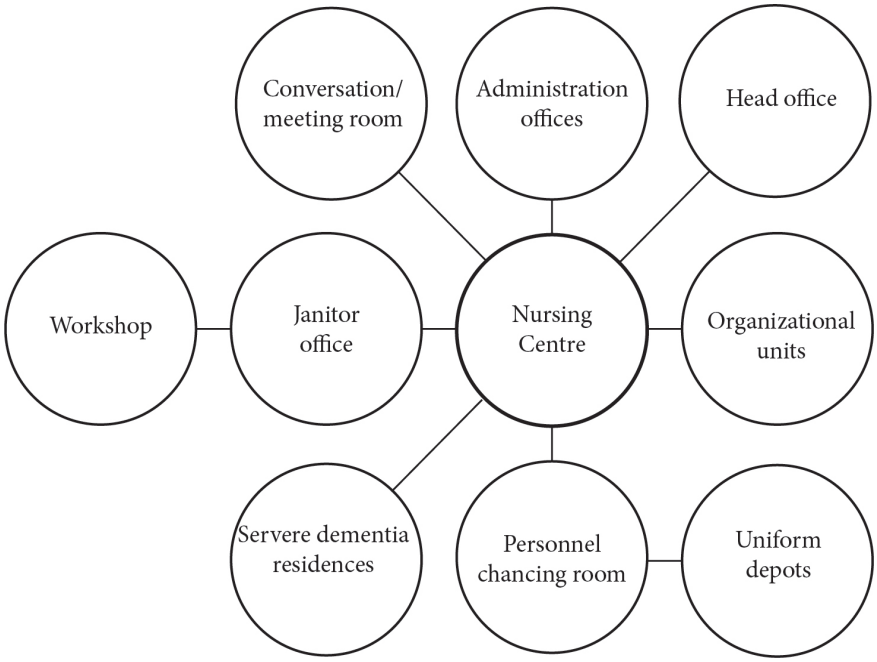


Ill. 49 *The overall layout of DBC Aarhus with the two overall facilities being the nursing home and day care centre.*

Functions

The diagram shows the interconnection between the different functions in the complex. The complex should not be physically divided since it is important for the personnel to move effortlessly between each unit in the new DBC Aarhus. The residents should however experience the housing unit as a "delimited" world, since it is not the intention for the residents to wander or stay anywhere else than the housing unit and the outdoor garden area. All residents and citizens can come and use the different facilities in the day care centre.

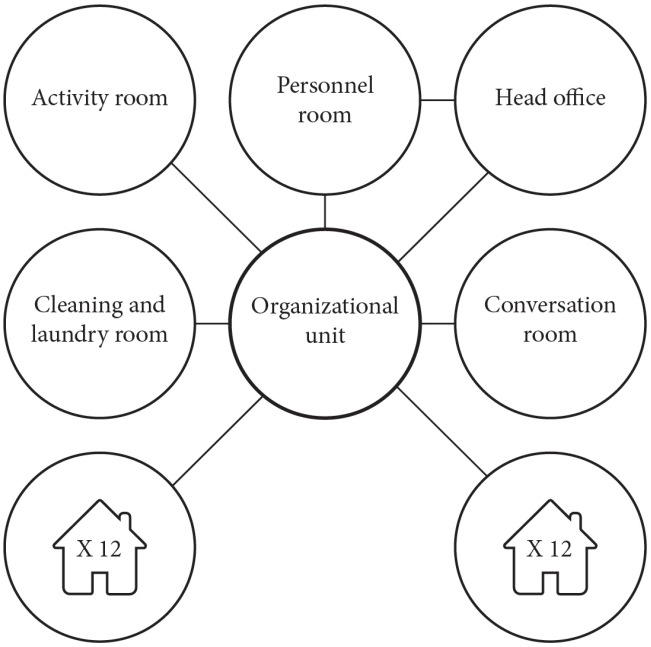
The new DBC Aarhus is divided into two main categories: The nursing home and the day care centre. Each category consist of different departments, as shown on ill. 49. The two main categories have some common facilities consisting of functions such as delivery depot, changing rooms, education and janitor office. The following function diagrams illustrates different sections of the centre.



Ill. 50 *The internal distribution of functions in the nursing home.*

Nursing Centre

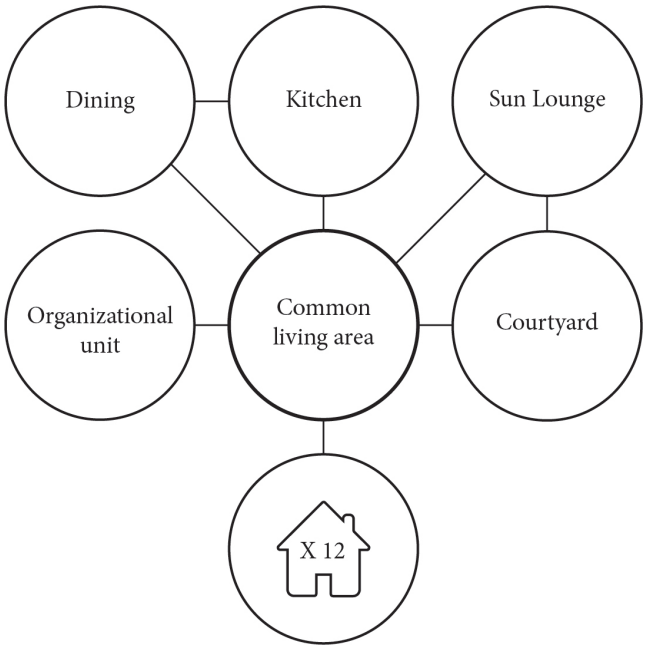
The nursing centre contains administration, the housing units and the residences for severely demented. These are placed with the nursing centre for logistical purposes. It is important that the personnel are in close connection to the severely demented residents they are in need of nurturance throughout the day.
The nursing centre also manages the housing units and educational functions but do not have to be directly connected to these.



Ill. 51 *Functions in the organizational unit.*

Organizational unit

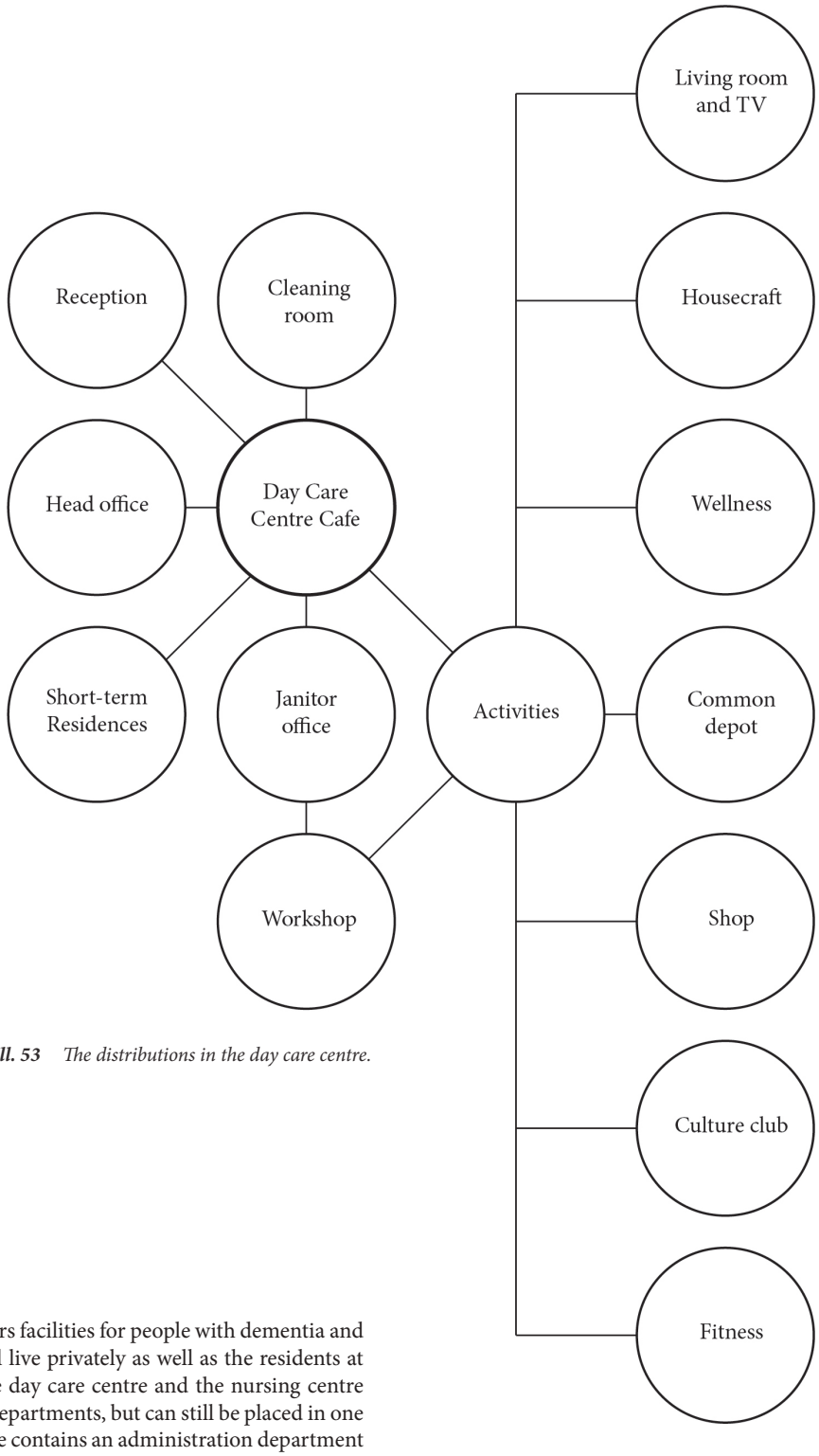
The organizational units consist of all the personnel functions in the housing unit such as cleaning/ laundry room, head office, personnel room, conversation room and activity room. The organizational unit is the area where the personnel can do administrative work and have breaks. One organizational unit manages two housing units each consisting of twelve residences.



Ill. 52 *Distribution of functions in the housing units.*

Housing unit

The housing unit consists of twelve one bedroom residences with private toilet and bath. The residences are well connected to a common kitchen, living room, dining area, activity room and a sun lounge. The common facilities do not have to be closed rooms, but can work as one large common space divided into smaller areas. Two housing units share an organizational unit. From the housing unit, there have to be a good connection to a secured outdoor area for the residences.

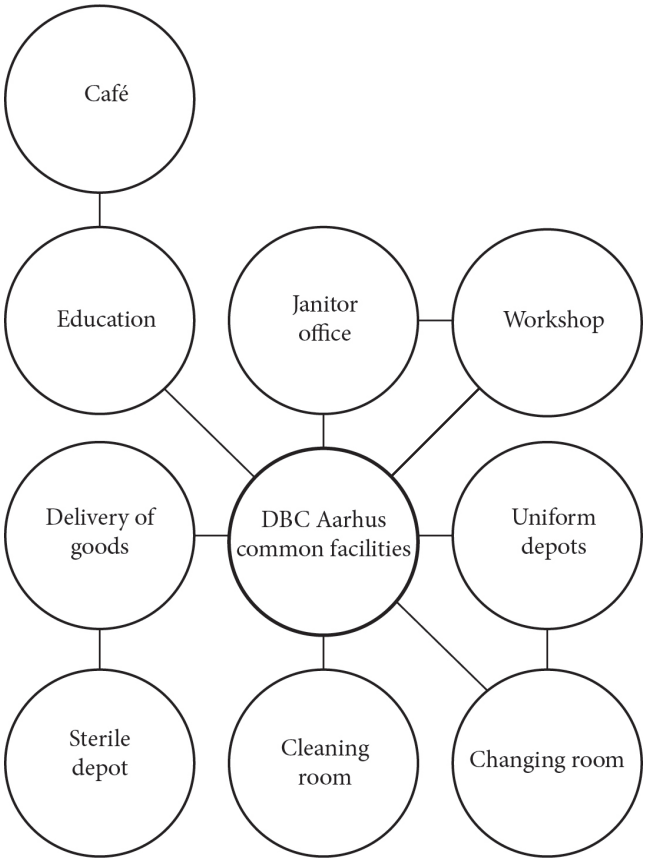


Ill. 53 *The distributions in the day care centre.*

Day care centre

The day care centre offers facilities for people with dementia and their relatives, who still live privately as well as the residents at the nursing centre. The day care centre and the nursing centre works as two separate departments, but can still be placed in one unit. The day care centre contains an administration department with offices and conversation room, and a department with different activates such as a café, workshop, wellness, fitness, culture club, housecraft. workshop and a small shop.

The café is a fulcrum for the social life for the new Aarhus DBC and is the place where residences, personnel, visitors and course participant eats and meets.



Ill. 54 *The distributions in the common facilities in the DBC Aarhus*

DBC Aarhus common facilities

Common facilities for the new DBC Aarhus consists of, delivery depots, classrooms for education, changing rooms and a janitor office.

Room Programme

Organizational Unit

Room	Number	Area [m^2]	Total area [m^2]
Vestibule	1	7	7
Head office	1	9	9
Personnel room	1	15	15
Meeting room	1	12	12
Cleaning/ Laundery room	1	10	10
Personnel toilets	2	2	4
Activity room	1	40	40
Total	8		97

Common areas

Room	Number	Area [m^2]	Total area [m^2]
Kitchen	1	18	18
Depot	1	4	4
Dining area	1	35	35
Living area	1	35	35
Sun lounge	1	20	20
Toilet	1	5	5
Total	6		117

Residences

Room	Number	Area [m^2]	Total area [m^2]
Living room (kitchenette)	1	20	20
Bedroom	1	12	12
Bathroom	1	7	7
Depot	1	3	3
Total	4		42

Administration

Room	Number	Area[m^2]	Total area [m^2]
Head office	1	30	30
Personnel office	1	28	28
Conversation room	1	12	12
Copy	1	6	6
Toilet (HC-WC)	1	5	5
Total	5		81

Residences for severely demented

Room	Number	Area [m^2]	Total area [m^2]
Living room (kitchenette)	1	17	17
Bedroom	1	10	10
Bathroom	1	7	7
Total	3		34

Common and personnel for residences for severely demented

Room	Number	Area [m^2]	Total area [m^2]
Common space (+ kitchen)	1	40	40
Personnel rom	1	20	20
Laundry	1	4	4
Personnel toilet	1	3	3
Total	4		67

Day Care facilities

Room	Number	Area [m^2]	Total area [m^2]
Vestibule	1	7	7
Café (+ reception)	1	100	100
Café depot	1	15	15
Culture club	1	50	50
Fitness	1	60	60
Wellness (+ toilet)	1	35	35
Housecraft	1	20	20
Shop	1	25	25
Workshop	1	20	20
Living room	1	30	30
TV-room	1	25	25
Toilets	2	6	12
Common Depot	1	15	15
Total	14		414

Administration

Room	Number	Area [m^2]	Total area [m^2]
Head office	1	30	30
Conversation room	1	12	12
Toilet (HC-WC)	1	6	6
Copy	1	6	6
Cleaning	1	12	12
Total	5		66

Short-term residences

Room	Number	Area [m^2]	Total area [m^2]
Living room (kitchenette)	1	17	17
Bedroom	1	10	10
Bathroom	1	7	7
Total	3		34

Common facilities for DBC Aarhus

Room	Number	Area [m^2]	Total area [m^2]
Wommen´s changing (+ 3 WC)	1	100	100
Mens changing (+ 2 WC)	1	50	50
Uniform depot clean	1	8	8
Uniform depot polluted	1	8	8
Delivery depot	1	30	30
Sterile depot	1	10	10
Janitor office	1	30	30
Bike room	1	30	30
Classroom (25 persons)	1	50	50
Classroom (12 persons)	1	30	30
Toilets	2	3	6
HC-Toilet	1	5	5
Total	13		357

Outdoor facilities

Room	number
Parking for personnel and guets	41
HC Parking (38+3)	3
Bike parking	40
Minibus parking	2

Way Station for Ambulance and Taxi

Shed for waste disposal

Ill. 55 *Room programmeme broken down in each overall segment of the DBC Aarhus, specified for the each segment. Each segment might occur multiple times throughout the project.*

Vision

The overall aim for this project is to create a sustainable nursing home, with a focus on dementia friendly design. The DBC should meet the building class 2020 requirements both in regards of energy and indoor climate. This will be achieved by implementing passive strategies. Altogether the goals should be reached using an integrated design process focusing on both the aesthetics and indoor climate, all with the aim of creating a well-functioning nursing home with minimized stress and a good sense of homeliness.

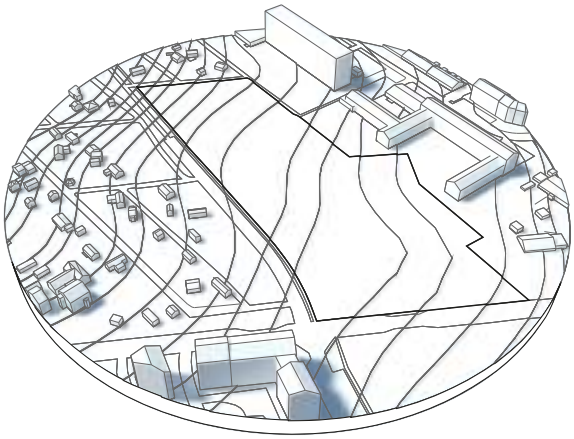
The architecture should explore and utilize the green areas, mixed characteristics and typologies, while still ensuring the relation to what the residents would consider as familiar or homely. The complex must include both a nursing home for the permanent residents as well as a day care centre to support external users.
The DBC Aarhus should both provide a safe environment for its residents while serving as a base for information and awareness towards the city of Aarhus in regards of dementia.

The huge social problem that dementia has become puts new demands to the design of modern nursing homes. With the mean lifetime expected to increase dramatically in the future, the problem is only increasing over time. With the only known factor to reduce the development of dementia is to avoid stress, the centre should be as stress free as possible.

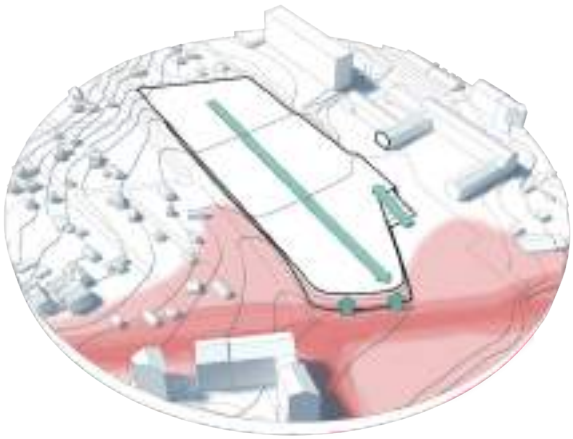
Design Parameters

- The complex should include both a nursing centre and day care centre, and the functions they share.
- The day care centre should be open to the public and facilitate numerous activities to activate elderly citizens.
- The architecture should contribute to the aesthetic experience of walking through the area.
- The overall shape of the building should facilitate an outdoor area that is both stimulating and secure.
- The complex should be organised to shelter from any potential noise disturbance from the road.
- The scare amount of ground floor access should be utilized to create secure sheltered outdoor areas.
- The characteristic green context should be incorporated in the project.
- The residences should be arranged in overall housing units that supports social life, easy wayfinding, wandering and administrative synergies.
- The relation between indoor spaces and the common outdoor spaces should be a gradient transition both in terms of privacy and exposure to the exterior.
- The building envelope should be utilized as an integrated part of the architecture, as part of the passive strategy or an interior design element.
- Windows in the complex should be designed to facilitate good daylight conditions, good visibility and functional usage.
- The indoor climate should meet all requirements in regards of the building regulations and building class 2020, but also be used actively in supporting a healthy circadian rhythm for the residents.
- The energy frame for the project should comply with building class 2020.
- The residences should accommodate multiple different stages of disability and dementia by being designed as flexible as possible to avoid moving residents around.
- All residences should include a personal niche for easy identification.
- All residences should have a visual connection to a green area.
- No residence should be allowed to have daylight only from the north.

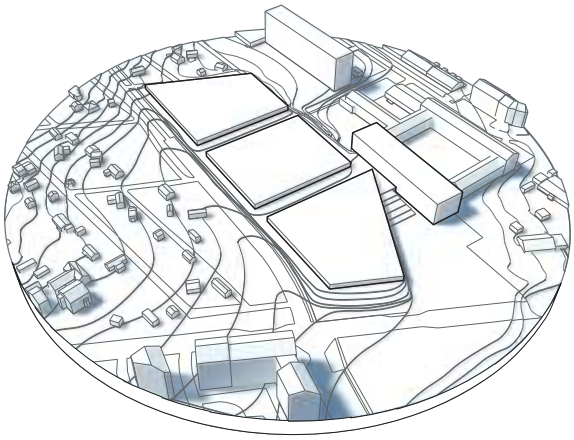
Presentation



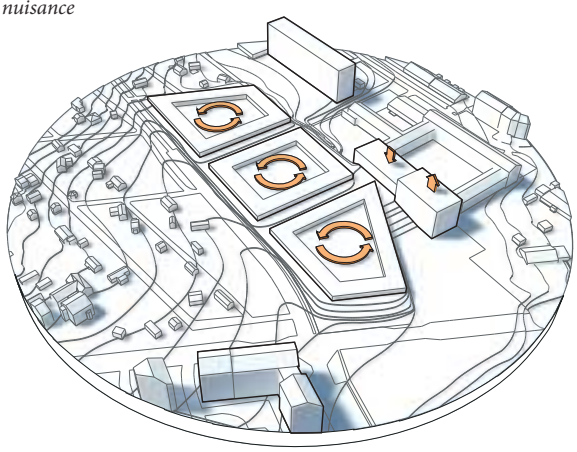
Ill. 56 *The site in its context.*



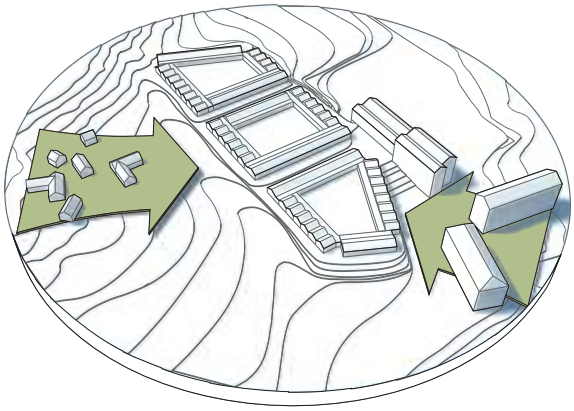
Ill. 57 *The terrain is lifted, increasing accessibility and preventing nuisance*



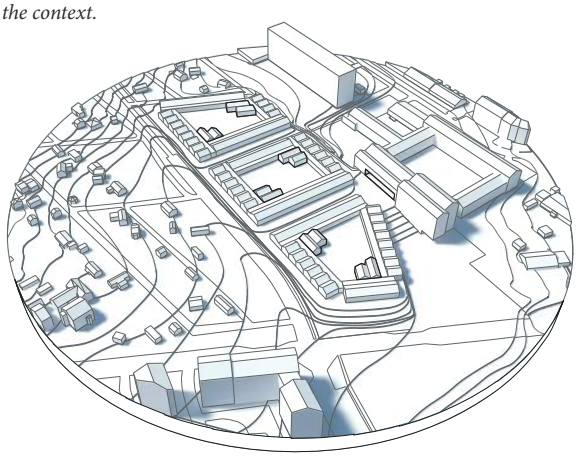
Ill. 58 *Building volumes are added with maximised ground floor area.*



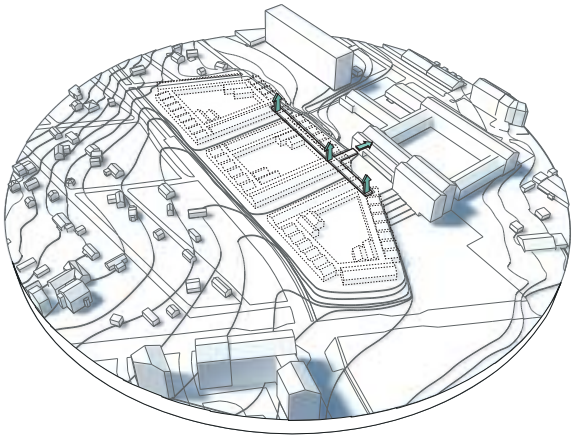
Ill. 59 *Internal courtyards are made, and the height is adjusted to the context.*



Ill. 60 *The typology is adjusted to become familiar for the users.*



Ill. 61 *Common areas are added and day care centre opened up.*



Ill. 62 *One basement connects the entire complex.*

Ill. 63 *The final complex is based on multiple courtyards, and open areas.*

Cenceptual Idea

In the following section the final project will be presented. The section is organised in separate segments, dealing with different parts and themes of the project, many of them are however interconnected to create a project that together performs in synergy to make a better nursing home.

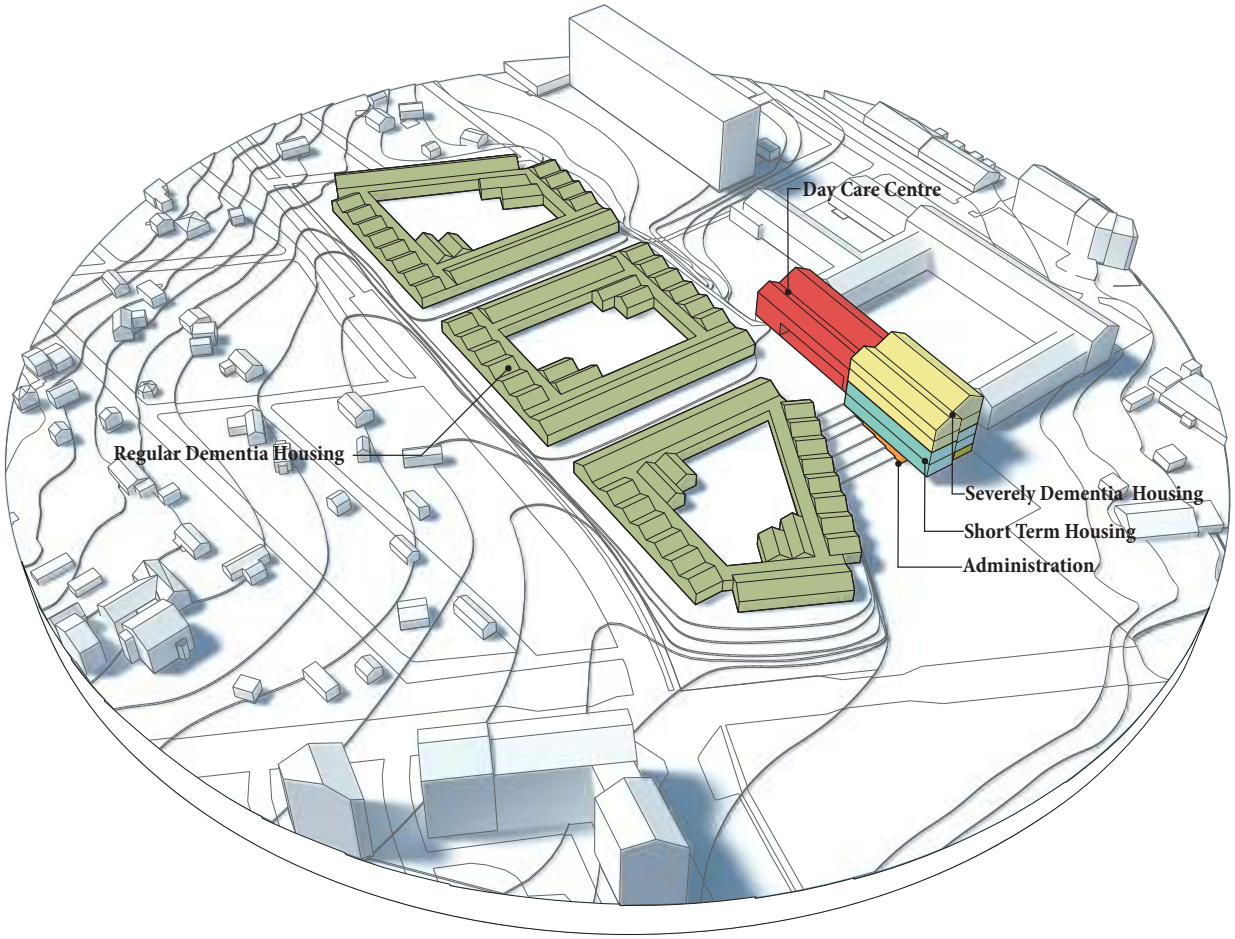
The site on which the project is sloping towards southeast, with an overall difference in height of about five meters. By elevating the terrain down towards the road, the increased elevation helps protect the nursing home from the potential noise nuisance that might occur along the road (ill. 57). Furthermore, by evening out the height differences across the site it is made easier for the users to move around, which is especially important when many of them are walking-impaired.

Three housing blocks are added, shaped by the site to maximise the highly valued ground floor area (ill. 58). The day care centre is placed in the middle between the existing and the new nursing home, functioning as a connector across the two levels. Each housing block is opend in the centre with a courtyard to maximise secure outdoor space, with the circulation in constant contact with the open courtyards. The day care centre is lifted up towards the city and direction of arrival, to mark the DBC Aarhus and to match the surrounding tall typologies (ill. 59).

The entire complex is adjusted to a familiar typology (ill. 60) to the people living there, but more importantly to resonate with the people coming to use the centre and live in the nursing home. The common functions in each housing unit is placed as a marker on the inside of the courtyard, while the day care centre is opend up towards the square in the middle of the site (ill. 61). The entire complex is tied together with one hallway extending from the existing nursing home under all the organizational units, to unite the complex (ill. 62). This is both making the complex open and accessible for the inhabitants, while making it as efficient as possible for the staff.

72 residences for mildly and moderately demented are placed in the housing blocks with easy access to the courtyards, while 16 short-term residences are placed in connection to the cafe in the multi-storey complex alongside 12 residences for the severely demented, which are then in close proximity to the personnel in the administration department.

The total gross area of the complex is 11,300 m^2 with a plot ratio of 70%.



Ill. 64 *The distribution of functions in the project.*

The Site in the Context

The use of outdoor space is very important in a dementia friendly complex. First and foremost a safe and sheltered space is provided internally in the housing blocks. Because of the high plot ratio, due to the high density of building in the city, a large green area exclusively for the nursing home is not an option. Therefore, the safe enclosed areas have been maximised, and the diverse context can instead be utilized. The different typologies allows for the nursing home to extend into community, and enables the inhabitants to go for a walk in areas with familiar characteristics, either with assistance from the staff, volunteers or on their own if deemed possible.

The arrival to the centre is through the parking area to the south, laid out with a large turning area, with an easy drop-off zone. The landscape ramp leads up to the square in front of the day care centre, and easy access to the housing blocks. The areas inbetween the housing blocks are generally kept as green as possible while still allowing emergency vehicle to access through the openings (see drawing folder for more details).

Ill. 65 *Masterplan of the site and the near context, showing the mixed typologies in the area. The northern part of the large green area to the south of the site should be used as an important extension of the nursing centre into its surroundings, the same goes for the more intimate paths west of the site in and around the allotment garden. To the west the existing nursing home is located.*


Allotment Gardens
Housing Block 2
Housing Block 1
Existing courtyard
0
20
100 m
N

Materials

The façade of the DBC Aarhus implements brick and wood as the two main materials, where brick makes up the exterior while wood is used for practical purposes such as shutters and solar shading.

Two types of bricks are used for the building: Classic bricks are used on the gables and inside the courtyard, while brick shingles, a sustainable alternative to the aforementioned, are used for the gables and the roof, as shown on ill. 68. By using brick shingles both on the façades and roof, it will show as a protecting coat and strengthen the silhouette which will resonate as something familiar and homely for the residents, while also relate to the nearby context. The dark zinc profile close off the brick shingles on the corners, in the windows and along the roof.

The static brick façade is challenged by using a monk bond with the header located above each other in each fourth course. This translates into a herringbone pattern, where work with recesses between the windows brings more depth. The recess and wood shutters, as shown on ill. 69-70, contribute to a changing façade during the year, where the shutters will be more utilized during summertime, leaving the recesses for people to see, while they will be covered during winter time when shading is no longer an issue.

Ill. 66 *Example of a gable façade, with the main material being brick tiles. The windows follow the rhythm of the residences, and by mirroring them the façade get slightly more dynamic. The façade shown is the western façade of the middle housing block.*

Ill. 67 *Example of one of the other façades orthogonal to the gables. There the main material is brick shingles, which are wrapped over the stern and roof ridge of the building. Each end of the roof is finished of with a dark zinc profile, strengthening the profile of the gables.*

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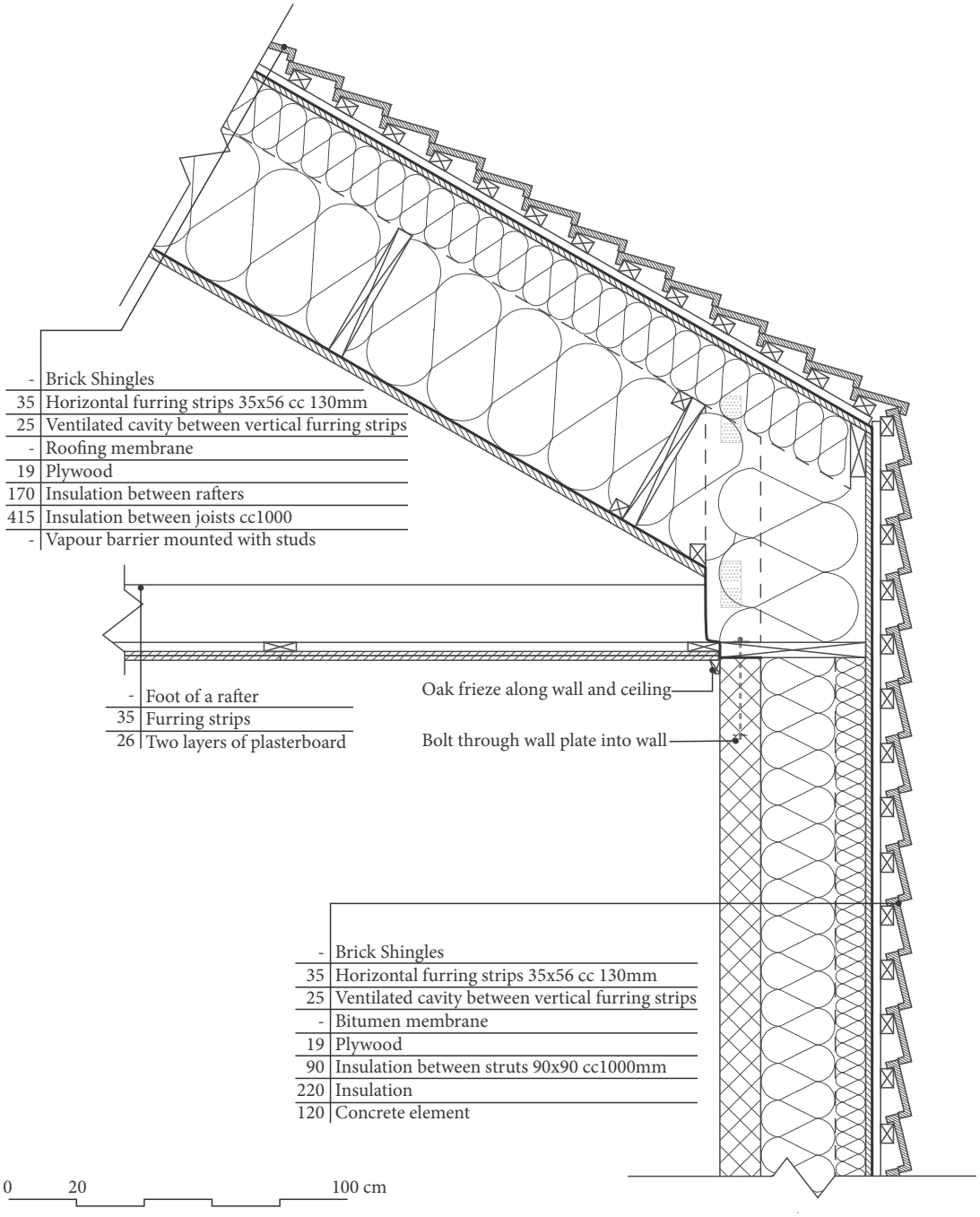


Ill. 68 *Detail of how the brick shingles wraps around the stern of the building. The wall is build up by two separate structures so the inner wall and front wall has as little contact as possible.*

Ill. 69 *Callout of the brick shingle façade showing the shutters, creating fields of wood in the façade, which also functions as solar shading. The very analogue system of shading, is highly efficient, easy to understand and creates a dynamic expression in the everchanging façade.*

Ill. 70 *Callout of the brick tile façade showing the fields of change in the brickwork, where every second course in the bond is recessed. This effect is strengthend by the movement of the dynamic shutters, which makes the fields appear at different times.*

Ill. 71 *Plan of the southernmost housing block (block three). Each block includes an organizational unit, two housing units with twelve residences and common areas in each. Everything is arranged around a common courtyard, creating a safe and sheltered environment.*

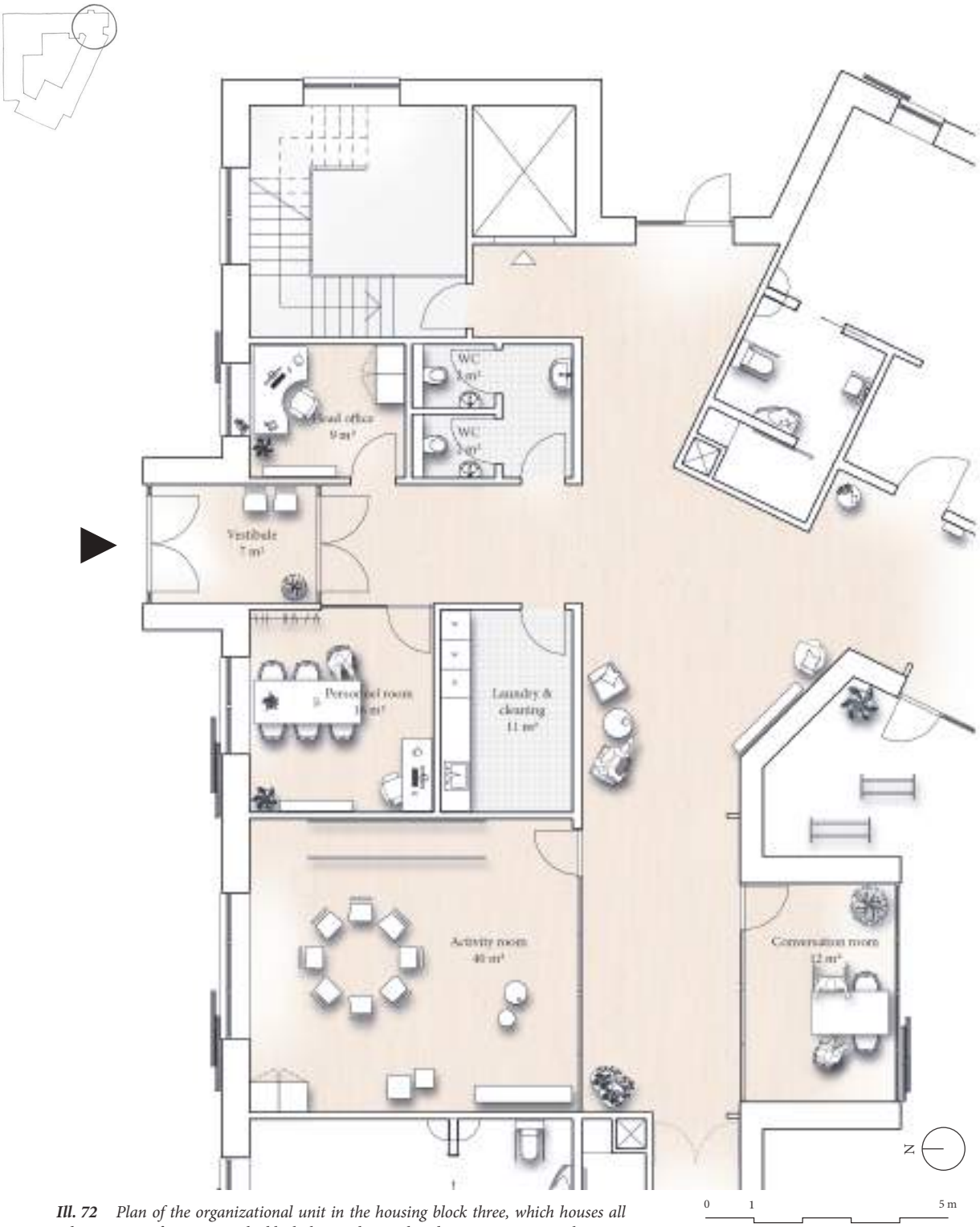
Housing Block

As described in the presentation of the masterplan, the nursing centre consist of three housing blocks and a day care centre. In the following section, one of the housing blocks will be described from the overall plan and down to the private residence.

The housing block is divided into two housing units, each with twelve residences and a common area. The housing units are physically connected, so it is possible for the residents to circulate around the block. When doing so the hallway opens to a secure and enclosed courtyard through large glass openings. The courtyard gives the residents the possibility to be outside unsupervised. The two housing units share one organizational unit placed in one of the corners, linked with the entrance to the housing block.

The courtyard is a common space for the two housing units, but are divided into smaller spaces, creating different scenarios for sensory stimulation, for example through a small pond where it is possible to hear flowing water, a greenhouse with vegetables, plants boxes with berry bushes and perfumed herbs, a training stair and a pergola where you can sit down in the shade. The division of the courtyard also make it possible to do several activates together or alone at the same time.

Along the façade, a path is laid out so the resident can walk around and end the walk where it began. Each housing unit have a private terrace in connection to their respective common facilities. The different functions in the courtyard are placed strategically so the resident can separate the two common areas from each other. The door from one of the common areas is for instance placed close to the lake, and the other closest to the greenhouse. Lastly, a small play area is created to encourage visits from relatives with children.



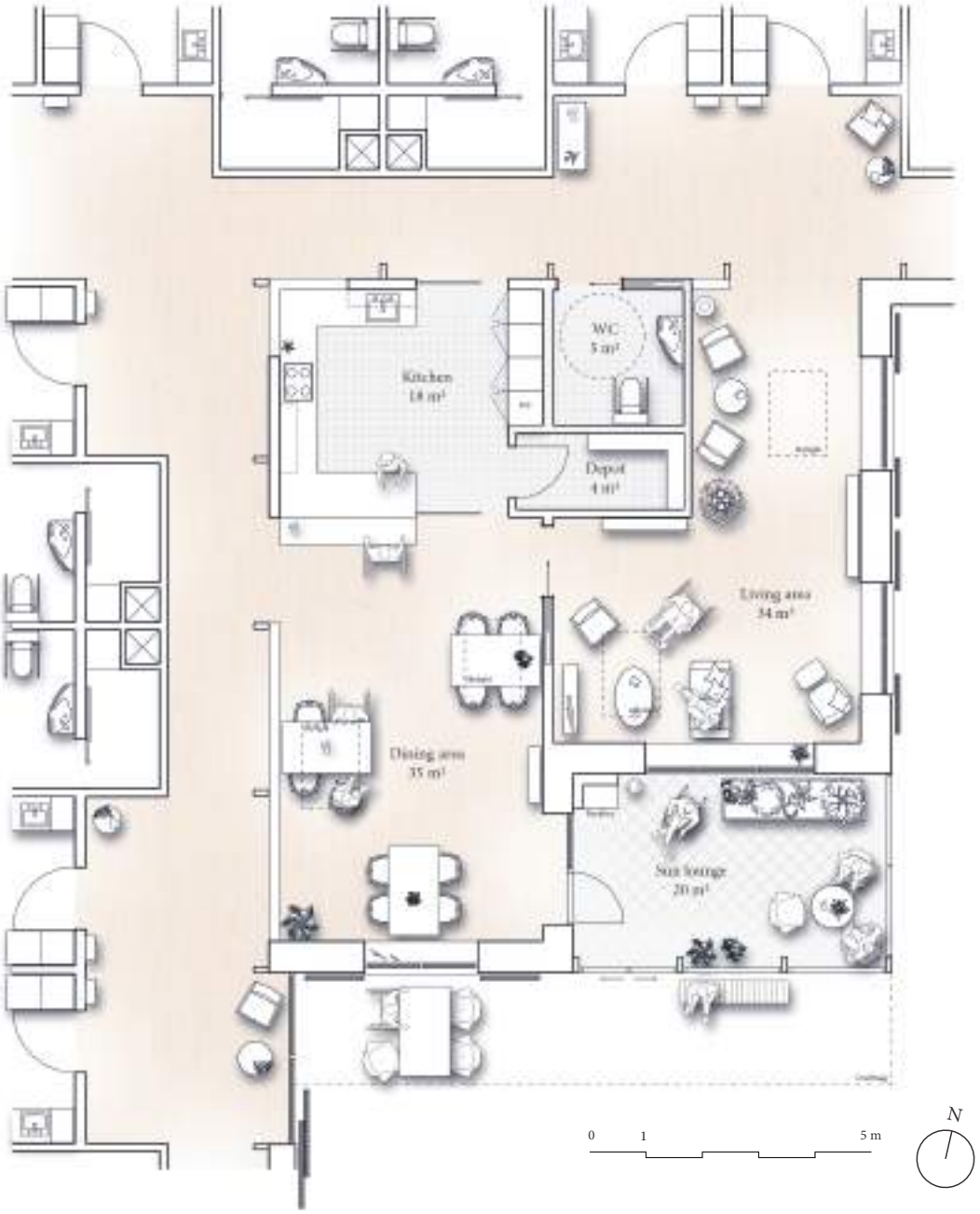
Ill. 72 *Plan of the organizational unit in the housing block three, which houses all administrative functions in the block that is always placed in near vicinity to the main entrance. The organizational unit also provides connection to the rest of the complex though the basement.*

Organizational Unit

When entering the housing block, through the vestibule, one is met by the organizational unit, programmemed with a head office, personnel room and toilets, laundry/cleaning room, activity room and a conversation room. The head office is placed next to the vestibule to make it possible for the block manger to overlook who arrives and leaves the housing block.

The personnel room are for aide handover, breaks, documentation and meetings. It is also opened to give a connection to the remaining organizational unit. Another room for meeting is the conversation room. Here it is possible for relatives to talk with personnel alone or together with the resident. The last room, connected to the organization unit, is the activity room. The activity room can support of different functions and can be shared for common facilities between the two housing units, or be used by only one of the housing units at the time together with people coming from outside.

The organizational unit is directly linked to the two housing units and their common facilities.



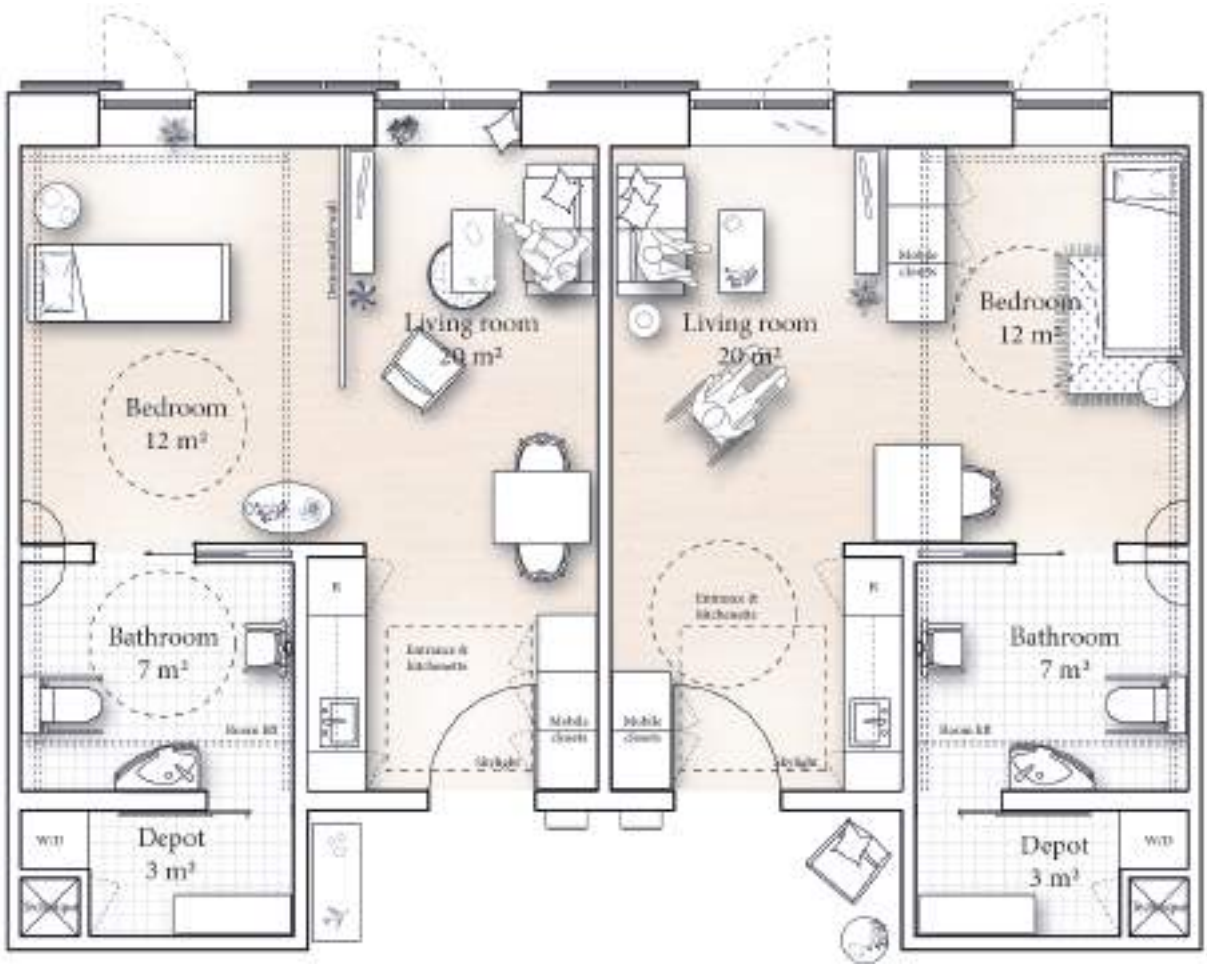
Ill. 73 *Plan of the common area in each housing unit. The kitchen is always placed in the corner of the housing unit as it is the strongest navigational element in the plan. All the areas are in connection with each other, but with the possibility of sealing them off.*

Common Area

Each housing unit have their own common area with kitchen, dining area, living room and a sun lounge. The common area opens up with a pitch roof with high ceiling and low walls out to the hallway. The kitchen is placed around a corner which make it more visible from the hallway and an easy navigation point. The low walls make it possible to look across the common area from the hallway or a residence niche and out to the courtyard. From the kitchen, the personnel can overlook the dining area and the living room at the same time. The two rooms are connected but can be closed off by a sliding door so different activities can take place at the same time without disturbance.

The living room is designed as an L-shape which creates a natural division of the room into two smaller spaces. A space for a TV-room, and a space behind the toilet where you can sit alone and relax undisturbed. By dividing the living room into smaller areas, it accommodates the residents and their different lifestyle. The dining area is placed as an extension of the kitchen with space for the residents to eat and take part in the daily doings.

The dining area is connected to the sun lounge with an integrated fireplace and space for both breaks and growing of different plants. The sun lounge is not warmed-up and is intended as the room where the residents can see and feel the changing of the seasons. The sun lounge also works as a compensation for the outdoor area when the weather and the season do not allow stay. Access to the courtyard therefore goes from the residence, through the common area and sun lounge.



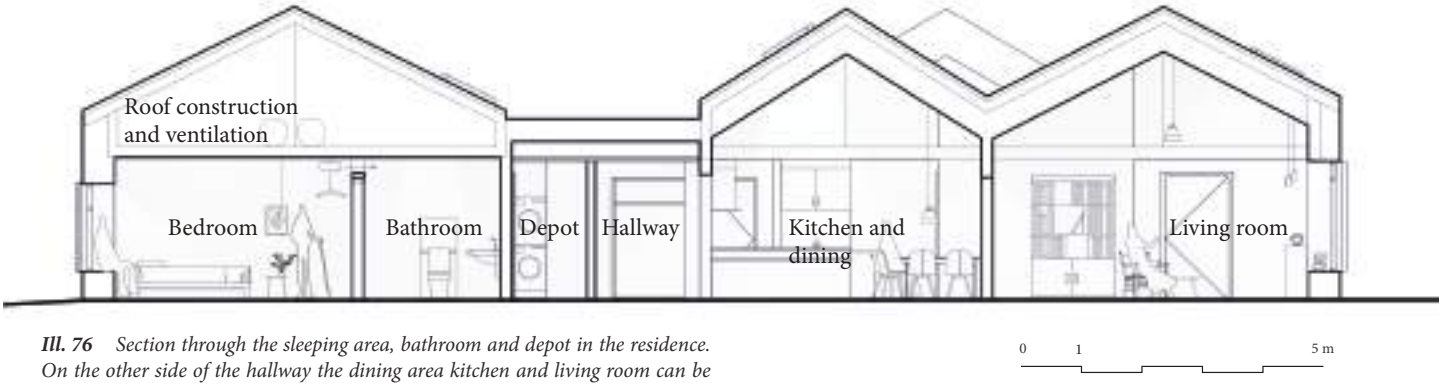
Ill. 74 *Plan of two individually decorated residences. All residences have their own niche in front of the door, big enough for placing furniture and functioning as a personal entrance for the resident. The niche is enclosed by depot for each residence and is installed with a washer and dryer.*

Residence

Each housing unit consist of twelve single-room residences which are arranged for flexibility in relation to furnishing and personality. It is important for dementia patients to have the possibility of retreating to a private residence with a homely atmosphere characterized by their own personal belongings and furnishing, if needed. Each residence is 42 m² with the opportunity to install a demountable wall so it can be divided into a sleeping area and a living area. Each residence has a small entrance with space for mobile closets and a small kitchenette with a sink and refrigerator.

In front of each residence, the resident has a small niche with space for personal belongings. This also creates opportunities for sitting outside the residence and follow the life in the hallway or common areas. Each resident has their own letter box in the niche which help strengthen the homely feeling. The niche also helps the resident to find their way back to their residence, since the personal belongings functions as a navigational point.

Ill. 75 *Section through the kitchen and living area in the residence. The section also shows the niche marking each personal home along the hallways, and the outside of the common areas, where the same structural system as in the hallways is creates a shaded transition to the garden.*

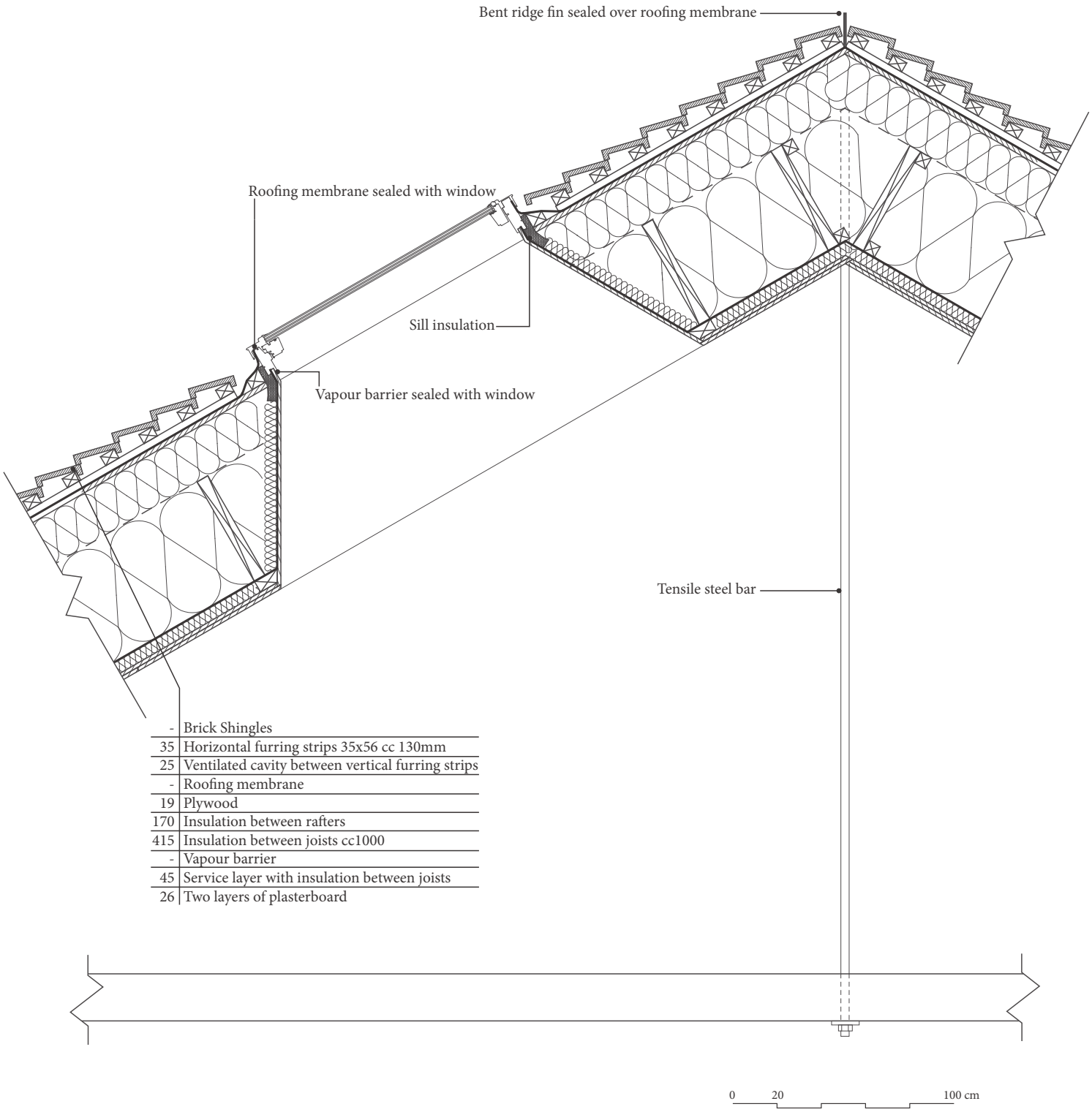


Ill. 76 *Section through the sleeping area, bathroom and depot in the residence. On the other side of the hallway the dining area kitchen and living room can be seen. Inside the residence, the lift is built into the ceiling allowing it to pass over the wall into the bathroom, making the everyday life much easier.*

The bathroom is spacious with easy accessibility and adjustable equipment. A room lift runs in the ceiling between the bedroom and bathroom and makes it easy for the aide to help the resident. The room lift can be stashed away in a built-in cabinet, when not in use. The cabinet can also be used for light storage.

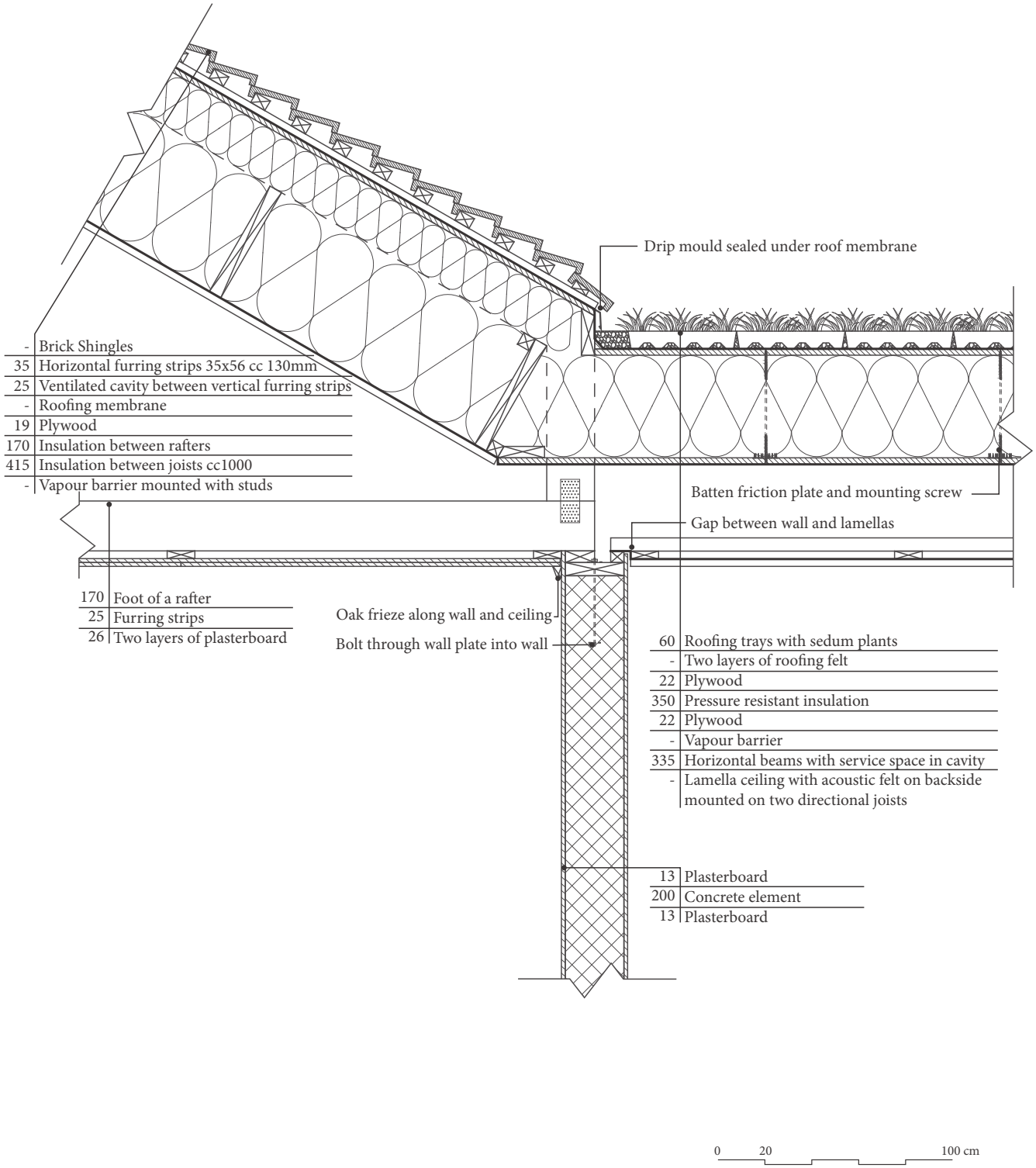
From the bathroom, there is access to a small depot which the resident can use for storage and as utility room, because of the inclined combined washing machine and tumbler. Technical installations such as water, heat and electricity is accessible from a built-in cabinet beside the washing tower. Ill. 76 shows a section where the room lift can pass the wall between the bedroom and the bathroom.

The sleeping and living area has generous daylight intake from two sides via windows in the façade and an opposite roof window, which also makes it possible to cross ventilate. The windows in the façade are placed low so the residents also can see directly outside in any given position. This also makes it possible for the resident to use the windowsill actively as a niche to sit in or as an extra table, as shown on ill. 76.

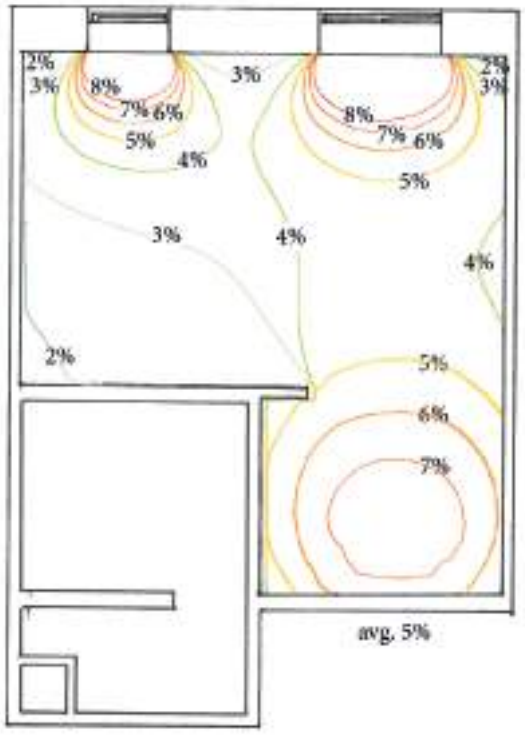


-	Brick Shingles
35	Horizontal furring strips 35x56 cc 130mm
25	Ventilated cavity between vertical furring strips
-	Roofing membrane
19	Plywood
170	Insulation between rafters
415	Insulation between joists cc1000
-	Vapour barrier
45	Service layer with insulation between joists
26	Two layers of plasterboard

Ill. 77 *Detail of the construction of the pitched roof ridge with high ceiling. Here the foot of the rafter has a second function of marking the transition between wall and ceiling, which important to for the spatial understanding. The rafter gets its tensile strength from a simple zinc bar connecting the ridge and the foot.*



Ill. 78 *Detail showing the meeting between the roof over the residence and the flat green roof over the hallways. Green roofs are chosen to emphasize the implementation of greenery in the area and to consider the residents of the multi-storey complex by giving them more to contemplate when looking out. The transition from wall to ceiling is marked by a wooden frieze in the residence, and in the hallways making a small gap between the wooden lamellas and the wall.*



Ill. 79 *Daylight simulation of the residence showing how the daylight is spreading through the room from the windows. By placing the skylight in the deepest part of the room the average daylight factor can be kept at a maximum of 5%.*

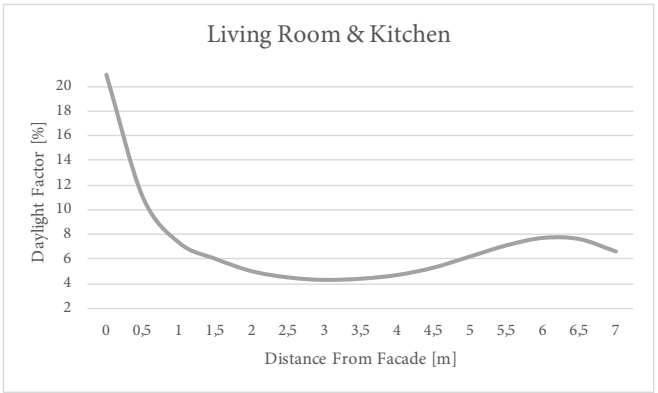
Light

The daylight conditions are essential to the residents of the DBC, both for their everyday comfort and for the overall circadian rhythm. As mentioned before, demented people generally have twice the regular demand for daylight to maintain their circadian rhythm and thrice the amount of light to be able to perceive details in their surroundings. Consequently, high demands have to be set to their surroundings, and especially their residence.

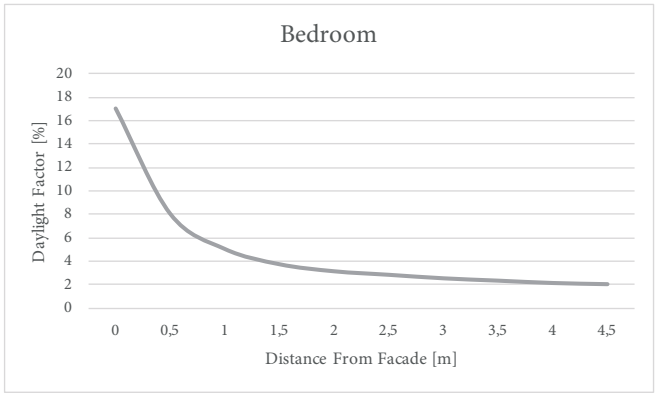
Daylight is the primary factor for our way to determine the time of day therefore every residence should have daylight from at least two directions. This is of course very convenient for the one otherwise oriented towards north, but is also an advantage for the other residences. The windows have multiple functions in the project: Getting light into the residence, enabling the user to gaze out upon the surroundings and both accommodating seating and placing personal artefacts in the deep windowsills. To get a high amount of daylight, the windows should be placed up high in the façade. However, this opposes a good visual connection to the outdoors and a functional windowsill - especially when a majority of the users are bound to a wheelchair. To accommodate both, tall windows that are placed low in the façade are used in a combination with a skylight, in the deeper parts of the room. In every residence, there is one wide and one narrow window. The large window is placed in the living area, where light and visual connection is the goal, and the narrow window in the sleeping area where privacy is more of an issue.

The average daylight factor for the residence is 5%, which is indeed higher than the 2% in half the room, as is required in the building regulations 6.5.2, provision 1. When examining the window area, it is required that the glass area should be at least 15% of the floor area, and this requirement is well exceeded especially when adding the 1,4 factor for skylights: 7.2.4.1, provision 6 (National Agency for Enterprise and Construction 2017). When studying the relation between the distance to the façade and the daylight factor, the effects of the skylight are quite clear, keeping a high amount of daylight throughout the room. This is opposed to the sleeping area where the daylight does not reach as long into the room before dropping.

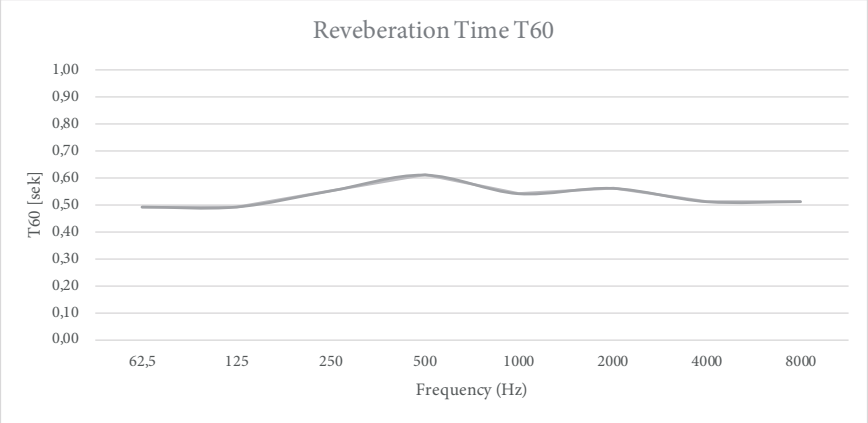
Ill. 80 *Visualisation inside the residence looking towards the façade from the kitchen. All residences have access to daylight from two direction thanks to the skylight, while the low windows are ideal for both using as a table and for sitting in.*



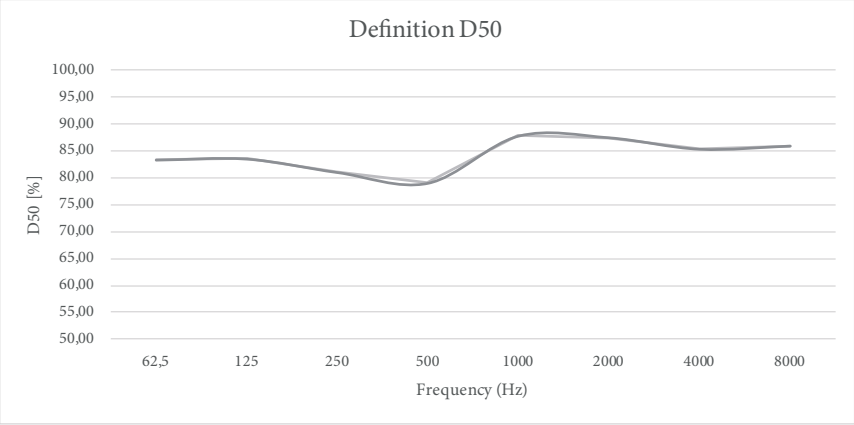
Ill. 81 *Graph showing the resulting daylight factor seen in relation to the distance from the façade, in the living room and kitchen.*



Ill. 82 *Graph showing the resulting daylight factor seen in relation to the distance from the façade, in the sleeping area.*



Ill. 83 *Graph showing the final reverberation time in the residence over the different octave bands the goal is to have a stable curve below 0,8 seconds.*

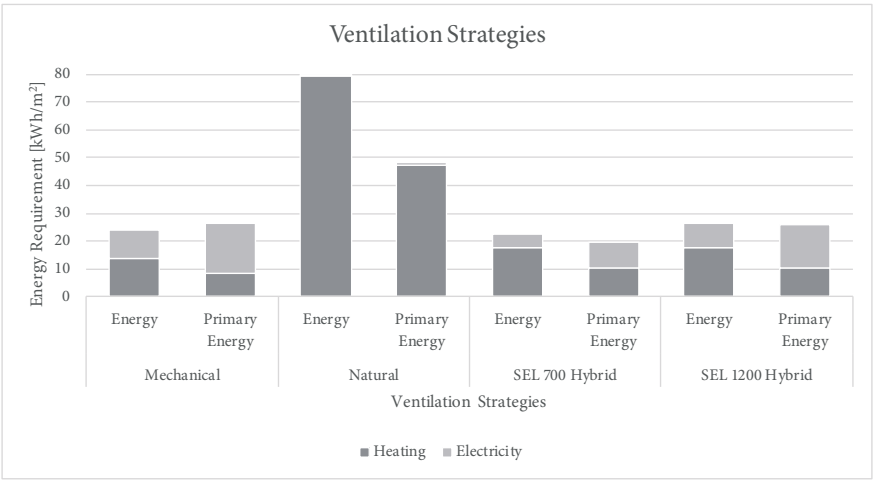


Ill. 84 *Graph showing the final definition in the residence over the different octave bands. The aim is to have a definition of at least 60 % to accommodate speech.*

Acoustics

The acoustical indoor climate should be considered both within the residence and the transference between them. To counter the airborne sound traveling through the walls, the loadbearing walls are 200 mm concrete with an insulation of 56dB. The non-loadbearing walls are made up of separate carrying frames with two layers of fibre gypsum and insulation in-between, giving it a total insulation of 57dB. Vertically, the footfall sound is insulated with floor build up on joists on acoustic underlay. The noise from installations are avoided by installing silencers on the ducts before the inlet enters a room and outlet leaves a room. In addition to this, the increased duct sizes result in lower airspeeds thus reducing resistance and ultimately noise from the system.

Internally, the acoustical indoor climate is dimensioned to accommodate speech, i.e. short reverberation times that could otherwise make it difficult to understand and difficult to follow the events in the room. The functionality of the room does not allow for the use of irregular and unparalleled surfaces - only the skylight functions as a scattering element. Consequently, the reverberation time of the room is controlled by use of materials and treatment of the walls. The reverberation time should be kept as stable as possible in all frequencies, and below 0,8 seconds (Long 2006). Ultimately this should result in a definition, of at least 60% and high speech intelligibility (Long 2006). The resulting reverberation time in the residences, is between 0,5 and 0,6 seconds in all frequencies, making a stable and clear acoustical environment. This can also be seen in the definition, which is high, indicating a room with high intelligibility. The key factor to this is the ceiling as it is the biggest surface in the room that will be exposed, when the room is furnished. By fitting it with acoustical panels, the large surface is used actively to absorb sound that would otherwise become an issue between the two large parallel surfaces being the ceiling and the floor.



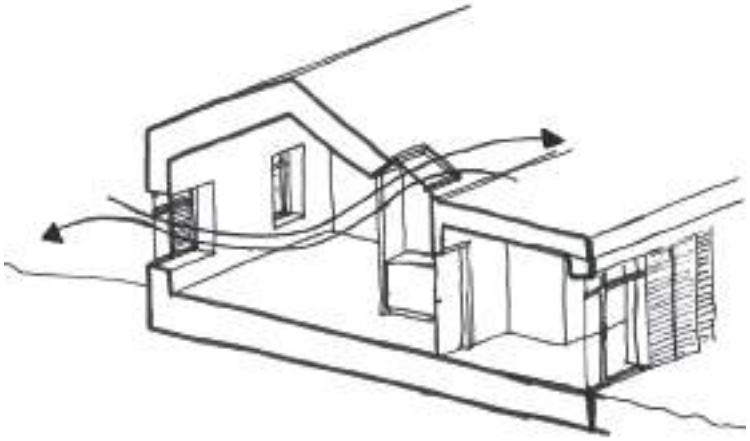
Ill. 85 *Graph showing a comparison between different ventilation strategies and the resulting energy frame, both in actual energy and in primary energy for the 2020 energy frame.*

Ventilation

The ventilation of the complex is vital for the project, both for the indoor climate and for the overall energy consumption of the building. The overall ventilation strategy is to use both natural and mechanical ventilation in a hybrid setup, where the system ventilates mechanically when the outdoor temperature gets below a certain threshold. Electricity used to ventilate mechanically is more profitable than the heating to compensate for the heat loss due to natural ventilation. During summer, when the temperatures increases, natural ventilation should be used. When overtemperatures occur, the natural ventilation can be more effective than cooling, otherwise the heat exchanger in the ventilation unit should be fitted with an option to bypass it.

The strategy for the ventilation has a huge effect on the overall energy frame as the natural ventilation can result in an increased heating demand and the mechanical requires electricity to run. The chart above shows a comparison between the three different ventilation strategies, and the result of an increased electricity demand for air transport. By ventilating completely natural the heating demand increases dramatically. By only ventilating mechanically the heating demand drops to a minimum while the electricity consumption increases. The total energy consumption is relatively low, but increases when the primary energy factors are applied, due to the high amounts of electricity used. The hybrid strategy results in the lowest energy consumption especially when considering the primary energy, due to the lower electricity usage over a completely mechanical solution. The effects of using more electricity to ventilate is also apparent when considering the increased SEL-value and the resulting energy frame.

The ventilation requirements have been calculated in accordance to DS/EN 15251 and 1752, to maintain a certain indoor climate, but also in accordance to the Danish building regulations that require a minimum ventilation rate. The results for ventilation requirements have then been tested in BSim to ensure a satisfying indoor climate can be met, both in terms of thermal and atmospheric comfort.



Natural Ventilation

The residences are ventilated naturally when the conditions for it is favourable or simply when the user wants to open a window. To create favourable conditions for natural ventilation the building needs to be designed with this strategy in mind. The overall layout of rooms, the height and depth as well as the position and size of windows are influencing the potential for ventilation. The extend of the air change made possible through natural ventilation is depending on the local microclimate in and around the room. The layout of the plan prohibits cross ventilation of the residences through windows in the façade, because of the hallways. It is however possible, by utilizing the skylight in all the residences, to ventilate through. The same applies for the common areas, where the skylights create the basis for natural ventilation.

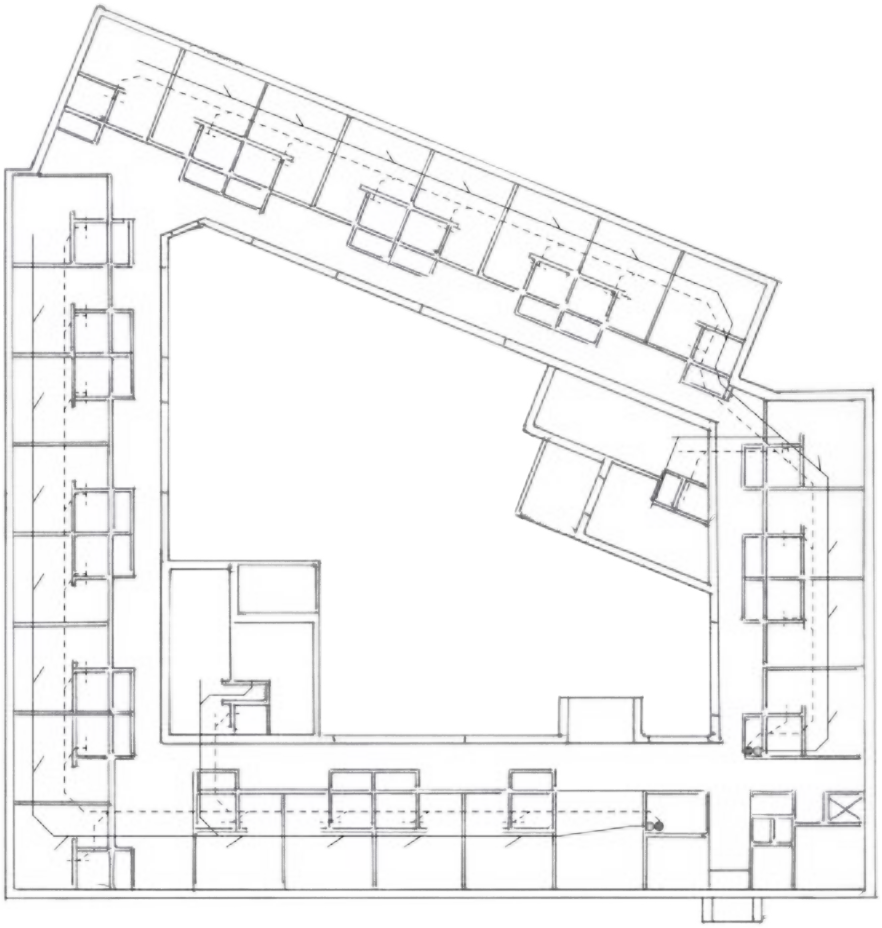
The natural ventilation of the residences affects the window layout as areas of the windows should be able to open automatically, as a response to a sensor measuring the temperature and CO2. The residents should however not be forced to be unable to open their windows and the system should be able to be overridden if a window is opened, so the residents themselves are able to control their personal domain.

The natural ventilation with the wind as a driving force has been calculated and can be seen in app. 2.

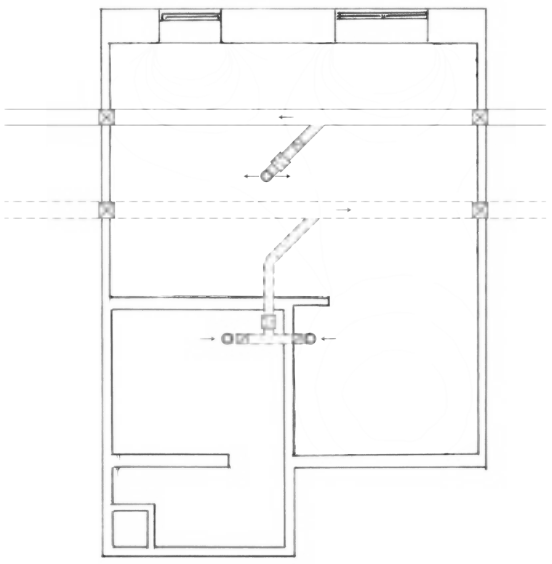
Mechanical Ventilation

The layout of the mechanical ventilation system is made with energy efficiency in mind. The goal has been to reduce the pressure loss in the duct system, i.e. having an efficient layout of the ducts with as few single components as possible and with as little resistance in each component and in the straight piping. To avoid unnecessary bends in the ducts the outtake pipe is always located towards the hallways, where the outtakes in the residences are located, to avoid the intake and outtake from crossing over. The main contributor to an increased pressure loss is high airspeeds in the system. In this project, it is attempted to keep the speeds below 4 m/s. To do so the diameter of the ducts can be increased from the standards normally used by for example increasing the size from one model to the next, the speed can be cut by ≈35% and the loss in pressure can be reduced by ≈60% (Jagemar and Bergsøe 2003). In this project three air speed thresholds have been tested to investigate the potential of improvement in performance, from the small duct (max. 7 m/s) to the large duct (max 4 m/s). The SEL for the duct system can be reduced by ≈50% in the ducts and then the ventilation unit should be added to that. A compilation of the results can be seen in app. 3.

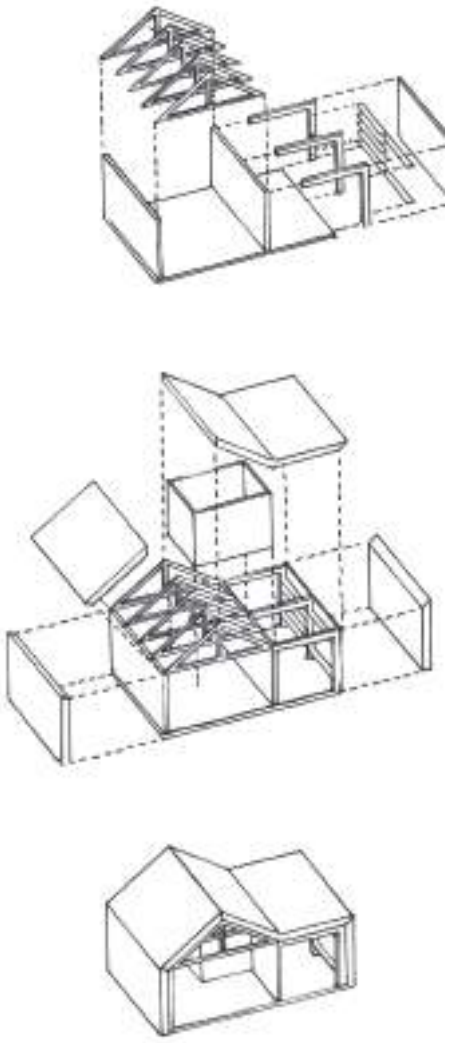
One ventilation unit will be installed in each housing block. The unit is placed in the basement, with the intake through an air pipe in the ground, and outtake through the roof. The ducts enter the ground floor in two places, one on each side of the hallway, as the ducts are too large to cross. The ducts are then distributed over the ceilings in the residences, with a damper between each one to seal them off in case of a fire. The inlet air valve in each residence in positioned in the living area, while an outtake valve is placed in the kitchenette and in the bathroom. A silencer is installed on the outlet duct before it exits the room and on the inlet duct before it reaches the inlet valve. The basement is mechanically ventilated all year around, simply because natural ventilation is not an option. This is however not only a disadvantage as the air pipe should be put to regular use to keep it operational.



Ill. 86 *Conceptual distribution of ventilation ducts for the mechanical ventilation. The critical route used for the calculation of the pressure loss is from the organizational unit around the right side of the block to the residence furthest away. (the solid lines represent the inlet ducts while the outlet is dashed)*



Ill. 87 *Conceptual distribution of the ducts for mechanical ventilation within the residence. The outtake is always placed towards the inside of the block in close vicinity of the kitchen and bathroom, to avoid crossings. (the solid lines represent the inlet ducts while the outlet is dashed)*



Ill. 88 *Diagram showing the structural concept of the building blocks, showing how the structural system also provides storage and seating opportunities.*

Structural System

The Primary loadbearing structure in the housing units is vertical concrete walls, one in the façade and one separating the residence and the hallway. The concrete walls transfer the loads from the room vertically down, and together with the separating walls in the structure they create spatial stability through shear wall effect. Thermal mass is one of the advantages of using a high-density material and helps in stabilizing the indoor climate, while improving the overall energy frame.

On top of the concrete walls, a system of wooden rafters is mounted, functioning as the structural element in the pitched roof over the residence. This provides access to sunlight from two directions in all residences, while providing space for the technical installations running over the ceiling.

The structural system is based on a series of L-shaped wooden elements that spans from one of the concrete walls and out towards the courtyard, were it transforms into the structural element in the wall on that side of the hallway. By having the elements visible in the hallway, and with a fixed distance between them, the structure in the building creates a rhythmic course throughout the building. This provides the residents with a subconscious sense of speed, which is one of the central elements in wayfinding. This is something that people assisted with walking or put in wheelchairs are often lacking physically but can be provided visually.

Lastly the columns created along the courtyard are used for carrying, supporting the wall. Between the columns, planks can be fitted to create horizontal stability, while integrating shelving or seating as a building element in the envelope. This is done to accommodate niches for resting along the hallways, and spaces to build in or place stimulating elements such as the "memory boxes" as seen in Liselund.

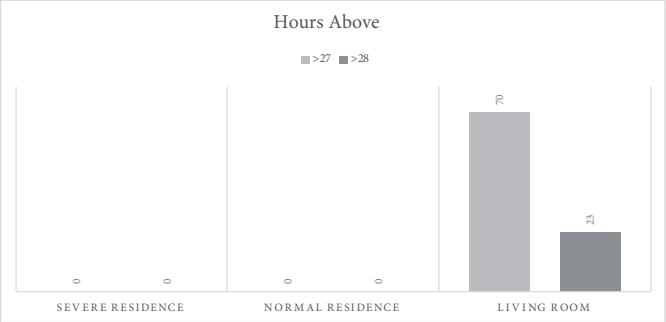
Ill. 89 *Visualisation showing the hallways around the building blocks. The hallways are made as open as possible to provide a strong visual connection to the courtyard. The open glass areas are always positioned together with the entrance to the residence to make an immediate basis for orientation directly from the personal niche. The common areas should always be within visual distance when roaming the hallways.*

Atmospheric and Thermal Comfort

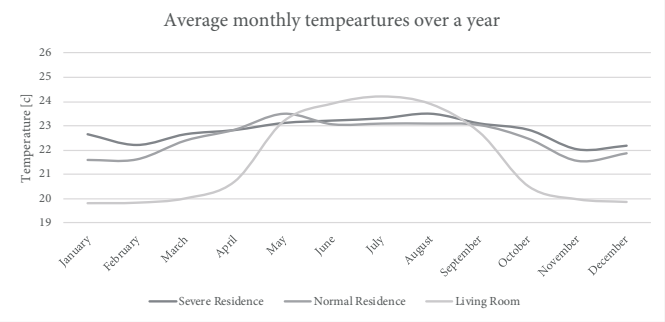
The final simulations of the thermal and atmospheric comfort have been calculated with the simulation software BSim. The calculations are made to document the indoor climate in relation to the Danish building regulations, DS/EN 474 DS/EN 1752. The studies are focused on three areas in the project. Firstly, one of the south-facing, normal residences has been picked to maximize external loads. Secondly, the one residence for the severely demented, to examine the indoor climate with a resident constantly present in the room. Lastly, one of the common areas in the housing units has been picked to compare an area with planned thermal deviations, as a contrast to the two others being more stable. The overall goal with the indoor climate has been to have a stable basis in the residences where the users can have an optimal and stable indoor climate. The common areas outside the residence should on the other hand be more dynamic to stimulate the inhabitants and give them a sense of time both over one day but also over the seasons.

In relation to the building regulations it is not allowed for the indoor temperatures to exceed 27 degrees Celsius for more than 100 hours, and 28 degrees Celsius for 25 hours over a year. These requirements are met by all the simulated zones, where only the living room is having problems with high temperatures, while the other rooms do not have a single hour above 27 degrees. These jumps in temperature is also an expression of the dynamic attributes that the zone has been given. These are also expressed in the average temperatures over a year. Here the living room has significantly larger fluctuations in the living room than in the residences. The residences are much more constant, with less deviation between summer and winter. When looking at temperatures over one week during summer, the graphs are quite similar. Only the living room has lower temperatures during night time. The living room is simulated with a very high internal load from a large group of users, using it in varied periods of time. This creates more jitter across the day due to the varying internal load, and much higher concentration of CO2. This increased level of CO2 also limits the temperature in some periods, as the ventilation increases to balance the atmospheric indoor climate. This jitter coming from high and varying internal loads also results in colder periods during winter when ventilation is increased due to CO2, and when temperature peaks during summer, when the internal loads falls together with the external loads.

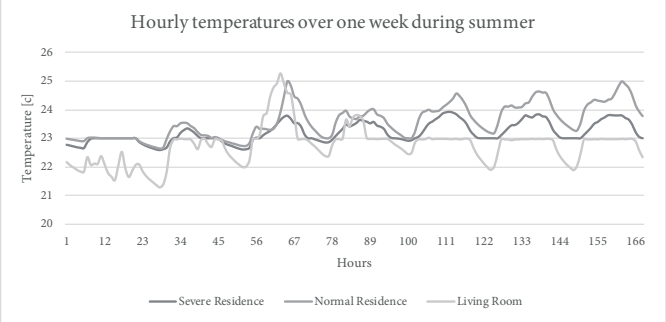
All together when comparing to the building class the residences are performing quite well. This is mostly due to the relatively constant and predictable environment, combined with effective solar shading it is relatively easy to control the indoor climate. In the living room the goal was to make a more dynamic but controlled indoor environment. It has however proven itself quite challenging to control a zone with very high and varying internal loads.



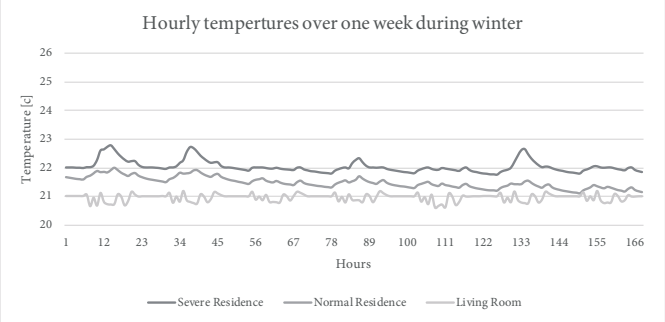
Ill. 90 *Graph showing the hours above the thresholds stated by the building regulations, in each of the simulated zones.*



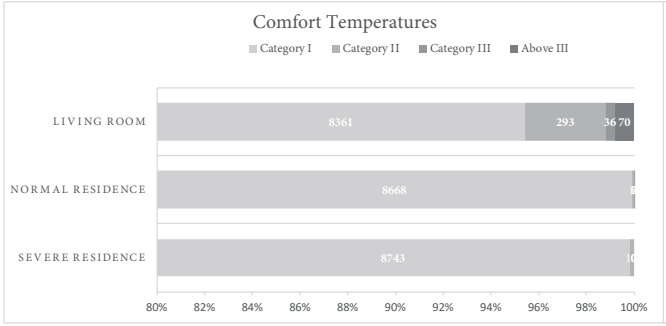
Ill. 91 *Graph showing the average monthly temperatures over a year within the simulated zones.*



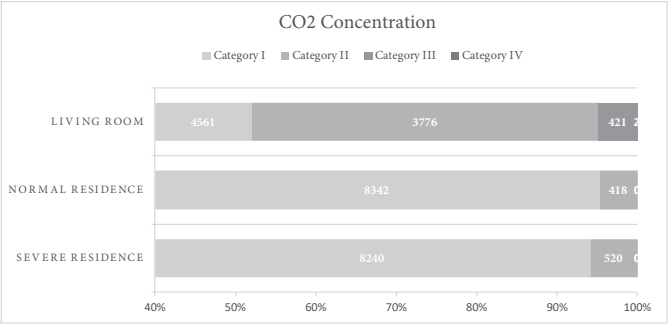
Ill. 92 *Graph showing the hourly temperatures in each of the simulated zones during one week in the summer.*



Ill. 93 *Graph showing the hourly temperatures in each of the simulated zones during one week in the winter.*



Ill. 94 *Graph illustrating the distribution of the hourly temperatures over a year, within the different building categories in relation to the thermal comfort.*



Ill. 95 *Graph illustrating the distribution of the hourly CO2 concentration over a year, within the different building categories in relation to the atmospheric comfort.*

Ill. 96 *Visualisation of the café in the day care centre. The double high room is the heart of the day care centre, as it pulsates with life and works as a distributer for all the other functions. The café opens up to both the square in the middle of the complex and the culture club, making it possible to expand during community singing, service etc.*

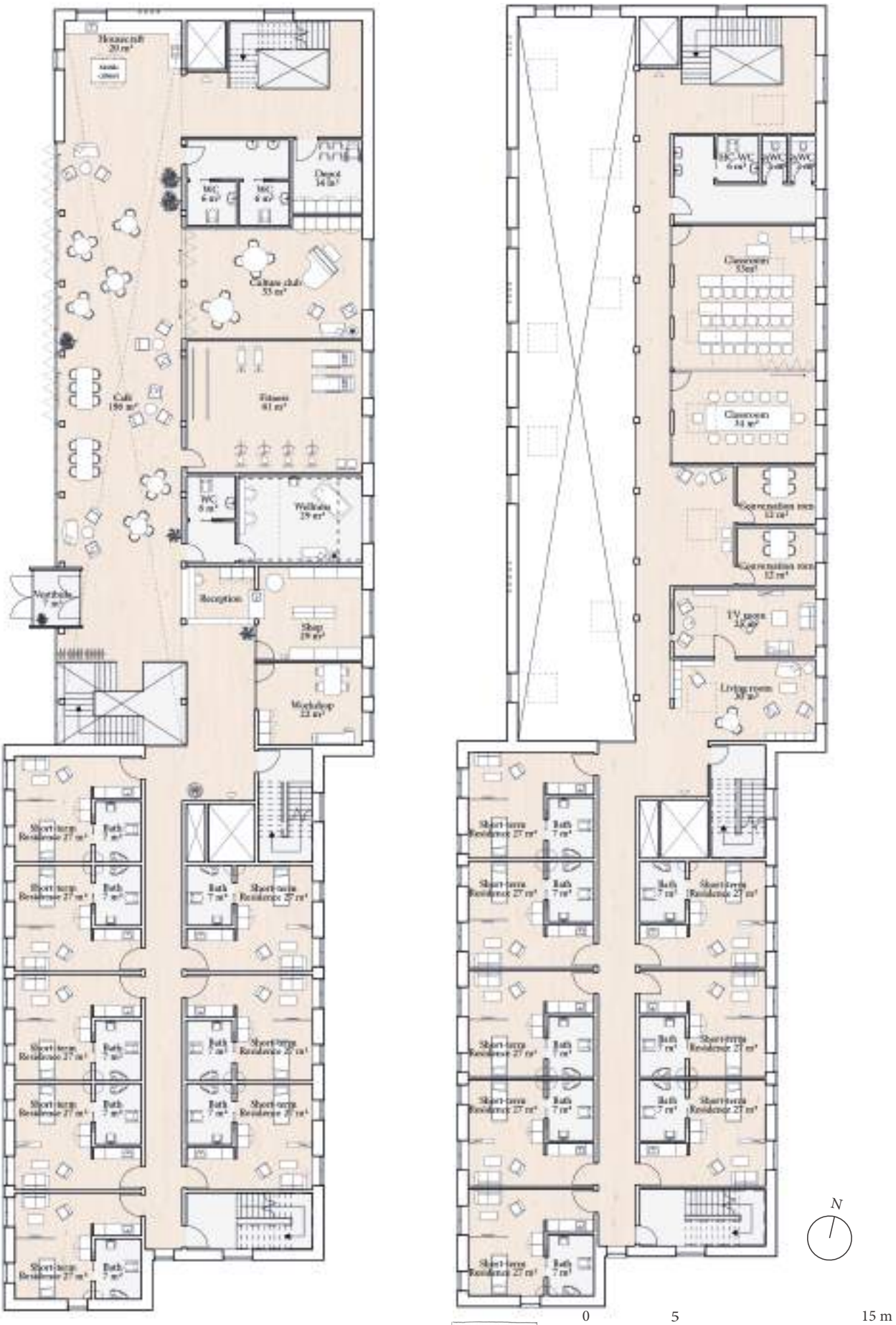
Day Care Centre

The new day care centre is DBC Aarhus' public image and contains various functions such as administration, different activity rooms and a café which can be used by visitors, employees and the residences.

The Day care centre is divided into five floors with the technical room in the basement (level -2). Administrative and personnel functions are placed on level -1, with direct access from the parking area. Day care functions and short-term residences are distributed on the ground floor and first floor, while the residences for the severely demented are placed on the second and third floor.

The social centre of attention for the new day care is the café, which can be entered from the central square. The café works as the place where personnel, visitors, course participants and relatives can dine and meet. The café is one large double-high room, but can by the furnishing be divided up into smaller spaces and therefore be used for several events such as church service, communal dinner and community singing. The western façade of the café is made transparent through a long glass wall and sliding doors can be opened during summertime to extend the café out on the square.

Along the eastern façade, the other day care facilities are placed as seen on ill. 97. A culture club, fitness room, wellness, a small shop and a workshop give the users of the day care centre the possibilities to maintain the everyday life as they were used to. By having the cultural programmeming closely connected to the café, small, informal interactions can occur between residents and visitors.
Openings in the roof allows for displacement ventilation where the air move from the floor through small openings and out through the roof. The ventilation strategy is used for dimensioning the total floor thickness.



Ill. 97 *LH Plan of the ground floor in the day care centre.*
Ill. 98 *RH Plan of the 1st floor in the day care centre.*

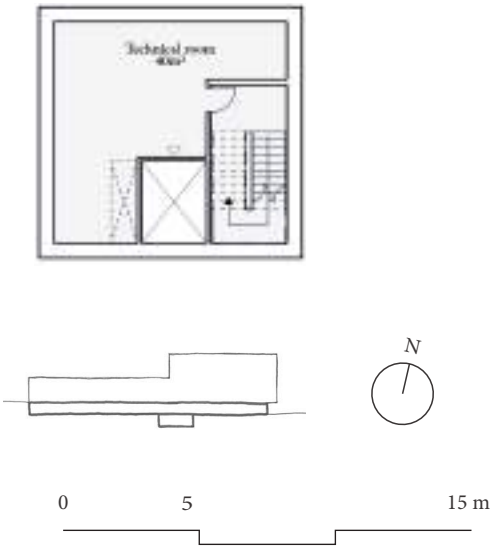
Ill. 99 *Section in the day care centre through the double height café, culture club and classroom on the 1st floor. In the basement the section goes through the depot and changing rooms (see next page).*

Day Care Centre and Short-Term Residences

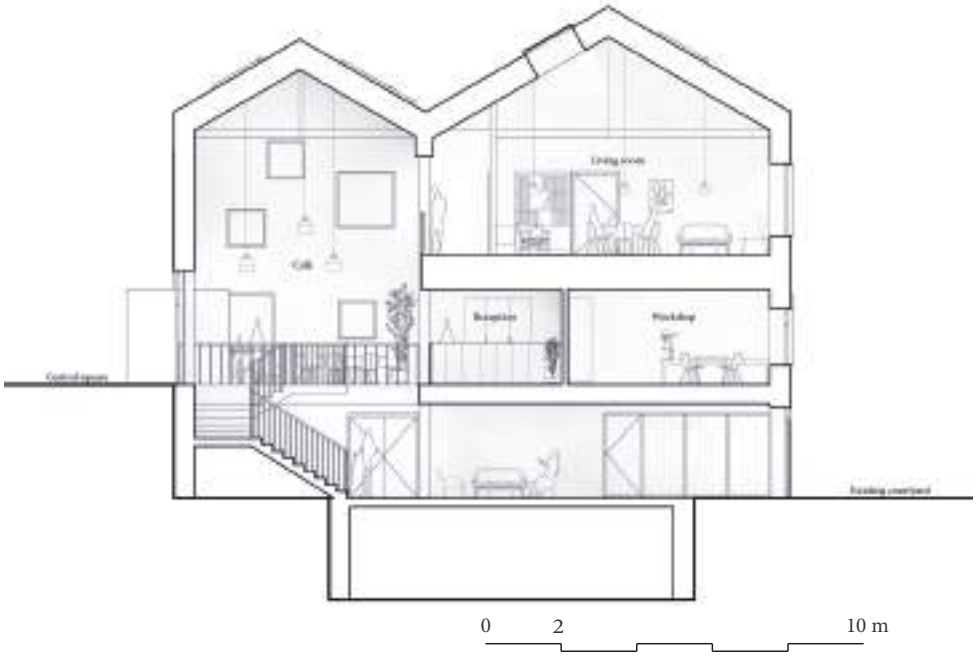
Two stairs, one in each end of the café, leads up to the first floor where lecture rooms, conversation rooms, TV-room and a living room are placed. The new DBC Aarhus will be the central dementia-knowledge-centre for Aarhus municipality and therefore contains facilities for educational purposes. A folding wall divides the two classrooms, allowing for a multifunctional room, which can be used for various purposes. The first floor is visually and aurally connected with the café and can be overlooked from the hallway along the functions (ill. 97-98).

Short-term residences are placed in the southern part of the multi-storey part of the day care centre on both the ground and first floor, creating a good connection to the day care centre facilities. The short-term residences work as local relief care residences for the municipality and overnight accommodations for relatives.

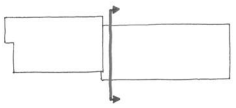
Ill. 100 *Plan of the basement in the day care centre, with access to the parking to the south, the existing nursing home to the north and the existing courtyard to the east.*



Ill. 101 *Plan of the lower basement housing all the installations for the day care centre.*



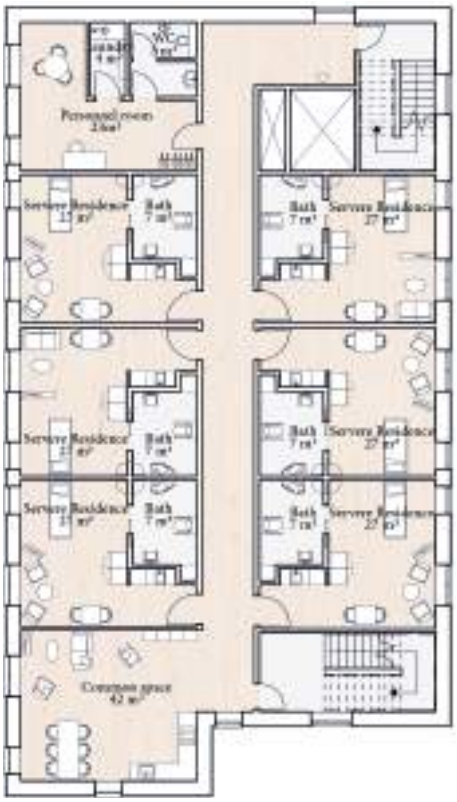
Ill. 102 *Section in the day care centre, through the stair and opening between the basement ground floor, the connection to the existing courtyard. By opening up the floor between the two storeys the café reaches down in the basement and connects the entire building both horizontally and vertically.*

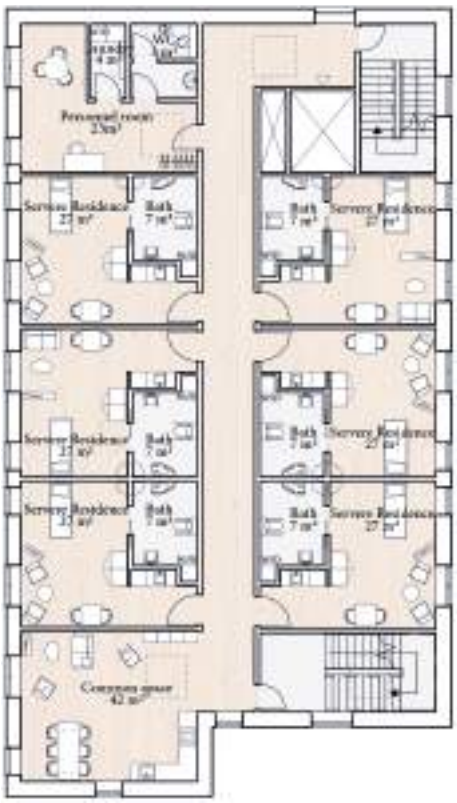


Administration and Basement

The basement in the day care centre is a working machine for the DBC Aarhus. It is here the personnel arrives when they go to work, changes and goes out to the different housing blocks or facilities in the day care centre. This floor also directly connects to Abildgaarden, through a small intermediate glass building, which invites residents in with a small lounge area with access up to the café. Here, the kitchen personnel have the possibility to distribute food from the industrial kitchen to the housing units through the basement under the housing blocks.

All the administrative functions are placed in the southern part of the day care centre. A cut-out of the building elucidates the entrance and leads visitors and relatives into the department where they can meet the different heads of departments for meetings. Visitors of the café and day care, who are incapable of using the ramp to the café square can use this entrance to utilize the central elevator which travels all the way through the building up to the third floor. Daylight enters the space down from the café through an open stair, and from the opening out to the green area between the new centre and the existing nursing centre, as shown on ill. 102.





Ill. 103 *LH Plan of the 2nd floor of the day care centre, housing the residences for severely demented patients.*

Ill. 104 *RH Plan of the 3rd and top floor of the day care centre, housing the residences for severely demented patients.*

Ill. 105 *Section through the day care centre, cutting through all the residences all with access to direct sunlight, due to the tall typology. In the basement the offices opens up to the existing courtyard while the ramp from the parking can be seen winding up to the main entrance.*

Residences for Severely Demented

Second and third floor are arranged with residences for severely demented, a common area and a personnel room on each floor. The residences for the severely demented are smaller, since they are bedridden and therefore have less need for the same generous floor space. The common area in the southern part of the floors have a kitchen where the personnel can prepare the food and be social with the resident who can manage to leave their residence. The personnel room is arranged on both floors for logistical purposes in regards of the residences and to accommodate meetings, small breaks, documentation and laundry.

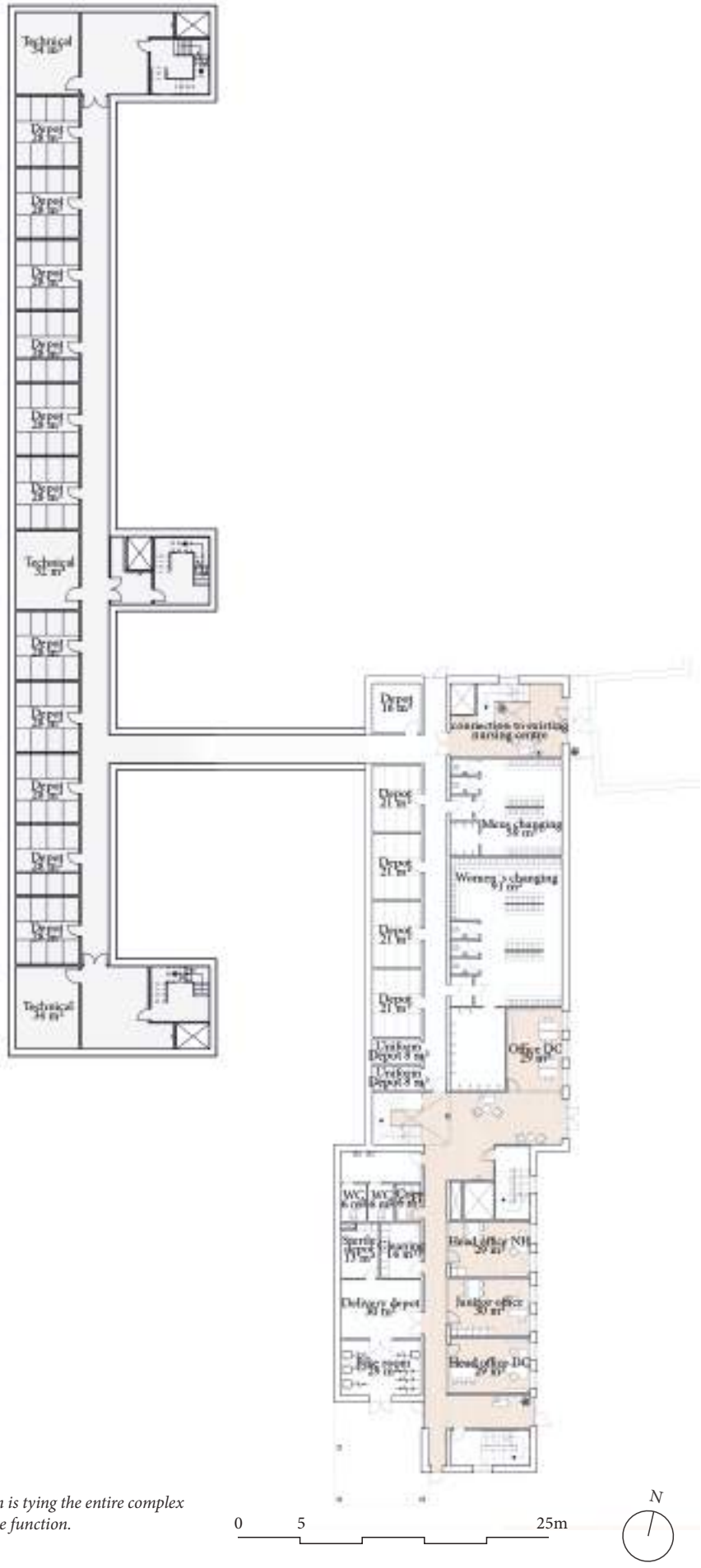
Façades

The façades and the roof of the day care centre, mimics those of the housing blocks. The gables are covered in classic brick while the long façade and the roof are covered with brick shingles. On the western façade, the windows for the residences are displaced slightly to break down the large, static façade. The café area is made transparent via a large glass panel, connecting it to the outdoors. Scattered windows over the glass panel and on the roof, drags the light into the bottom of the café and down through the opening to the basement.

Like the gables on the housing blocks, recesses are used to create dynamic façade. The basement floor creates a base for the rest of the building by pushing in every third course, while the rest of the gable has every header in every third course pulled out. The façades are a reinterpretation of the 60's brick slabs found in the nearby context, thereby creating a good relation. The thin, black zinc profile frames the windows and the building silhouette elegantly by emphasizing how the brick tiles wrap around.

Ill. 106 *The western façade of the day care centre is like the housing blocks, cladded with brick shingles parallel to the ridge of the roof. The wrapping effect is lifted along the café in one long glazed façade, while square windows are clearly stamped out in the façade, clearly differentiating the day care centre from the rest of the complex. The eastern part housing the residences, is calmer in its expression but keeping in touch with the slightly dynamic expression of the housing blocks.*

Ill. 107 *The southern façade of the day care centre facing the route of access is like the other gables in the housing blocks cladded with brick tiles. The gables are very much in line with the strict expression in the context. The bond used in the brick system is worked to emphasise the effect of a base and the high structure rising from it.*



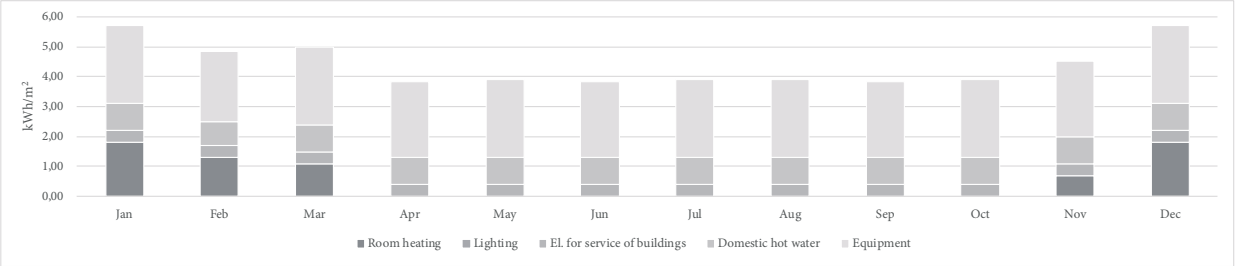
Ill. 108 *Plan of the basement which is tying the entire complex together, and makes the nursing home function.*

The Connecting Basement

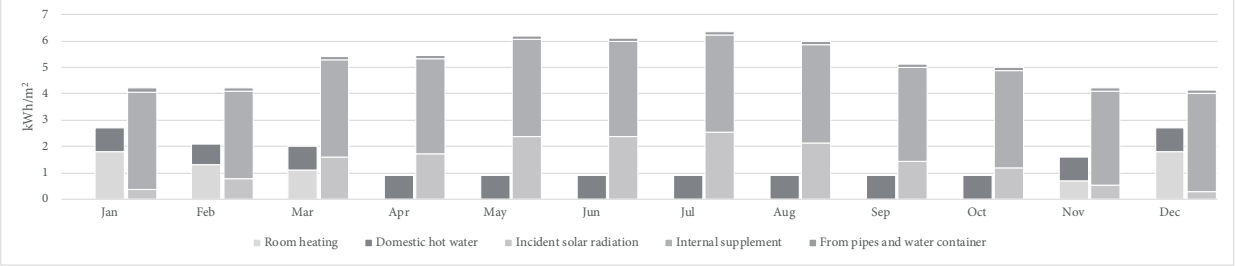
As mentioned earlier, the basement of the day care centre is the working machine for the whole complex of DBC Aarhus. When the personnel arrive in the morning, they will use the entrance in the southern part of the day care centre. From here, they can move to their office in the administration department or down to the changing rooms before they spread out to the day care facilities or housing blocks. On the way to the changing rooms, the personnel pass the uniform depots where they can take a clean uniform for the day.

The personnel can enter the housing block through a corridor, which connects the basement with the administrative department of the day care centre. The basement under the housing blocks consist of extra depots for the residents and a technical roof for each housing block. Via a staircase or elevator, the personnel can enter the organizational unit in each housing block and from there move further on to the residences. The basement also acts as the transportation route, when residents have to be transferred.

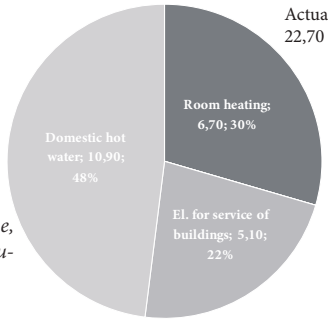
The basement is also the connection to Abildgaarden, allowing for easy distribution of food from the industrial kitchen and out to the housing blocks and café.



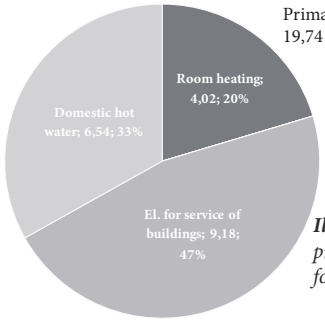
Ill. 109 *Distribution of the energy consumption in the housing blocks.*



Ill. 110 *Heating demand and heating supply in the housing blocks.*



Ill. 111 *Energy frame, actual energy for the housing blocks.*



Ill. 112 *Energy frame, primary energy BC 2020 for the housing blocks.*

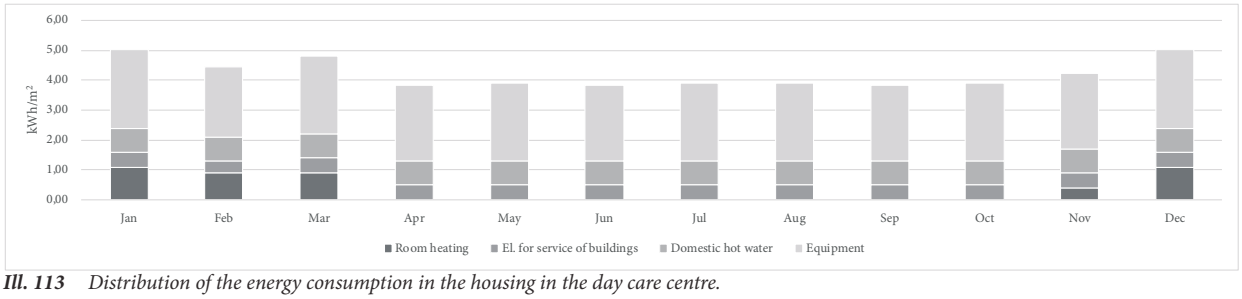
Energy

The combined energy frame for the entire project is aimed to meet the demands of building class 2020. To reach this goal should be done without implementing active solutions but through the use of passive strategies. The final energy frame is calculated using the certification software Be15, which calculates on a monthly basis. Throughout the design process, a parametric version of the software has been used to investigate different potentials in the overall design.

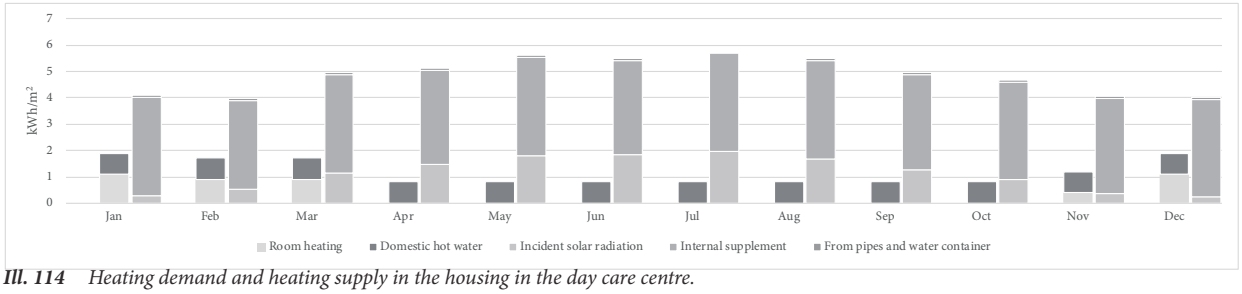
For the calculations of the project it has been subdivided into three structures: One containing the housing units, one with the housing in the multi-storey complex and one with the public and administrative functions in the day care centre. The housing structures are calculated as nondetached housing, while the day care centre is calculated as "other building", due to the many different functions of education, office spaces, café, etc. The different types of buildings results in different energy frames to comply with and elements included in the calculation. For housing, the total energy frame may not exceed 20 kWh/m^2, and includes heating, ventilation, cooling and domestic hot water. For buildings in the other category, the energy frame may not exceed 25 kWh/m^2, and includes the energy consumption to lighting in addition to the ones in the housing category. Furthermore, the loads in the building vary between the two categories for example the internal loads and the DHW consumption.

To make the calculation, rough calculations have been made on a couple of areas, for example on the pipes throughout the buildings for both domestic hot water and room heating. The domestic hot water consumption is based on areas that contribute to this consumption: Residences, common areas, toilets and sculleries. In addition to this, the energy demands for lighting of the day care centre refers to other projects, as the exact electricity usage has not been calculated. Energy demand for the ventilation is calculated in accordance to the DS/EN 15251 (see app. 4), while still being able to accommodate the needed air change to meet the building regulations and the desired indoor climate. The specific electricity use for air transport in based is on rough calculations on the pressure loss in the duct system. The transmission coefficient for the transmission loss in the envelope has been calculated and can be seen in app. 5.

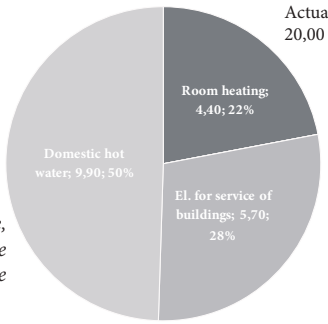
When comparing the results between the three analyses, it is quite clear that the housing units are a significantly ineficient typology when it comes to transmission loss, using more than two kWh/m^2 than the two other buildings. When converting that by the primary energy factor for the building class 2020 however, the energy used for heating becomes significantly less of a factor. Considering the day care centre,, the energy demands for electricity consumption is much higher due to the added entry lighting, making the electricity use for service of the building almost twice as big as the other buildings. This only increases when looking at the entry with primary energy factors, The total energy consumption increases dramatically, making it the one of the three with the highest energy consumption.



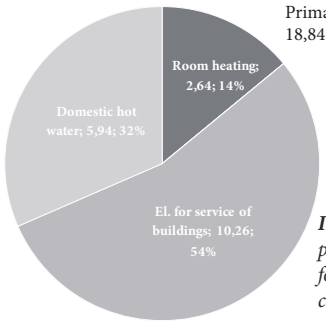
Ill. 113 *Distribution of the energy consumption in the housing in the day care centre.*



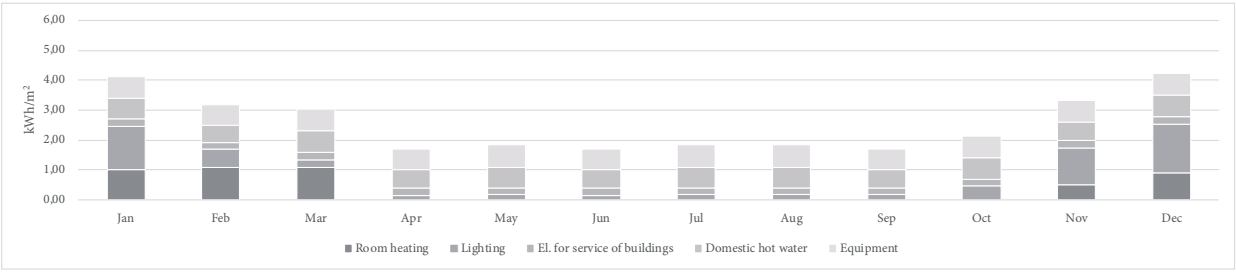
Ill. 114 *Heating demand and heating supply in the housing in the day care centre.*



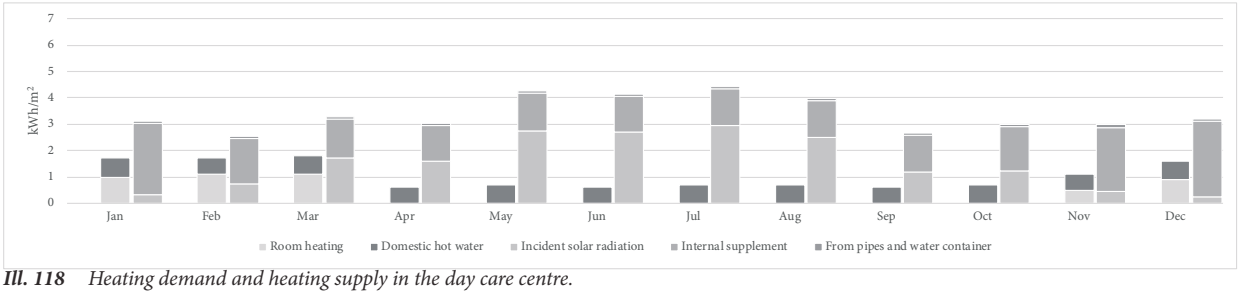
Ill. 115 *Energy frame, actual energy for the housing in the day care centre.*



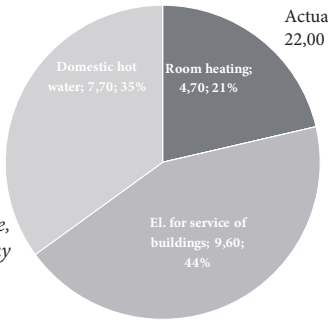
Ill. 116 *Energy frame, primary energy BC 2020 for the housing in the day care centre.*



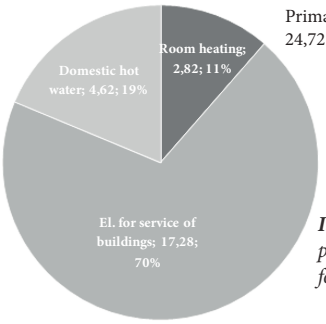
Ill. 117 *Distribution of the energy consumption in the day care centre.*



Ill. 118 *Heating demand and heating supply in the day care centre.*



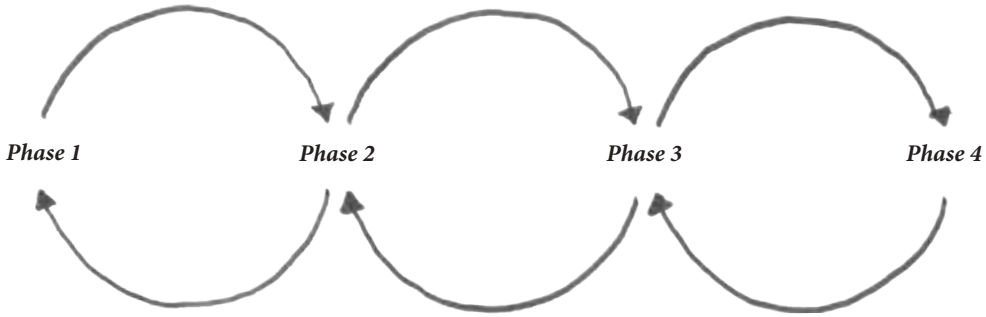
Ill. 119 *Energy frame, actual energy for the day care centre.*



Ill. 120 *Energy frame, primary energy BC 2020 for the day care centre.*

Design Process

Introduction
Initial Studies
Housing Units
Day Care Centre
Urban Design



Ill. 121 *The iterative design process*

Introduction

The following depiction of the design process is divided into four phases, which processes different themes by applying gained knowledge from analyzes and theories accumulated in the design programmeme. As expressed on ill. 121, the design process is not executed linearly but iteratively, meaning that alternations between phases occurs continually according to the iterative design process. The work practice in the different phases utilizes both sketching and modelling whilst simultaneously incorporating technical aspects. The aim of the composition is to present different tools, methods and parameters used throughout the process.

The final design has been concluded from the following design process. This is a means to elaborate on the process through description and reflection upon various design choices. The design process is purely divided to create a clearer overview and should therefore not be interpreted as four chronological steps, but rather as a complete project with many different aspects.

Initiating Studies

The first phase followed up on the design programme, by making use of gathered knowledge. Phase 1 is characterized by analogue designing tools such as physical modelling and drawing by hand and using CAD.

First step was initial studies of an overall plot ratio in order to determine the extents of the complex, followed by typology studies, which took climate, volume and orientation into consideration.

Last step zoomed in on the arrangement of the individual rooms in order to further test the typologies in regards of aforementioned considerations as well as logistics.

Plot Ratio Studies

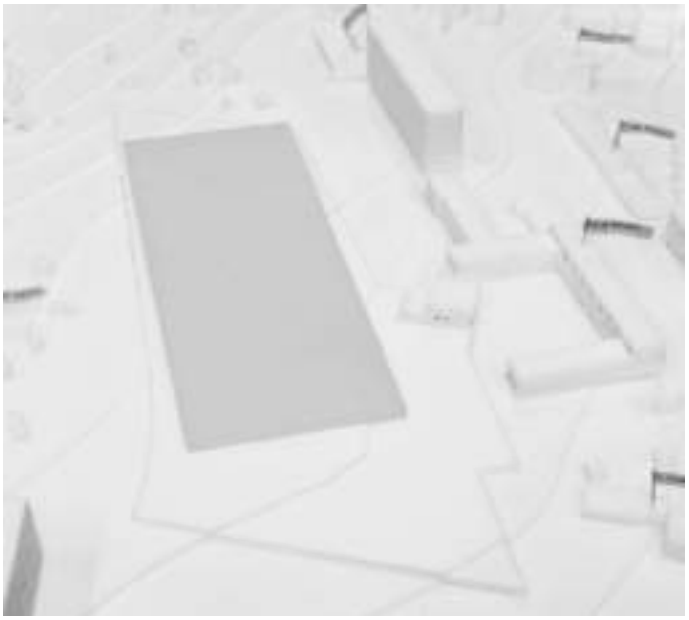
The design process started off with a volume study of the plot ratio to investigate how much space the new DBC Aarhus building complex would fill out on the project site. The study is done through an extruded footprint in one floor, two floors and combinations of both. The combination illustrated on the opposite page is a study of all residences in two floors whilst the rest of the complex is one floor.

• One floor footprint at 8500 m^2 gives a free space on 7542 m^2 (47%) for outdoor areas and parking

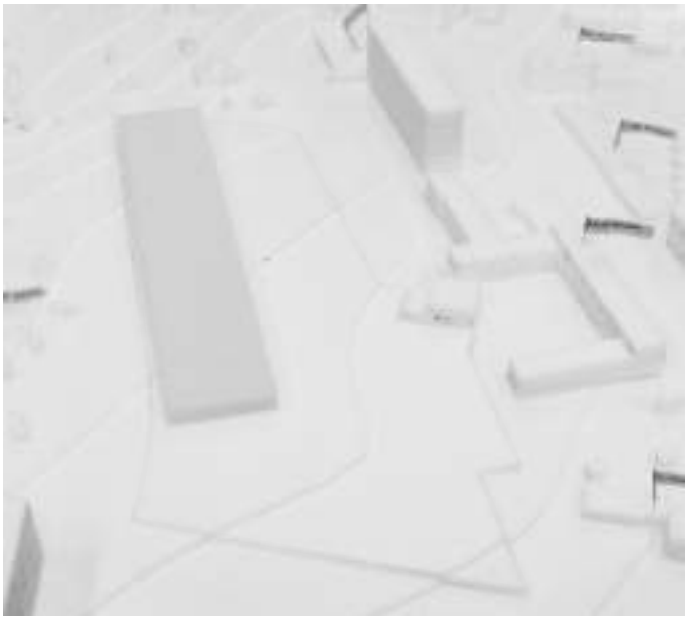
• Two floor footprint at 4250 m^2 gives a free space on 11792 m^2 (73.5%) for outdoor areas and parking

• Combined footprint at 4950 m^2 gives a free space on 11092 m^2 (69%) for outdoor areas and parking

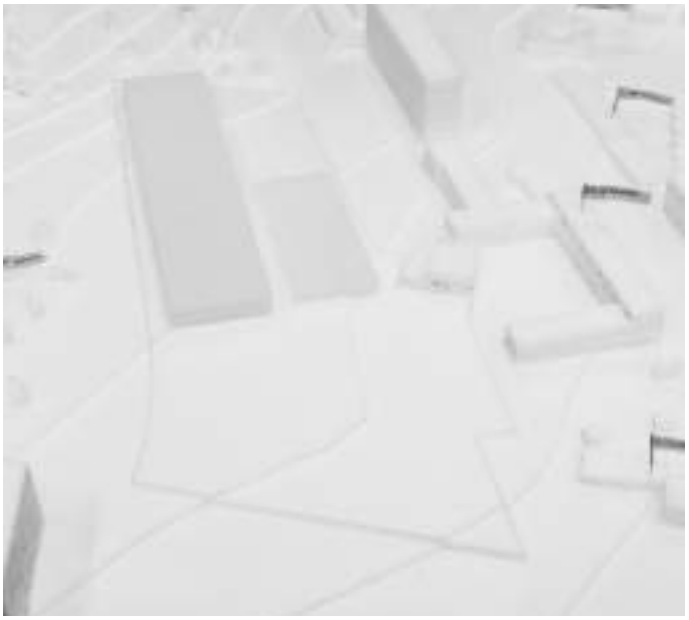
The proposal of combined storey heights seemed preferable due to the potential for good outdoor areas in relation to the number of residents. This is contrary to the two-floor-proposal, which gives a distant connection to the outdoors by potentially compromising the accessibilities for some residents. The one-floor-footprint creates complications since it almost fills out the whole project site.



Ill. 122 *Plot ratio - 1 story*



Ill. 123 *Plot ratio - 2 storeys*



Ill. 124 *Plot ratio - mixed storeys*

Typology Studies

By deconstructing the models from the prior study, this one vestigates how different typologies i.e. their form, sequence and hierarchy respond to the context, site and organization of the DBC Aarhus. The investigation contains three typology studies: The urban block, the slab and the Kasbah.

Other typologies such as the urban villa, high-rise, super block, barcode and the conglomerate are discarded since they do not have the potential to fit to the organization of dementia friendly housing. Several design proposals for each typology was created, but only an excerpt is presented here.

The extent of the parking area was integrated from the start and considered in each proposal.

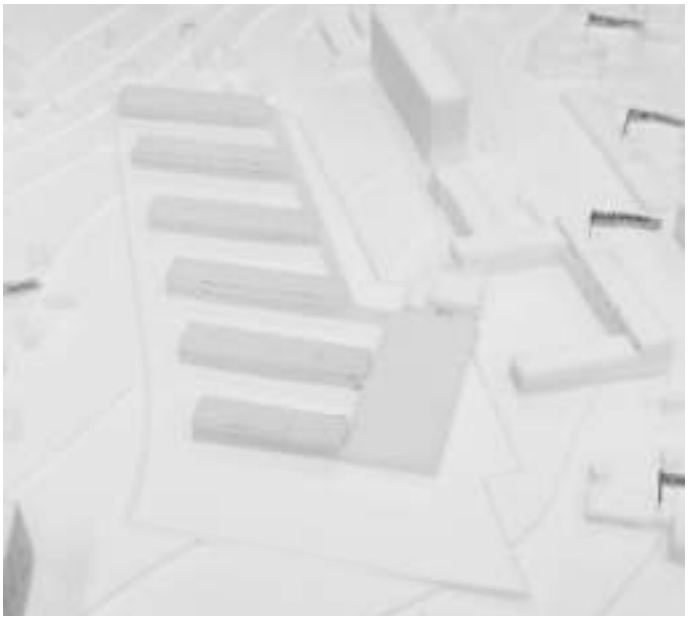
Slab
The slab shows potential for a direct connection between the residence and the outdoor area, but can be experienced as introverted because of the strong division of the outdoor spaces. The typology gives good condition for direct sunlight and use of natural ventilation. The typology relates well to the context in terms of form.

Urban Block
The urban block brought about the most proposals. The study can be divided into two categories, with one consisting of an urban block and a large courtyard, and the other being small urban blocks with several smaller courtyards.
The advantage of the smaller urban block is the circular arrangement which works well in relation to wayfinding. The challenge, however, lies in the narrow and long project site which complicates placing ten housing units with easy access to an appertaining courtyard. The different proposals all work with two housing units and varying storeys.

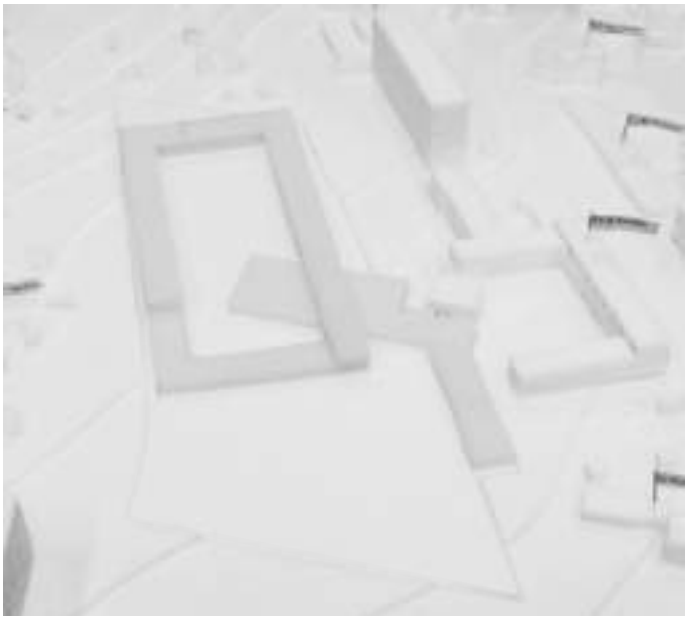
With the single urban block, it was possible to have the whole DBC Aarhus in one floor, and the open courtyard could then be broken into smaller segments if needed. The single urban block connects the residents with the outdoor area but create long corridors for the personnel, forcing them to go through numerous housing units.

The investigations concluded that the shape of the small urban blocks should be challenged for instance by stretching it, whilst the single urban block should be arranged so to divide residences from the corridors.

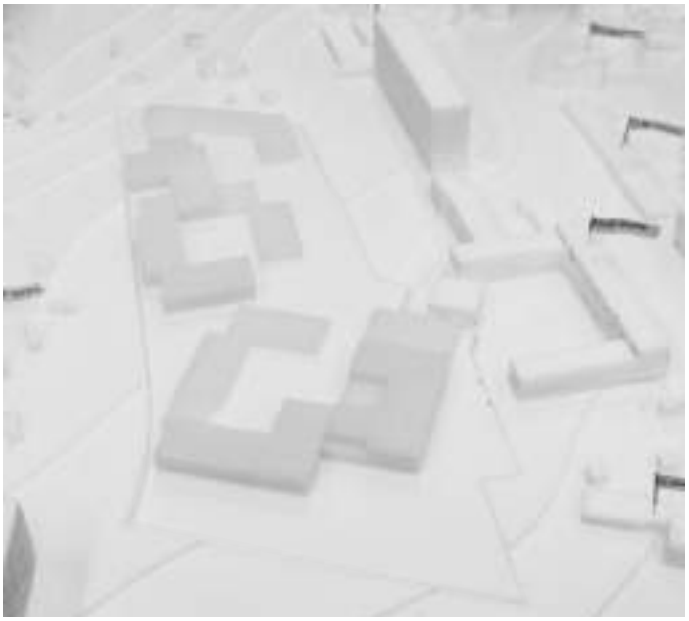
Kasbah
The Kasbah typology creates a good diversity by using different building heights alongside potential for outdoor spaces for the residences on the first floor. The different building heights also breaks down the scale of combined complex. Common for all the proposals are the lack of orientation of the outdoor spaces and the building flow in relation to the context. The designs have many scattered lines and therefore do not relate well to the context. All the proposals work with entrance areas which are created by using both public functions and residences. It gives a sensible connection to both the residents and the city.



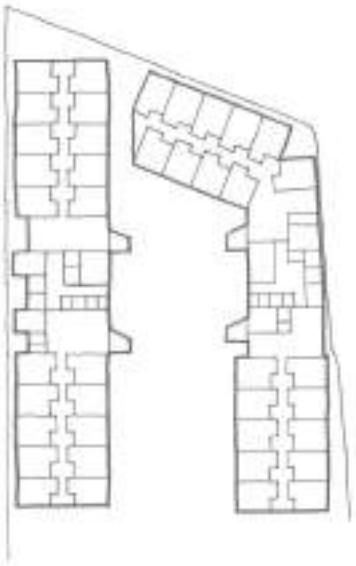
Ill. 125 *Slab*



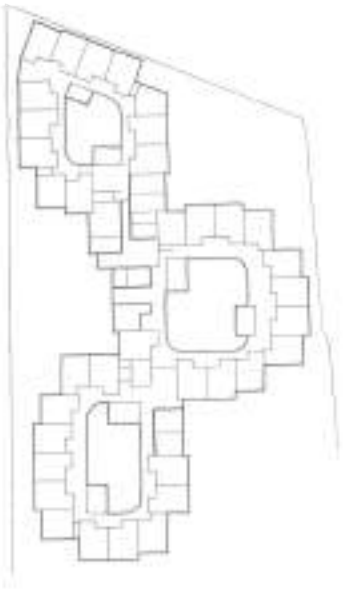
Ill. 126 *Urban block*



Ill. 127 *Kasbah*



Ill. 128 *Plan layout-Large urban block*

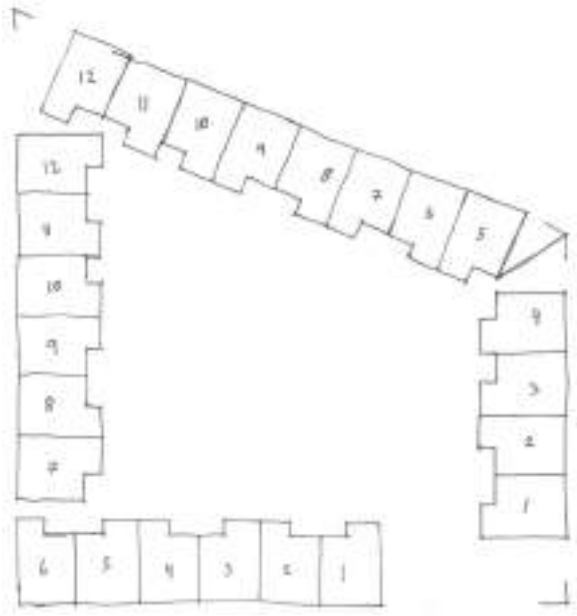


Ill. 129 *Plan layout-Small urban blocks*

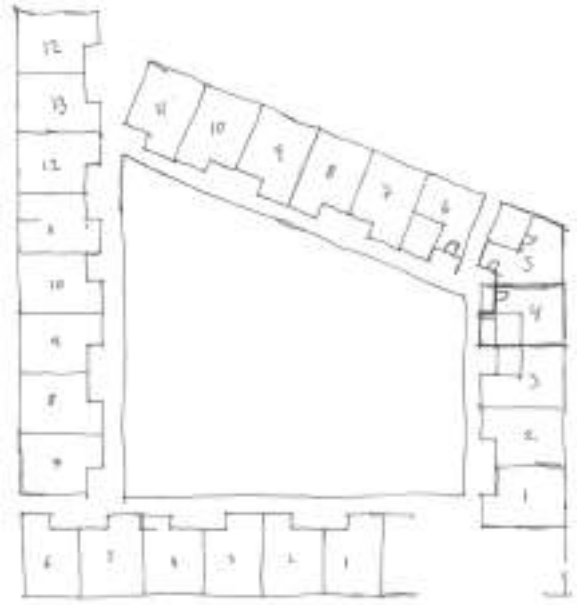
Room Arrangement

After finishing the initiating studies, the design programmeme was revisited and extended with additional studies to further support an optimal typology and building organisation for the users.
Here, it was concluded that the most advantageous would be the urban block with its continous, circular flow and enclosed, appertaining courtyard. The housing units should not extend beyond ground floor in order for residents to have easy access to outdoor areas.
In order to cater the limitations of the narrow project site, the residents were statistically divided into their respected state of dementia (see *Dementia*), allowing for 85% of them on the ground floor. Since severely demented are bedridden, they do not have the same need for outdoor spaces and could therefore be placed differently.

Urban block proposals from the initiating phase was then further developed in regards of organisation and logistics.



Ill. 130 *Room arrangement option 1*



Ill. 131 *Room arrangement option 2*

Housing unit

The optimal layout to fit the criteria of the design programmeme and general theory was to combine two housing units of 12 residences per unit into one urban block. This allowed for a sufficient use of the project site, leaving a large, enclosed and shared courtyard in the centre of a continual, circular shape. This allows the residents to wander around the unit and the courtyard unsupervised which results in more freedom for them and a more flexible work environment for the personnel.

The last step of Phase 1 involved sketches and 3D-modelling in order to arrange the rooms in the housing units and the housing units on the project site. Visits around several dementia care-centres contributed to an understanding of the composition as well as areal extents of the individual rooms, which was beneficial in regards of the overall volume of the housing unit.

Partial conclusion

This phase has primarily been focusing on combining analogue tools such as sketching and physical modelling in order to investigate the extents of the new DBC Aarhus. The volume based plot ratio study has been further developed into specific typologies based on accumulated knowledge from the design programmeme.

Additional theoretical studies pointed towards a typology with circular flow and an enclosed courtyard, and arrangement of rooms has then been implemented within these restrictions.

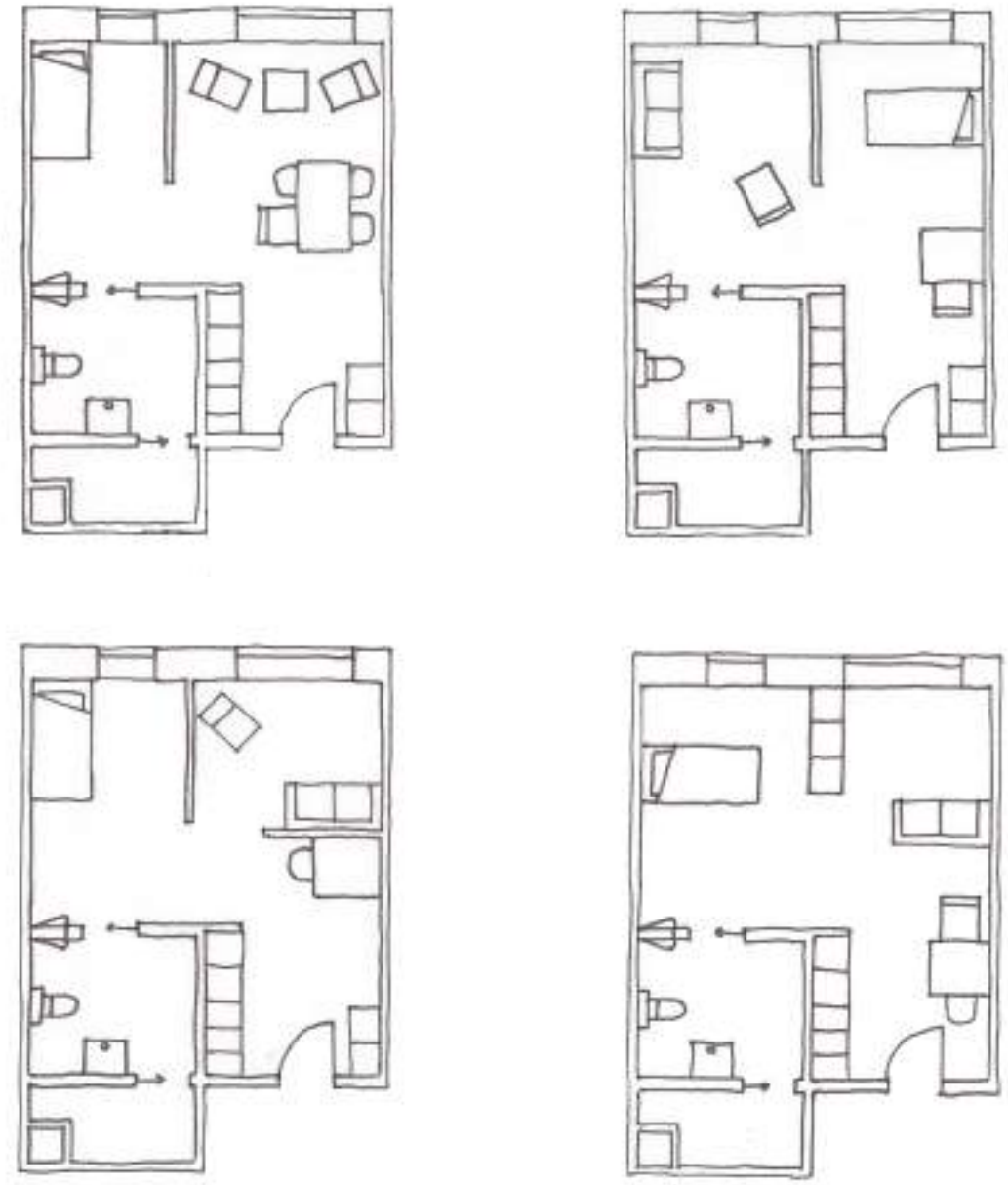
However, further detailing in regards of the technical implementations, volume and the inclusion of remaining functions could have caused an effect of the overall layout. These investigations will be discussed in the next phases.

Housing Unit

Based on the previous volume studies and plan layout, Phase 2 followed with further detailing of the housing unit i.e. residences, organizational units and the appertaining courtyard.

The housing units are the focal point of the project and so contains more integrated considerations in order to create synergy between the architectural and engineering aspects. This concerns spatial qualities and experiences along with the implementation of passive strategies such as natural ventilation and daylighting as well as heating and ventilation system.

For verification purposes the implementation of classification and simulation tools such as Be15 and BSim respectively was introduced to ensure the restrictions of BR15 building class 2020 was met. The work method thus alternated between handmade sketches for quick idea generation, CAD- and BIM-drawing and calculation software.



Ill. 132 *Residence layout proposals*

Arrangement

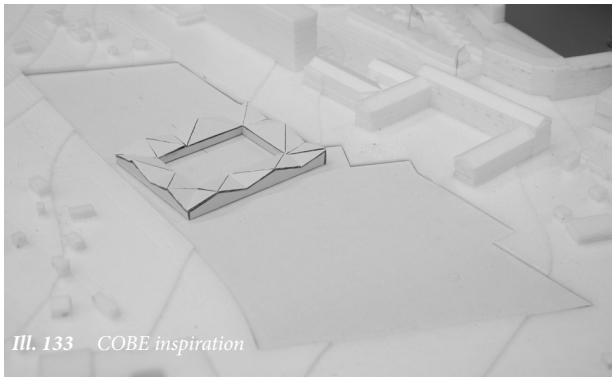
Dementia is an illness with effects that varies with each type, which makes it challenging to design to cater each individual need. Every residence should therefore take cognitive, sensory and physical degradation into account. It is therefore also recommended to design a layout with focus on clearness, preferably by arranging the residence as one combined room with the possibility of dividing it with demountable walls, so the resident can divide the room if desired.

This also corresponds well with the idea of homeliness which is formulated as having control over one's own surroundings. The feeling of homeliness can therefore be emphasized by allowing the resident to furnish his/her own room with furniture and personal belongings accumulated over his/her lifetime.

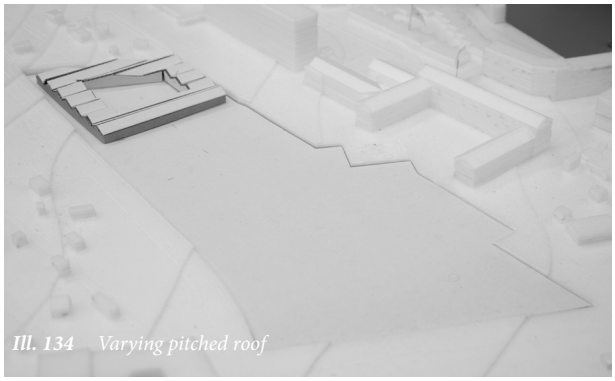
By law, a residence must include a living area, kitchen and toilet facilities with bath included. These facilities will include fixed equipment while the rest of the residence will be for the resident to furnish. This requires extra depot space to store purpose-bought furniture, giving the resident does not bring own belongings.

Niches in front of the apartment with space to place personal belongings are advantageous in regards of resident's ability of wayfinding and is therefore also sought to be implemented in the design.

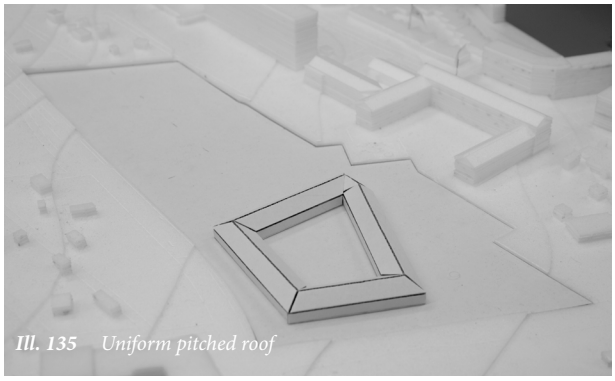
The size of the apartment has been adjusted according to the care-centres visited and with phenomenological studies to get the sense of space.



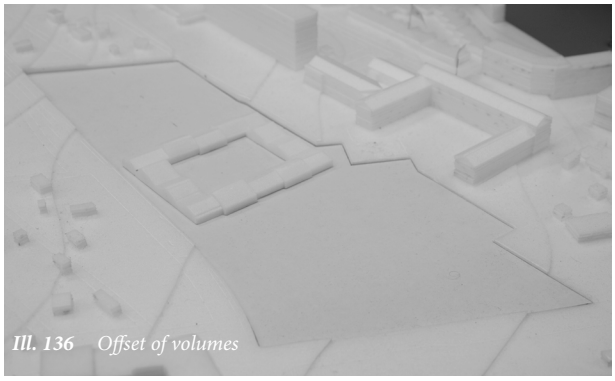
Ill. 133 *COBE inspiration*



Ill. 134 *Varying pitched roof*



Ill. 135 *Uniform pitched roof*



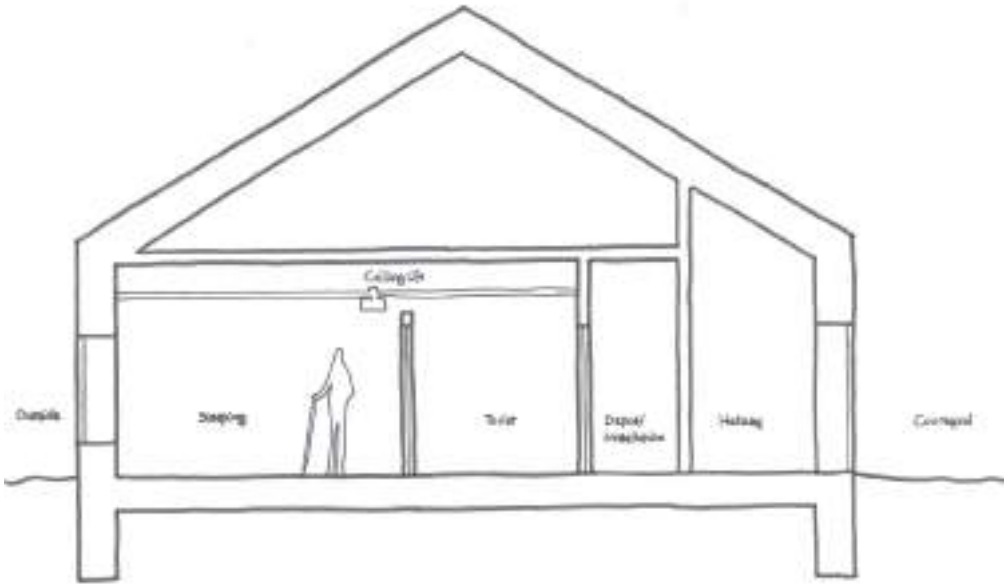
Ill. 136 *Offset of volumes*

Volume study

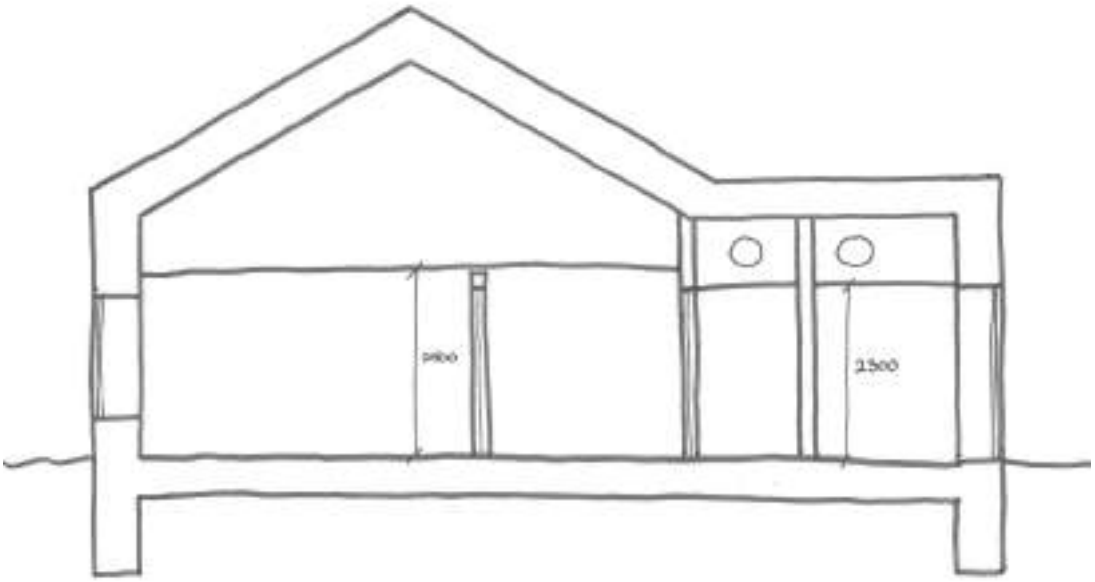
In the execution of the further volume study, both contextual considerations as well as theoretical studies have been considered.
To comply with the resident's well-being, it was important to move away from an institutionalized aesthetic and instead shape a housing unit into a silhouette with which they are familiarized. A pitched roof was chosen as the base ground since this shape not only adapts to the context but also suggest a typical, Danish, suburban villa.

The volume studies sought to challenge this silhouette and the four illustrations above depicts different variations of this parameter, varying from a prismatic roof shape inspired by COBE's Krøyers Plads to a uniform pitched roof.

Finally, the shape on ill. 136 was chosen since the shifts in the façade creates a differentiation, that both breaks up the long stretch of the volume while also creating a sense of personnel ownership of each individual room, since it stands out as a small house silhouette



Ill. 137 *Section - Combined pitched roof*



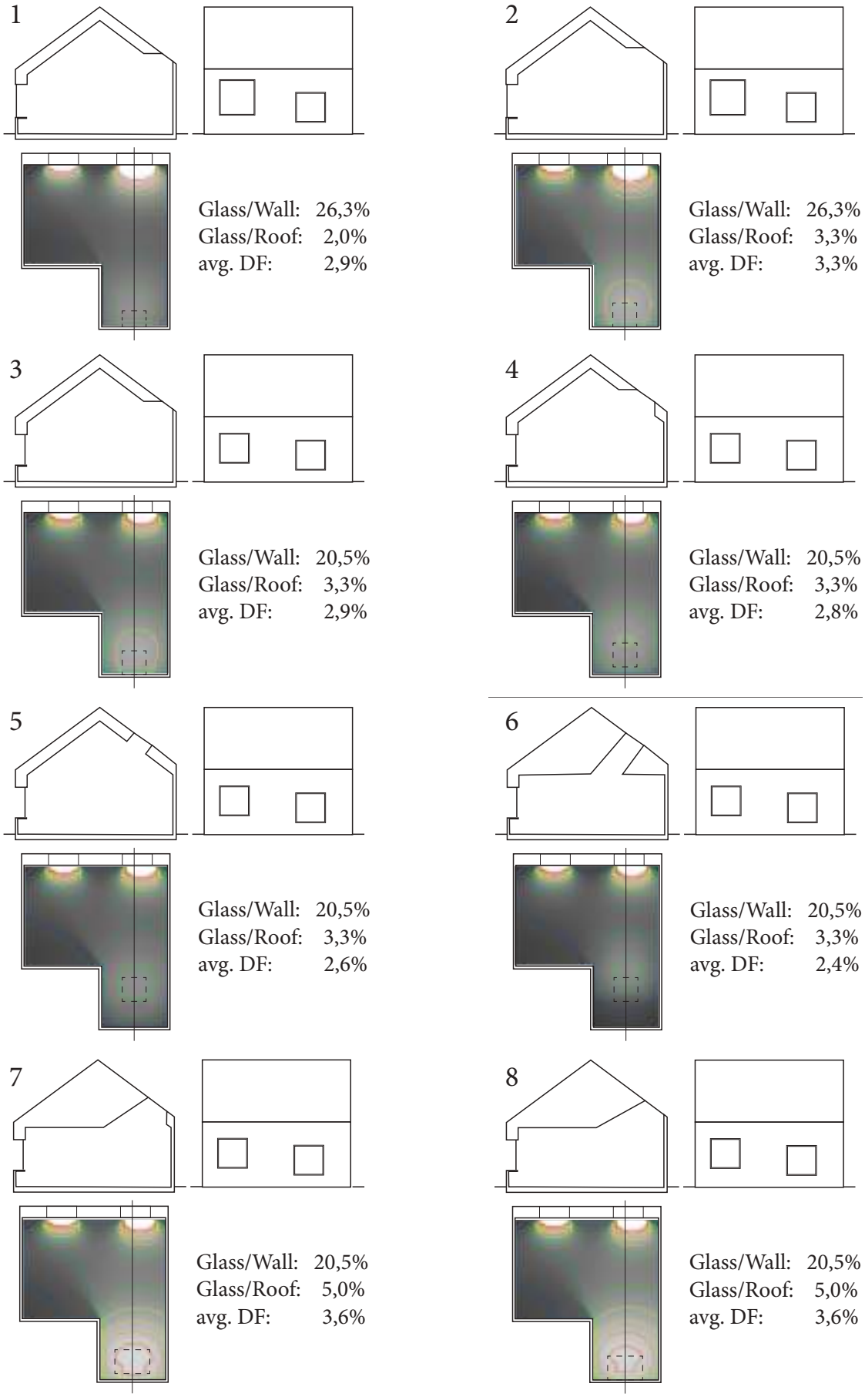
Ill. 138 *Section - Pitched and flat roof*

Residence

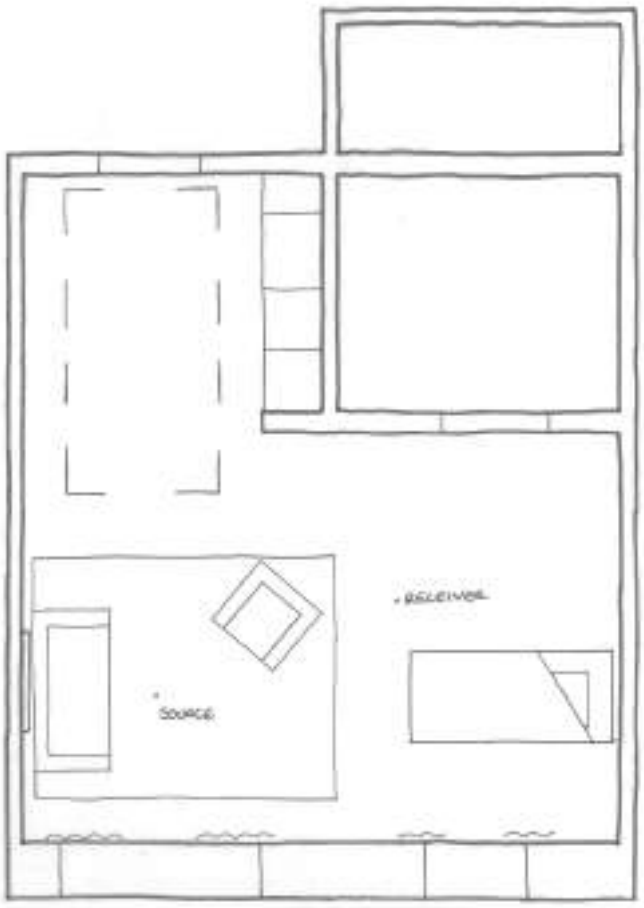
Ill. 137-138 show the detailing of the room and connection to the appertaining hallway. The initiating idea was to combine both under one pitched roof. This however created difficulties in regards of placement of a skylight – which is important due to the residents need of daylight from two directions to follow the circadian rhythm more easily. As the roof ridge was moved out of the residence making the roof covering the residence face north in some cases.

Ill. 139 show a daylight study executed in VELUX Daylight Visualizer, with the parameters of a window for each dividable space as well as a skylight in the opposite end of the room. It is important to work with windows of bigger sizes to let in more daylight for the benefit of the resident. At least one window should have a low parapet, so the resident has the possibility of looking out whether the person is standing, sitting or lying down. Option 7 were chosen to differentiate the wall from the skylight and to bring the room down to a more human scale, by not letting it go to ceiling height.

Room heights were adjusted to fit the ventilation ducts. Ill. 134 shows the initiating thoughts where the ducts run along the hallway, the only straight room in the housing unit, causing a lower room height compared to the residence.



Ill. 139 *Simulation of daylightfactor*



Ill. 140 *Asoustic - Source and Receiver*

Acoustic indoor environment

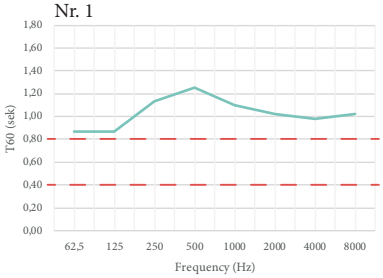
Dementia patients can experience difficulties in handling hearing equipment, resulting in them not using it. Therefore, it is important to secure a suitable acoustical environment so the remaining hearing can be put to best use.

Via Pachyderm it was tested how different materials in a residence influence the acoustic indoor environment. The analysis is set with a source in the living area and a receiver in the sleeping area.

Analysis 1 is the base analysis for desired materials. Analyses 2-5 shows the reverberation where one of the desired materials are replaced and shows that acoustic gypsum board ceiling (2) delay the reverberation time significantly, and brick on load-bearing walls (5) reduce the reverberation time insignificantly. Analyses six is a combination of acoustic gypsum board ceiling and brick on load-bearing walls.

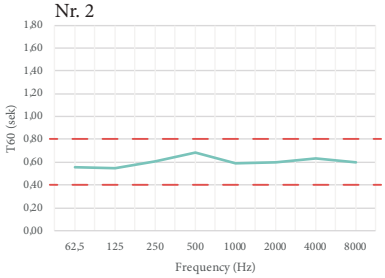
Analyses 7-9 combine the best results of analyses 1-6 (2, 5, 6) with furnishing as a small kitchen, curtains and a bed. The analyses show a stable reverberation time and a satisfying result with only few changes in the materials and combination with furnishing.

Nr. 1



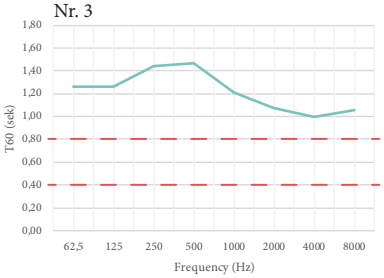
Wood floor on studs
Gypsum board ceiling
Load-bearing walls in painted concrete
Other walls in 2 x gypsum boads

Nr. 2



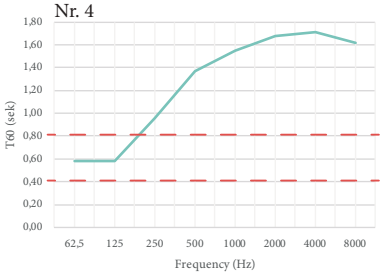
Wood floor on studs
Acoustic gypsum board ceiling
Load-bearing walls in painted concrete
Other walls in 2 x gypsum boads

Nr. 3



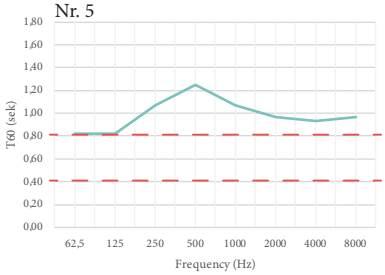
Linoleum floor
Gypsum board ceiling
Load-bearing walls in painted concrete
Other walls in 2 x gypsum boads

Nr. 4



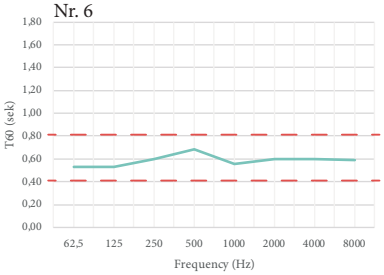
Wood floor on studs
Wood ceiling
Load-bearing walls in painted concrete
Other walls in 2 x gypsum boads

Nr. 5



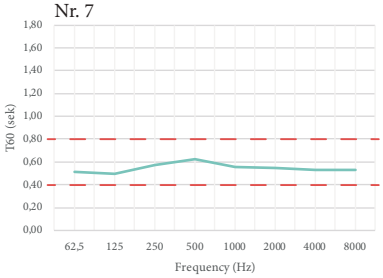
Wood floor on studs
Gypsum boad ceiling
Load-bearing walls in brick
Other walls in 2 x gypsum boads

Nr. 6



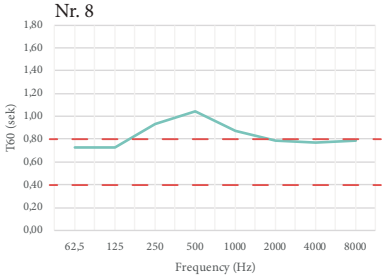
Wood floor on studs
Acoustic gypsum board ceiling
Load-bearing walls in brick
Other walls in 2 x gypsum boads

Nr. 7



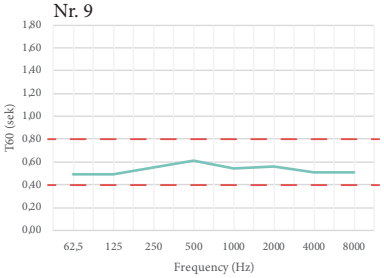
Combination of nr. 2 and furnishing:
Kitchen, curtain and bed

Nr. 8



Combination of nr. 5 and furnishing:
Kitchen, curtain and bed

Nr. 9



Combination of nr. 6 and furnishing:
Kitchen, curtain and bed

Ill. 141 *Acoustic - Results*

Ill. 142 *Materials - 1) Brick shingle, 2) Brick tile, 3) Gypsum, 4) Dark aluminum, 5) Beech wood.*

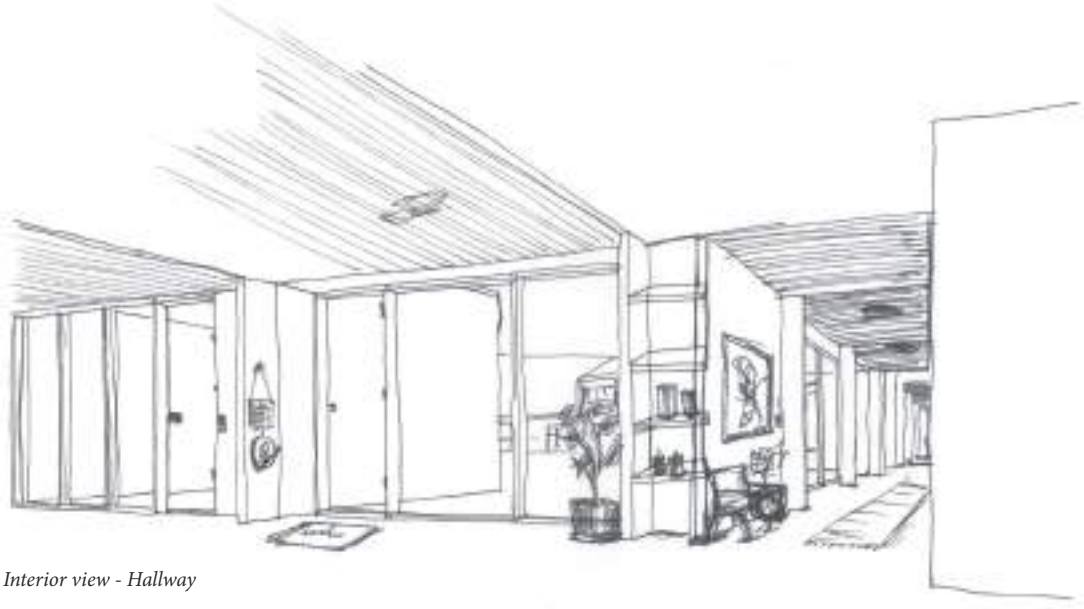
Materials

To adapt to the nearby context, bricks was an obvious material choice. Much like the approach to the initiating volume study, the classic 60's brick housing envelope, known from the nearby context, was sought to be challenged. Inspiration was drawn from Lundgaard and Tranberg Architect's Sorø Museum and Kannikegården, which both utilizes brick shingles that appeal to traditional brickwork.

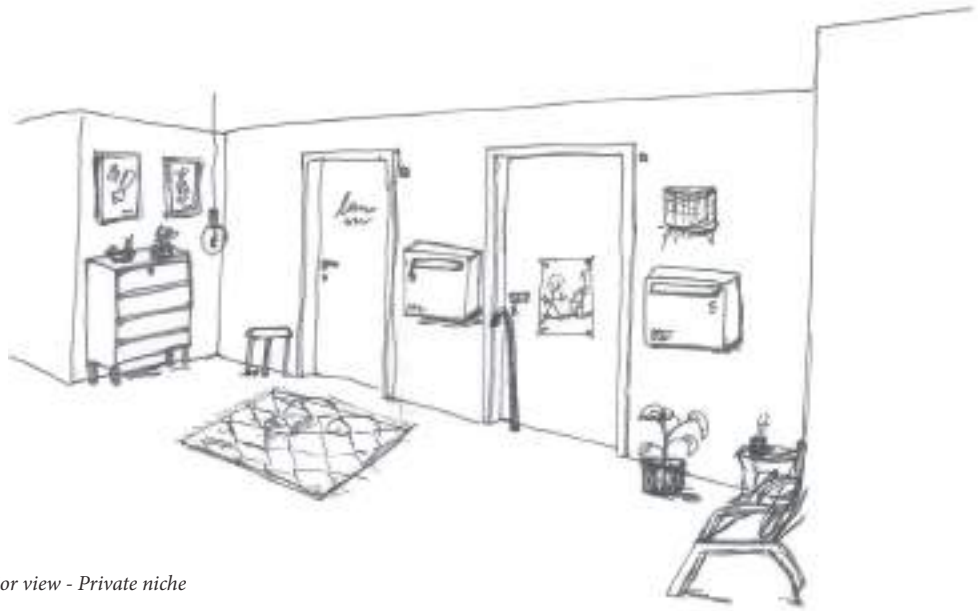
With further inspiration from CEBRA's Children's Home of the Future, the slips could be used as a wrap around the envelope, emphasizing the building silhouette. As a contrast, the gables were intended as wooden lamellas. This was however changed to classic bricks in order to minimize the use of different materials for the confusion of the residents and to better adapt to the nearby context.

The interior materials consist of concrete and gypsum as a result of the constructive principle and the acoustical climate analysis.

The chosen materials resonate well with classical Danish building tradition and will presumably create a familiar environment to the residents.



Ill. 143 *Interior view - Hallway*



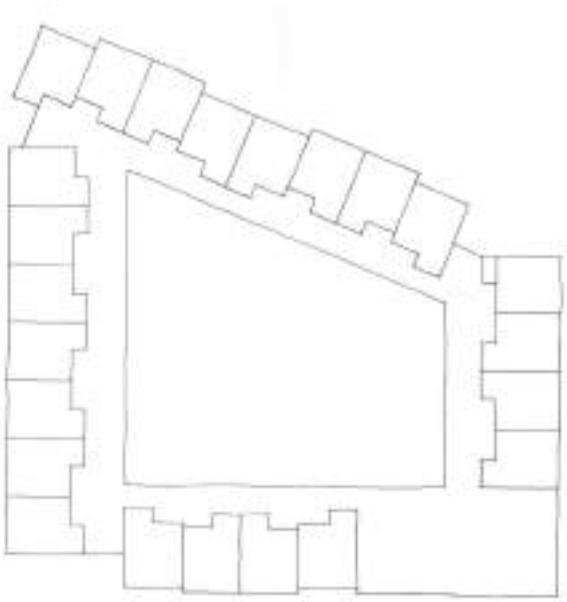
Ill. 144 *Interior view - Private niche*

Interior

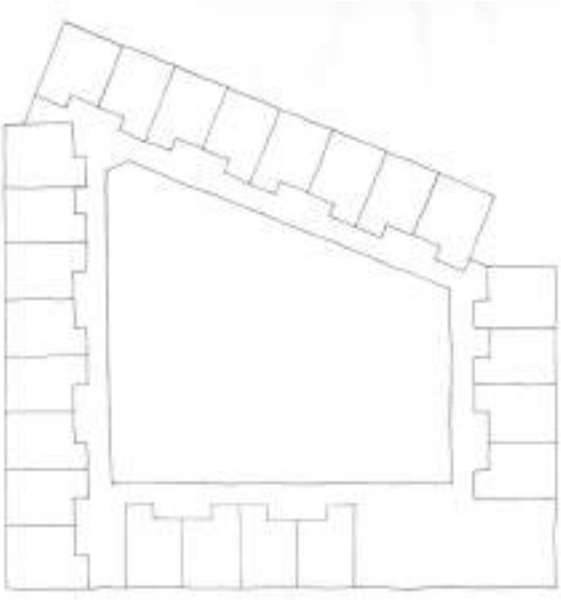
The hallway is intended as a varied space, subdivided by personal niches in front of the residences and with furniture along the façade facing the appertaining courtyard, inviting the resident to smaller breaks.

The hallways will predominantly consist of large floor-to-ceiling windows to let in a large amount of natural daylight and to create clear views into the courtyard. The close connection to the outdoor area both acts beneficial in terms of wayfinding and for the sense of the circadian rhythm and change of seasons.
The interior furnishings will be made of wood, as it compliment the brickwork and concrete and appear warm and tactile.

The ceiling will consist of wooden lamellas for acoustical purposes, and artificial light will be placed in the in-between spaces to cater the residents' need for extra LUX. The wooden lamellas will only stay within the straight boundary of the hallway to emphasize the transition between the common area to the niches in front of the residences, which will appear as a unique, personal spaces. The niches will have enough room to furnish with personal belongings.



Ill. 145 *Plan layout - Offset rooms*



Ill. 146 *Plan layout - Residence in-line*

Shaping the Housing Unit

In connection to the detailing of the hallways and niches, the housing units with the offset residences seemed to create a chaotic abundance of spaces that would appear disruptive to the residents. Combined with a Be15 calculation which showed difficulties in complying with the demands of the energy frame for building class 2020, the housing unit was sought to be straightened, both to create calmer and more well-arranged hallways and to minimize the area of the building envelope.

Straightening the housing units reduce the building envelope by 120 m^2 for the given example in ill. 146 and a total of 400 m^2.

Ill. 147 *Room layout - Organizational unit*

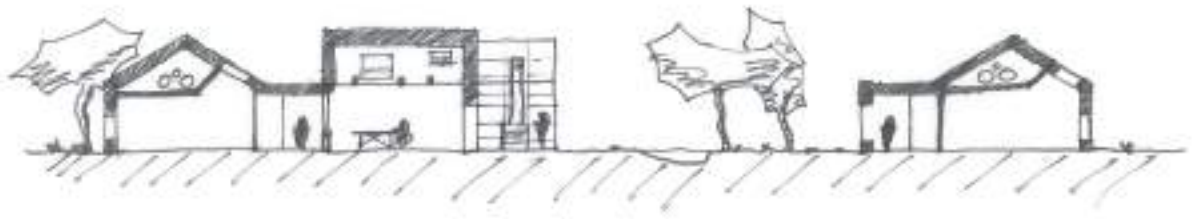
Ill. 148 *Room layout - Organizational unit*

Organizational Units

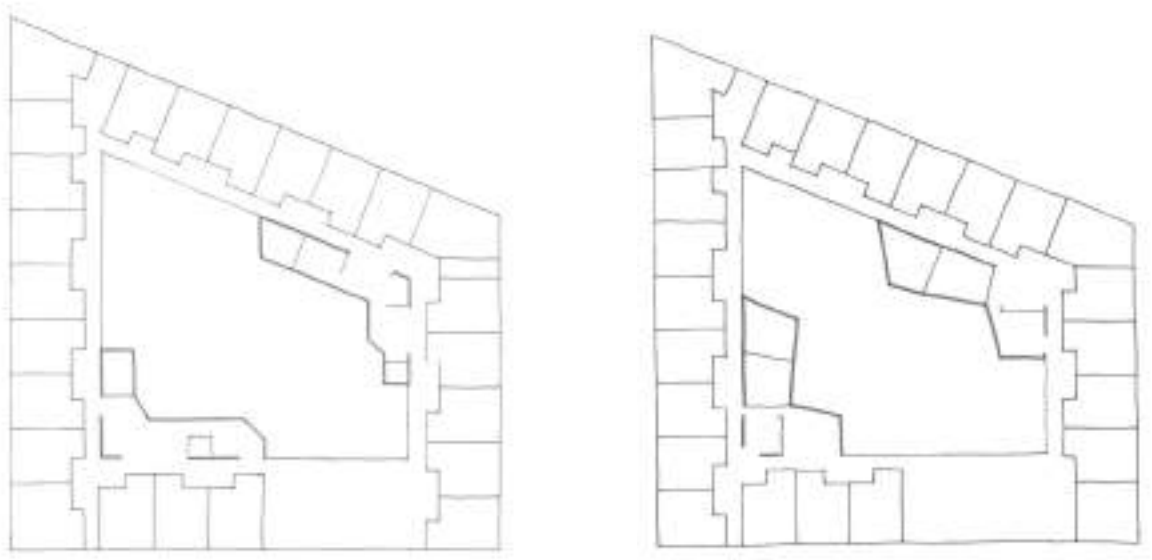
Even though the personnel will spend most of their time close to the residents, it is important for them to have their own office facilities. This is both beneficial for documentation-purposes in regards of a resident's well-being or other alike, but also to converse privately if a resident needs to discuss personally sensitive matters.

The organizational unit contains various programmeming such as a head office, personnel office, an activity room and a conversation room. The unit also acts as entrance to the entire housing unit, making it unlikely for the residents to leave without supervision.

As ill. 143-144 shows, the rooms have been arranged within the leftover space determined by the residences in the housing units. In connection to the implementation of the connecting basement, the organizational units had to be rearranged in to cater fire regulations as specified by the Danish Building Regulations (see app. 6).



Ill. 149 *Section - Connection between residence and common area.*



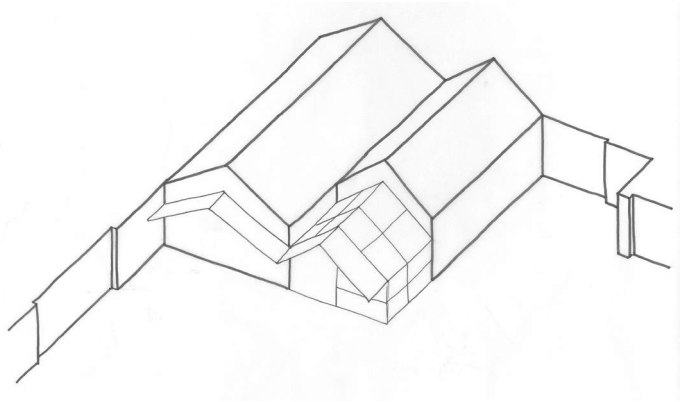
Ill. 150 *Form studies - Common area*

Common Area

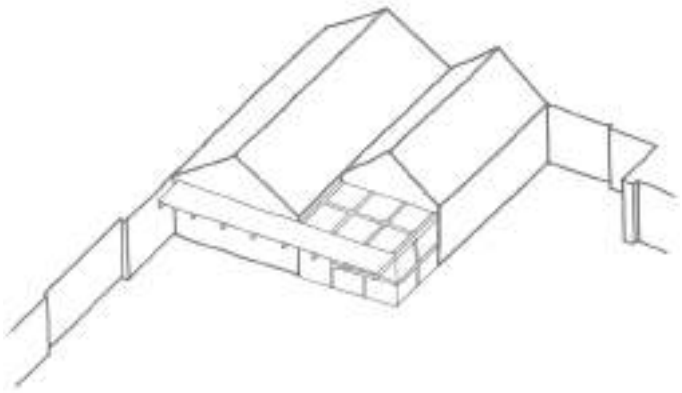
Each housing unit has an appertaining common area pr. twelve residences containing both a kitchen, a dining area and a living room.
Studies have shown that the kitchen is the most important landmark within the housing unit, and it should therefore be arranged for easy recognition and wayfinding. The parameters for the common areas where therefore to make an open dining area to invite the residents inside while having a closed-off living room in connection, to avoid noise nuisance between the rooms.

The initiating studies as shown on ill. 150 sought to create a unique shape for the common area to emphasize it as a landmark and making it easier recognizable from the courtyard and hallways. However, it was decided to go with a form language similar to the residences to mimic the homely atmosphere.

The common areas are facing the courtyard to act both as a link between indoor and outdoor and for easier orientation for the residents around the building.



Ill. 151 *Winter garden - Pitched roof*

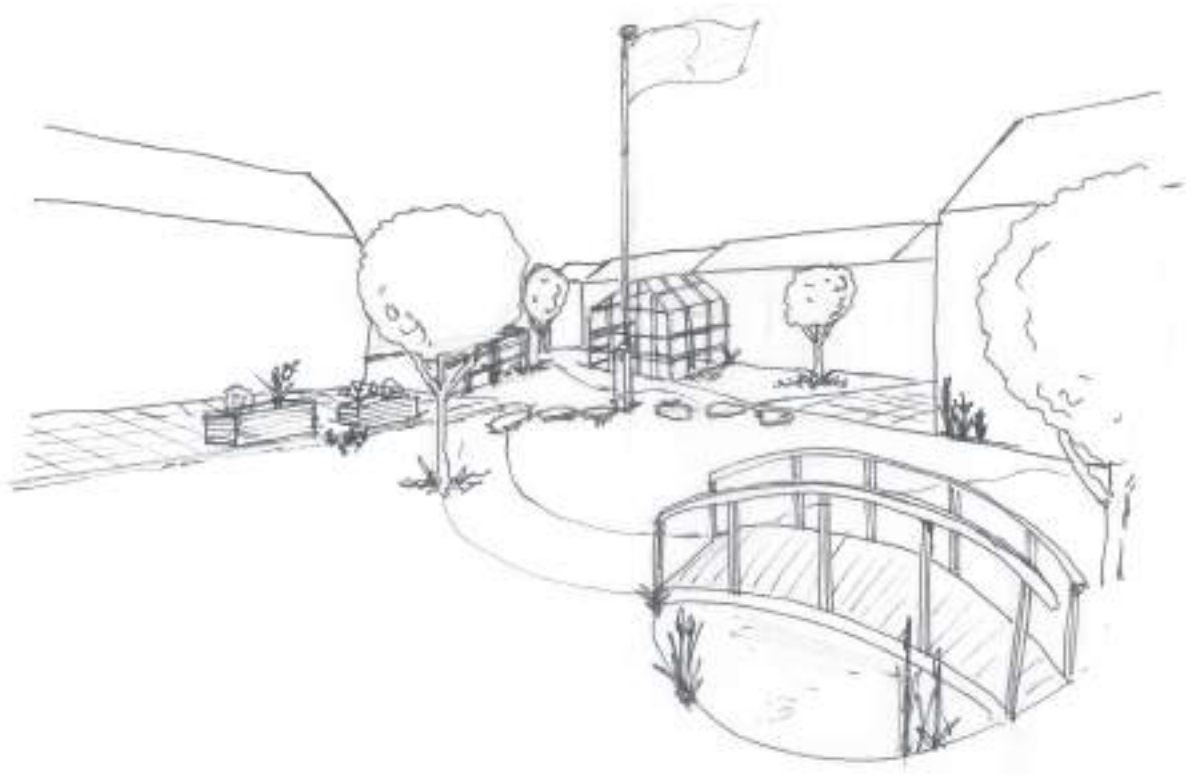


Ill. 152 *Winter garden - Flat roof*

Winter Garden

The winter garden is the border between indoor and outdoor. Here, the residents will be able to feel the change of seasons, since the room is not heated by anything other than a fireplace. The connection to the outdoor is important for the resident's well-being, and the winter garden can potentially compensate, when given circumstances prohibits venturing outside.

Several shapes have been tested through sketching and 3D-modelling. Where an extension of the original shape (ill. 151) seems to create a large, infinite space, the small, cubic shape (ill. 152) appears more intimate. In connection to the winter garden, an overhang out on the terrace had to be integrated to create shading for the common area and part of the terrace.



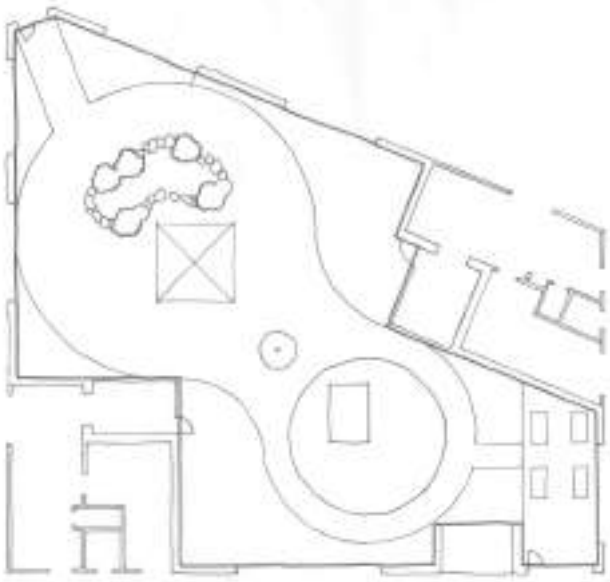
Ill. 153 *Exterior view - Courtyard*

Courtyard

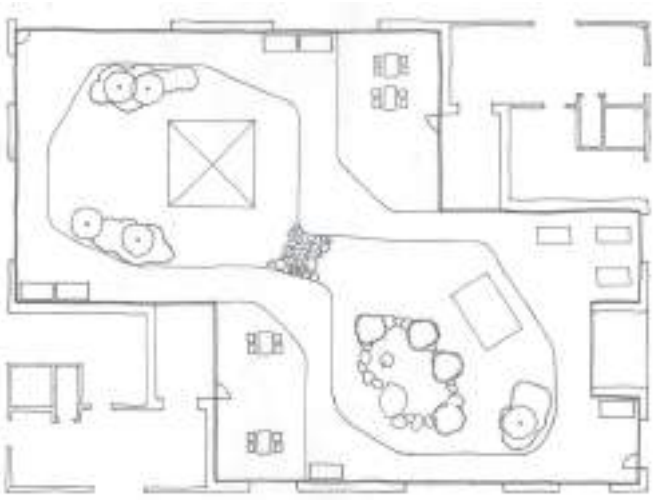
Nature and green areas contribute to sensorial stimuli and the accessibility to outdoor areas are therefore important. The enclosed courtyard is beneficial since it creates a safe and secure environment without any need for supervision.
The outdoor area should appeal to the residents senses and memories, and should therefore include familiar objects such as greenhouses, pergolas, fountains, etc. The planting should vary in types and sorts, blooming and declining at different times during the year, to visualize the change of seasons.

The pathway should be built in a non-skid material and differentiate itself from the greenery to create a sense of control when walking by oneself. It is important that the pathway lead around the courtyard in a circular manner, so the resident can exit the same way he/she entered.
Inviting places for stay over a period of time should be scattered around the courtyard and placed in a manner in which the resident can overview most if not all of the courtyard.

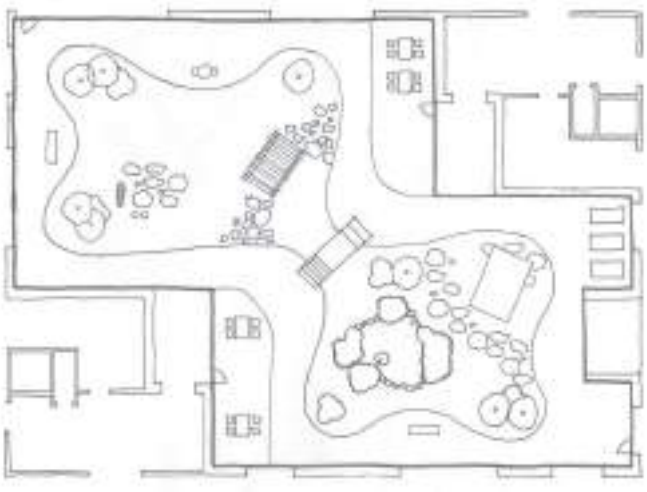
Ill. 154-156 show the process of the courtyard. An organic form was chosen as suitable since it appears more informal and creates small pockets of intimate spaces around the courtyard. The courtyard consist of a pathway along the hallway façade with small diversions appearing here and there, to encourage the residents to take other routes.



Ill. 154 *Courtyard - Option 1*



Ill. 155 *Courtyard - Option 2*



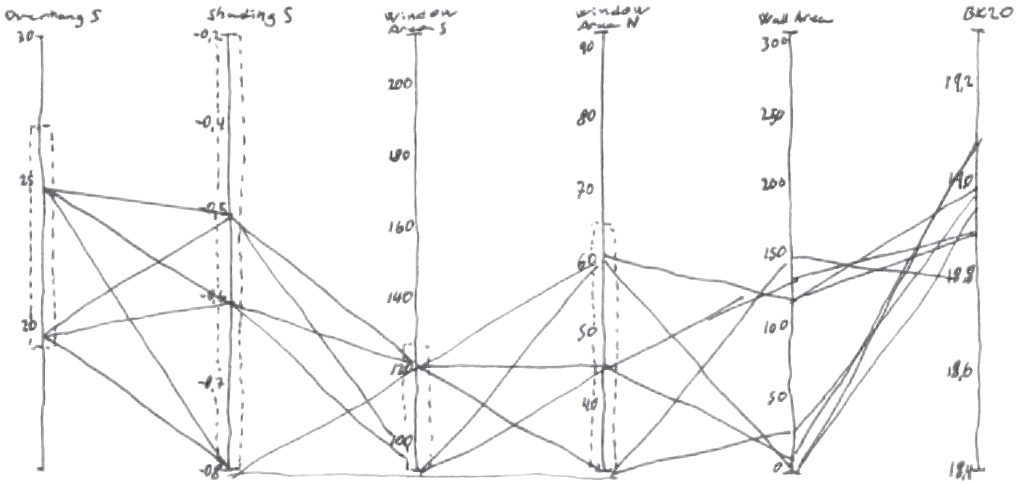
Ill. 156 *Courtyard - Option 3*

Optimizing the Passive Strategies.

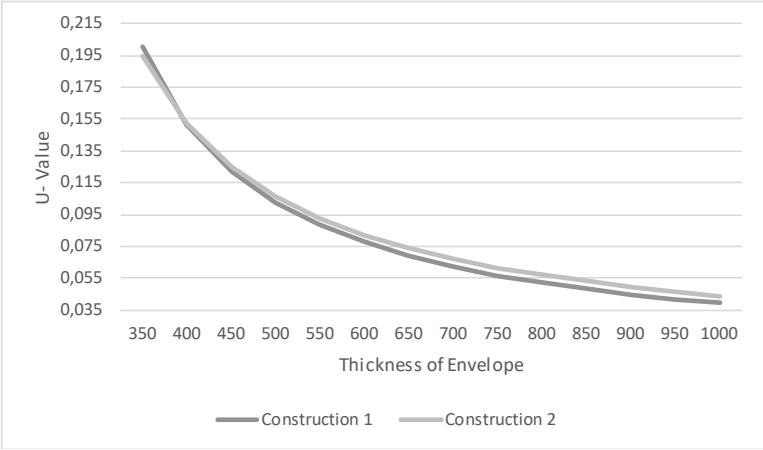
In a search for optimizing the energy performance of the building, through the use of passive strategies, it has been important to keep a very structured approach to finding areas to improve. Simple energy frames has been created for the different typologies tested during the design. For making these energy frames, a parametric spreadsheet version of Be15 have been used. By making the energy calculations parametrically it has enabled more iterations of the design proposals.

The accuracy have slowly been increased over time, starting with very simple tests of volumes, glass proportion and shading. Later in the process more and more details have then been added, increasing the level of detail and accuracy. The point of the calculations have never been the result, but the possibility to evaluate design during the process, instead of controlling the design at the end. Doing continuous controls throughout the process have resulted in the energy being used as a way of selecting and improving instead of an obstacle as it can often become. The example shown on the opposite page is an early calculation of a housing block, testing different areas of windows and shading types and what effect the different decisions have had on the total energy frame.

A similar approach have been taken to the construction of the envelope, although in a far less extend. As the materials and structures have started to emerge they have been tested in different versions and constructions to evaluate which is the most feasible one. The goal with this has been to optimize the envelope in terms of transmissions loss, with a cynical goal of getting as much insulation with as little envelope as possible.



Ill. 157 *Example of the evaluation done by making a parametric energy frame, this calculation contains 256 results.*



Ill. 158 *Example of the evaluation of different construction types, this graph show the comparison between two versions of the pitched roof in the common areas and the resulting U-values as a function of the thickness of the envelope.*

Partial Conclusion

The volume studies performed in phase 1 has been further processed and shaped into a unit which speaks to the nearby context in its form language and materials. Based on the design programme, theoretical studies, the boundaries of the project site and the use of calculation software, they have been detailed and tweaked to cater every parameter.

The understanding of spaces and atmospheres has been a vital point to this phase and been an important guideline in the design which has not been compromised. This goes all the way through from the residence to the courtyard, which creates a safe environment for the residents.

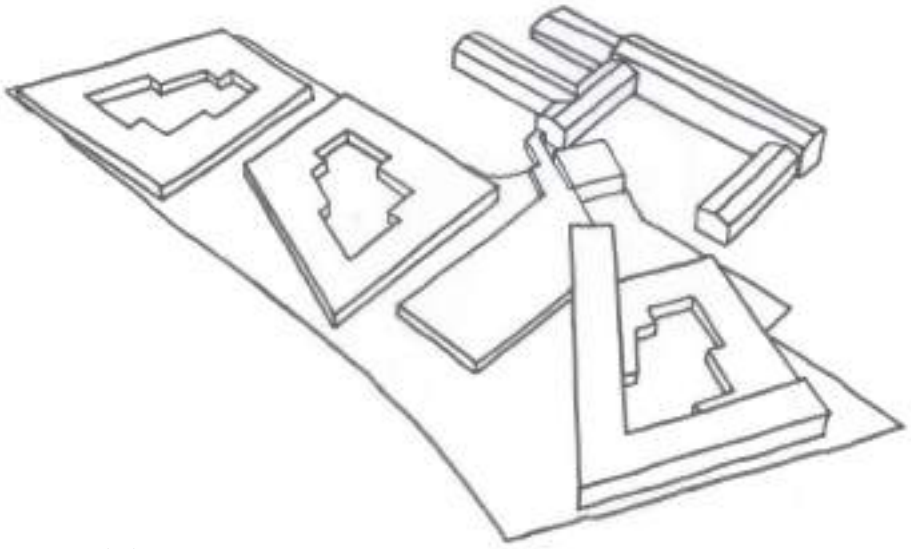
Phase 2 has focused solely on one aspect of the whole project, but has set a base point for the rest to follow. The next phases will then focus on the design of a day care centre and the connection between this and the housing units.

Day Care Centre

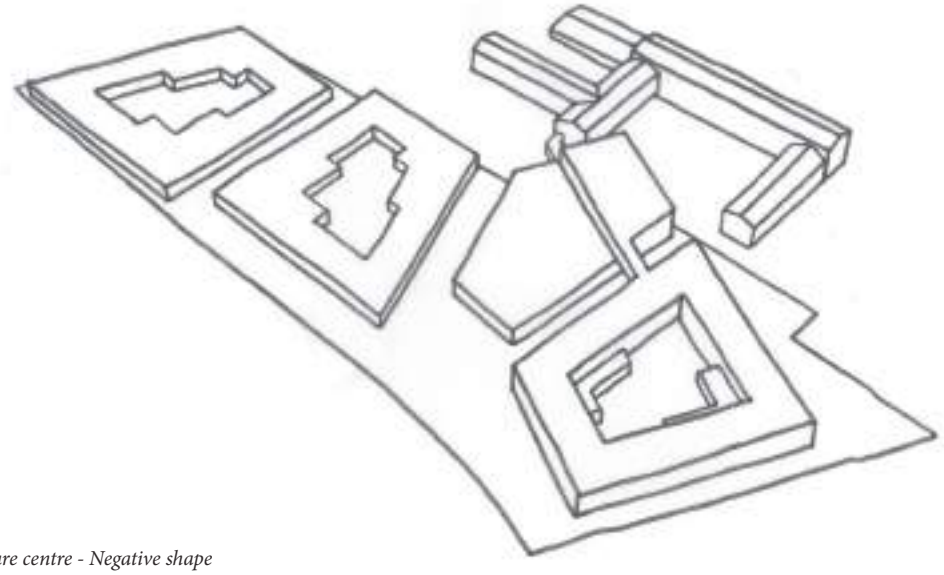
The day care centre is the linking element not only between the residents of the DBC Aarhus and visitors but also between the exisiting and the new complex. The centre building is a cluster of different programmeming stretching from administration to public functions to residences for severely demented.

Even though the design of the housing units and the day care centre are divided into separate phases, it is important to emphasize, that the design of both have taken place simultaneously, and therefore some changes made one place will affect the whole.

Even though the day care centre is not the focus point of this project, passive strategies have still been implemented to the building and classification systems have still been put to use to ensure the compliance of the Class 2020 energy frame.



Ill. 159 *Day care centre - Simple shape*



Ill. 160 *Day care centre - Negative shape*

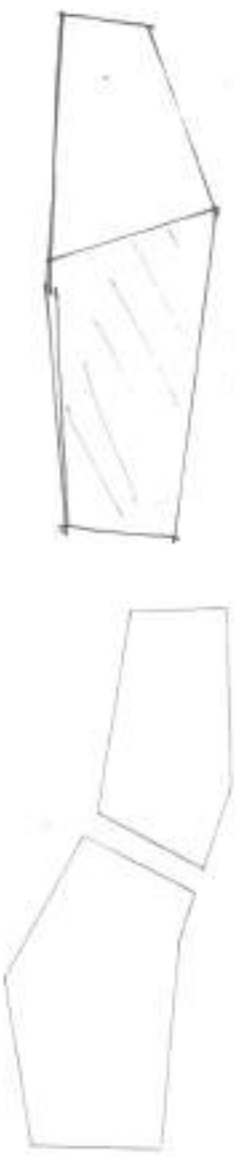
Initating Sketches

Ill. 159-160 show an excerpt of the initiating design process for the day care centre. The centre should connect the existing care-centre with the new and likewise connect the housing units. Therefore, it seemed obvious to centre it on the project site to emphasize its role as a linking element.

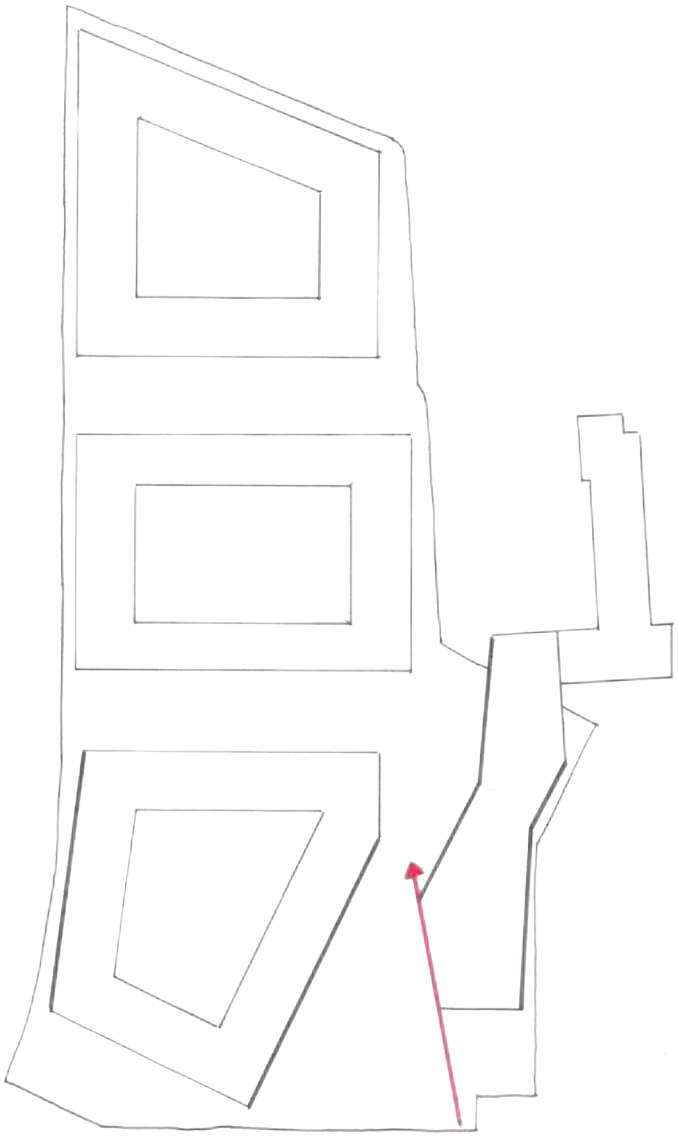
The first iterations show the day care centre following the axis of the project site and the hallway to the existing centre. This, together with the negative spaces left by the housing units, shaped the base point for the day care centre.

The southern-most housing unit were designed in two storeys due to the large slant of the site. The second floor could then potentially hold the severely demented and be connected directly to the day care centre via a lifted hallway.

The parking area was kept in mind and set to be placed in the middle of the project site in front of the day care centre.



Ill. 161 *Day care centre - Initial shapes*



Ill. 162 *Day care centre - Axis*

Base Shape

The initiating sketches showed some hierarchal imbalances with the day care centre hidden in-between housing units with the southern-most seeming placed almost solitary. Further development of the masterplan, and ultimately the placement of the day care centre, therefore resulted in the removal of the existing assembly hall which up until then had brought about unnecessary restrictions to the arrangement.
The day care centre was then placed in close connection to the existing complex on the eastern part of the project site, which allowed the housing units to line up and create a stronger connection.

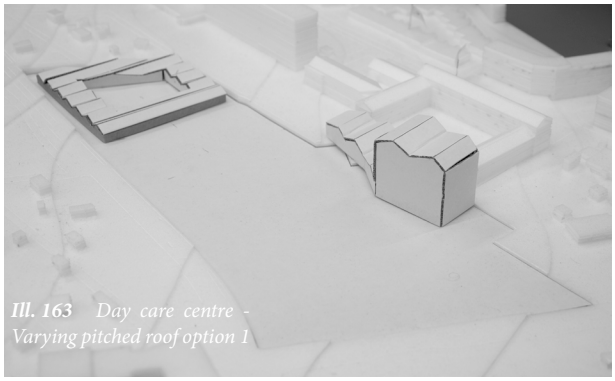
The base shape arrived from the angles mimicking the parallel-running housing unit, as shown on ill. 162 and one to guide visitors in from the parking lot which could be placed south of the project site, with direct entry from Skovvangsvej.

Volume Studies

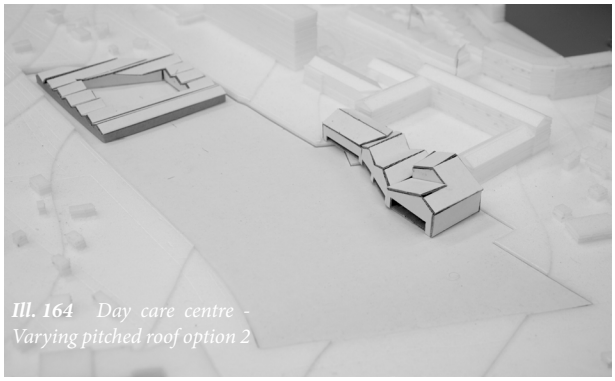
After the base shape was found a volume study, concurrent with the housing unit, was commenced, and the aesthetic principle followed in order to create coherence. The study was likewise based around the plot ratio study from initiating phase.

The study showed that scale was an important factor considering the relation to the housing units. It therefore was decided to divide the volume into two segments: A smaller segment near the housing unit and a larger facing the parking south of the project site. By doing so it was not only more considerate towards the housing units, but also Abildgaarden behind. The tall building would have the ability to act as landmark for the DBC Aarhus and interacts with the tall typologies in the context.

The study resulted in a double pitched roof to break down the massiveness of the volume and to establish a coherence with the rest of the complex.

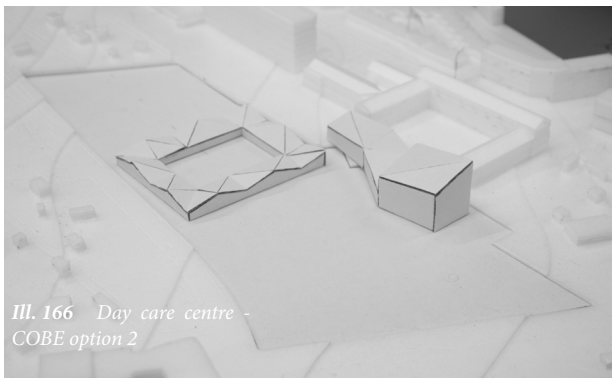


Ill. 163 *Day care centre - Varying pitched roof option 1*

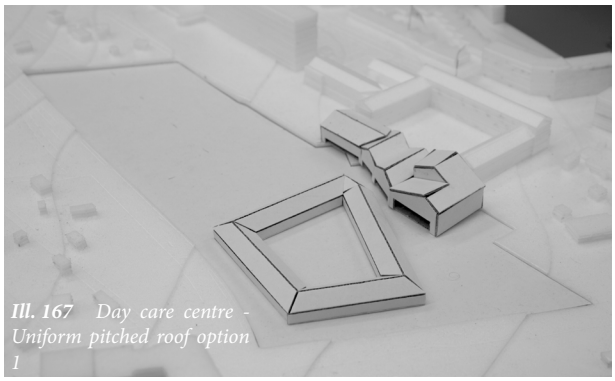


Ill. 164 *Day care centre - Varying pitched roof option 2*

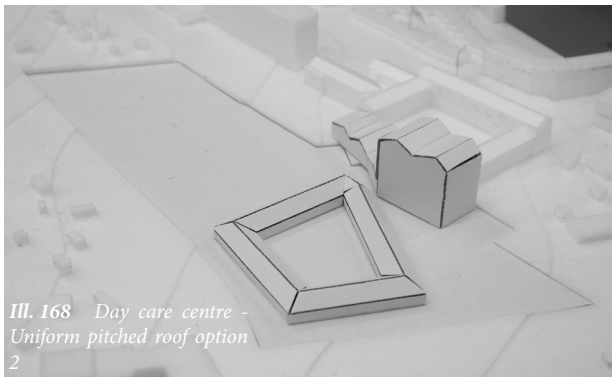
Ill. 165 *Day care centre - COBE option 1*



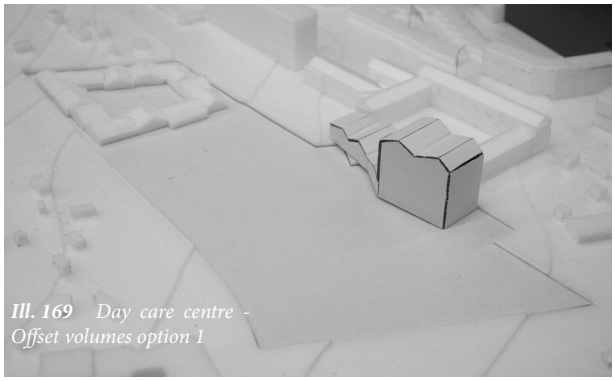
Ill. 166 *Day care centre - COBE option 2*



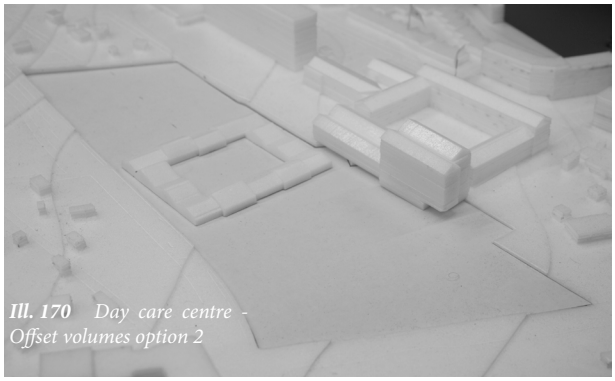
Ill. 167 *Day care centre - Uniform pitched roof option 1*



Ill. 168 *Day care centre - Uniform pitched roof option 2*



Ill. 169 *Day care centre - Offset volumes option 1*



Ill. 170 *Day care centre - Offset volumes option 2*

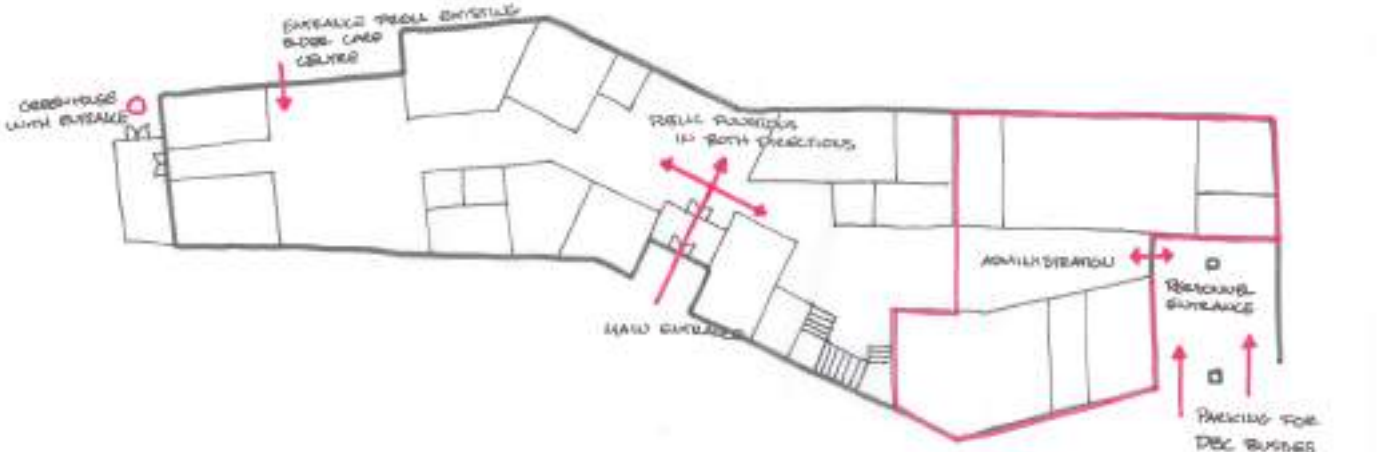
Room Arrangement

The volume study was supplemented with additional plan studies with specific room arrangements in order to determine each shape's potential.

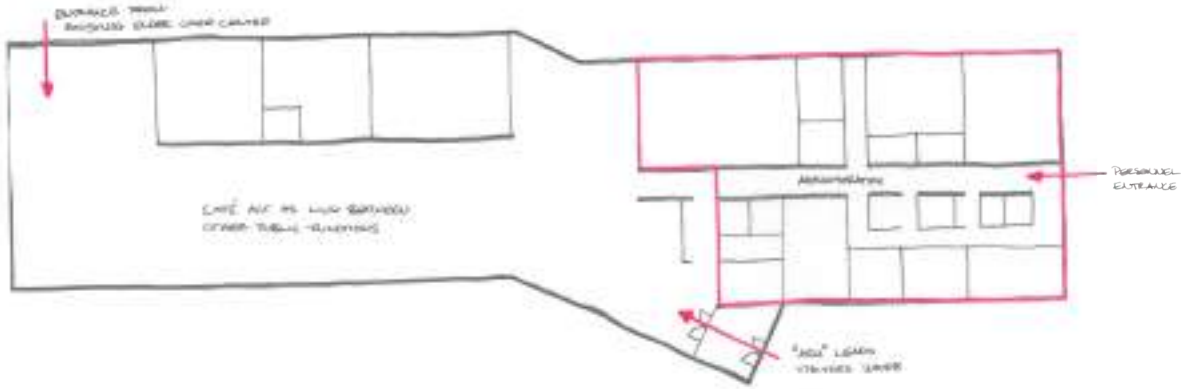
As shown on ill. 171-173, the plans share the same division of functions with administration on one side and the day care with public functions on the other. The day care centre should be more centred around the housing unit while it would be more beneficial to have the administration in close relation to the parking for easy access for the personnel, easy handling of delivery goods, etc.

This inside-out-approach proved to be beneficial in the final shaping of the building, since the room and programmeming was the defining factor rather than an overall shape in which functions are placed.

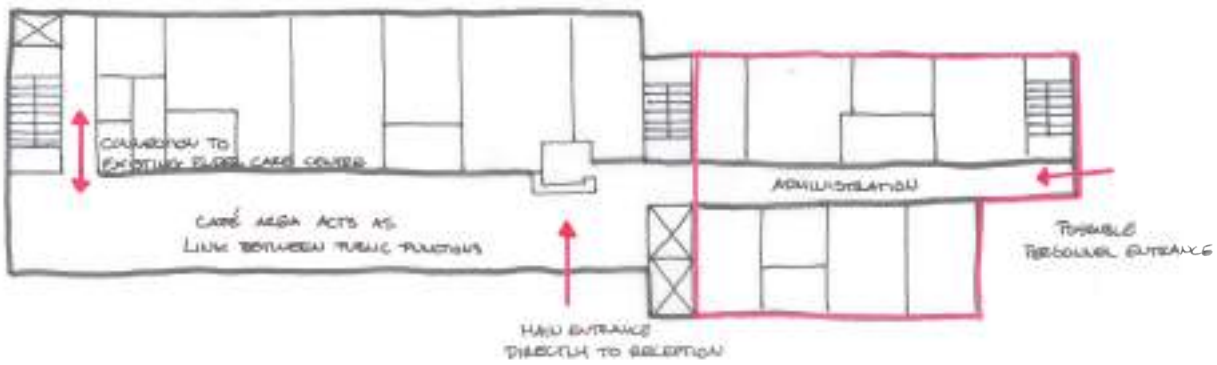
The end result was a plan divided in two pieces with an administration department left of the entrance, and the public facilities on the right, with a long, open café area acting as a linking element between the public functions.



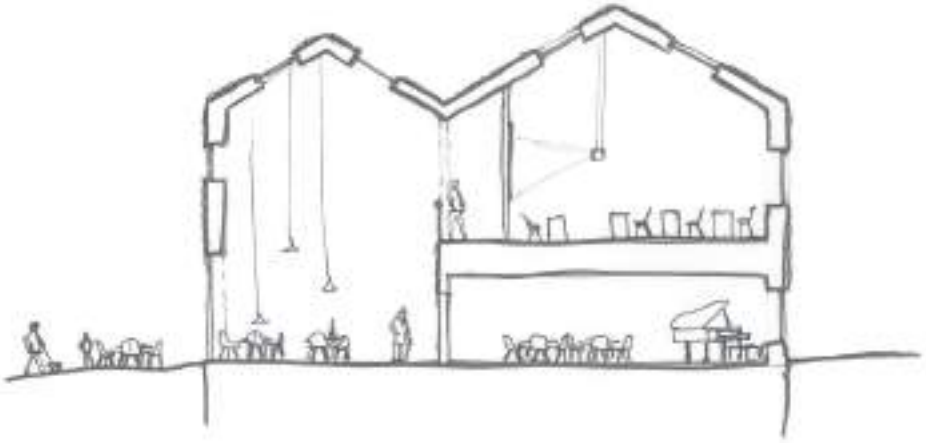
Ill. 171 *Day care centre - Plan layout base shape*



Ill. 172 *Day care centre - Plan layout bend*



Ill. 173 *Day care centre - Plan layout offset*



Ill. 174 *Section - Cafe*

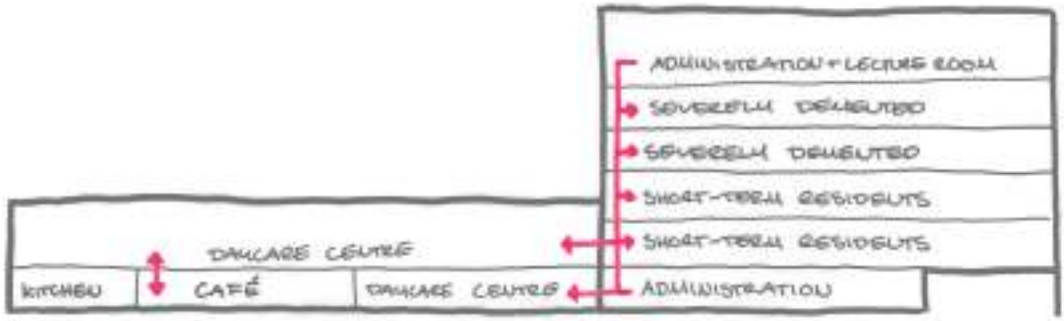
Ill. 175 *Interior view - Cafe*

Café

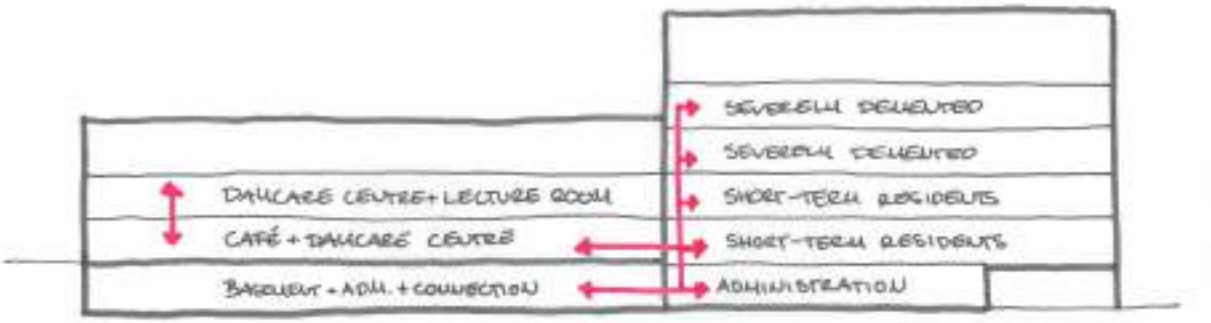
To fit all the programmeming of the day care centre into the given building volume, an extra floor had to be implemented. As ill. 175 shows, the café appears as a double-high room which is visibly and audibly connected to the connecting rooms on both floors.

Dementia patients are often having difficulties traversing vertical distances be it by staircase and sometimes elevator. Therefore, the arrangement of the programmeming is organized so administrative-based functions such as lecture rooms, etc. are placed on the second floor, while the more cultural offers are placed on ground floor in direct connection to the café. This will contribute to let informal meetings happen between residents with different reasons for being in the day care centre.

The thickness of the deck arrives from calculations on ventilation ducts which run across the different day care rooms.



Ill. 176 *Section - Vertical flow option 1*

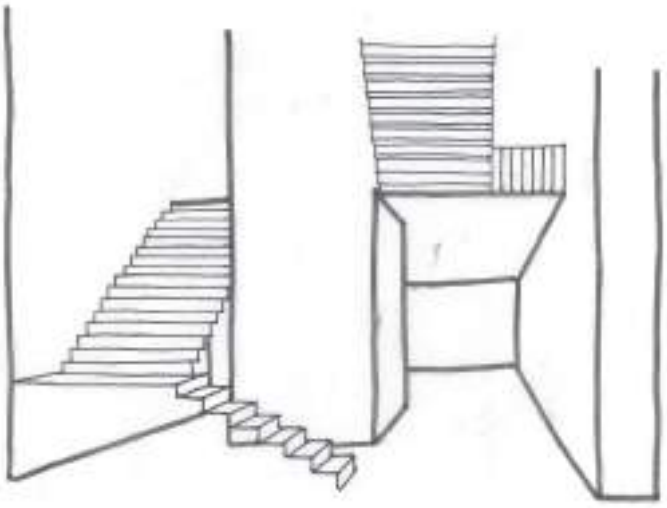


Ill. 177 *Section - Vertical flow option 2*

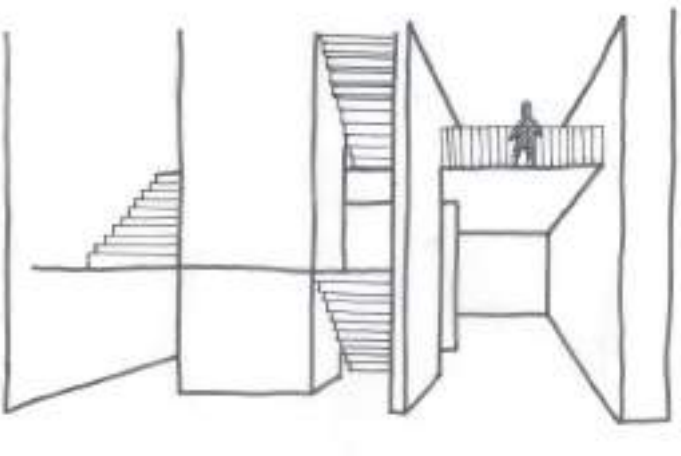
Vertical Flow

With the day care centre sorted out, the administration and housing department could then be arranged accordningly. The benefit of placing the short-term residents in the tower is the direct access to the day care centre facilities, which is appropriate since they do not otherwise have informal meeting places, compared to the appertaining courtyards of the housing units.

The severely demented are logistically well placed in regards of personnel having easy and quick access when needed. However, as can be seen on ill. 176, there seemed to be a displacement in regards of floors between the two volumes, resulting in only one floor of short-term residents having direct access to the day care centre. This could be solved by offsetting the day care centre by one storey – making way for other administration functions such as changing rooms on ground floor in direct connection to the rest of the department.



Ill. 178 *Connection to cafe staircase - option 1*

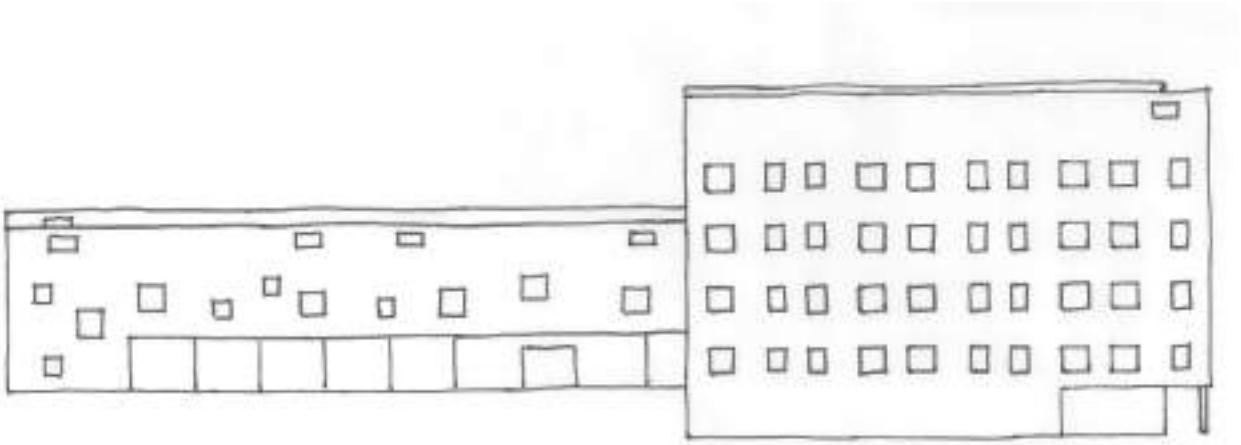


Ill. 179 *Connection to cafe staircase - option 2*

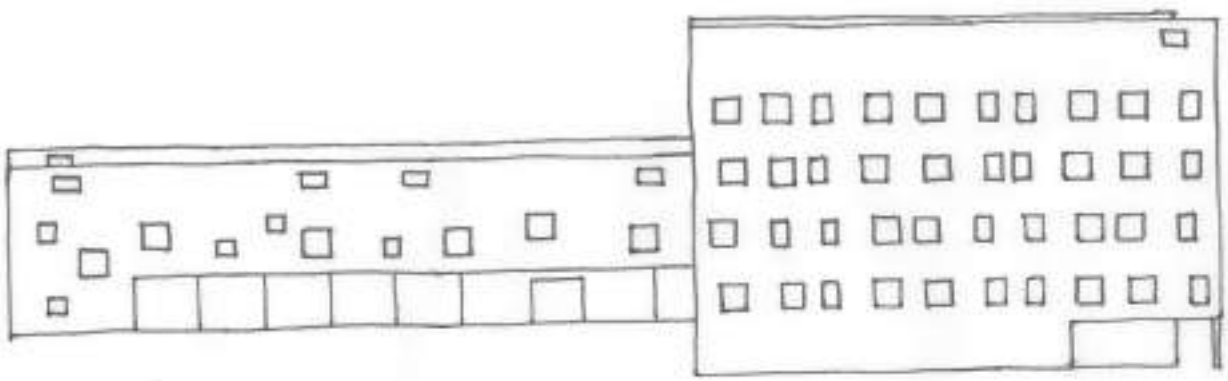
Connection Between Existing and New

With the offset of the day care centre, a vertical connection from Abildgaarden had to be established. Ill. 178-179 show some sketches from the hallway from Abildgaarden to the café area on the floor above. The general idea was to create a visible and aural connection much like what had already been designed in the café

The stairwell and elevator would connect the ground floor to the second, creating an efficient vertical flow from Abildgaarden to every function in the day care.



Ill. 180 *Day care centre - rigid façade*



Ill. 181 *Day care centre - Shifting façade*

Façade

The façade of the day care centre can be divided into two segments: One for the private functions of the administration and housing, and one for the public functions.

The latter takes inspiration from Lundgaard and Tranberg Architect's Kannikegården, where the façade towards the housing unit is lifted to create an open building with good daylight conditions, which invites residents inside.
To create and interdependence, the remaining windows are casually arranged with windows with matching dimensions as the residences in the housing unit. This both differentiate the public functions from the remaining, and create different views on bot floors while letting in a lot of additional daylight.

The façade on the administration and housing department is made less rigid to give a playful tweak to the contextually known slab and thereby soften the otherwise institutionalized aesthetic.

The material choice follows the housing units to enhance coherence.

Partial Conclusion

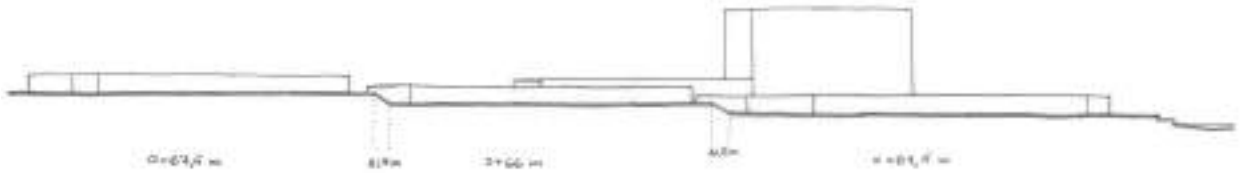
A coherence has been established between the day care centre and the housing units, creating a unified complex. The design process of the day care centre has resulted in a building with a clear readability in terms of programmeming, and the logistical arrangement both vertically and horizontally has been optimized in regards of flows and connections.

Like the housing units, it has been important to move from top view to eye level in order to familiarize oneself with the potential atmosphere of the given space. In this case, the café has been the craze, since this acts as the linking element between visitors and residents and between functions in the centre.

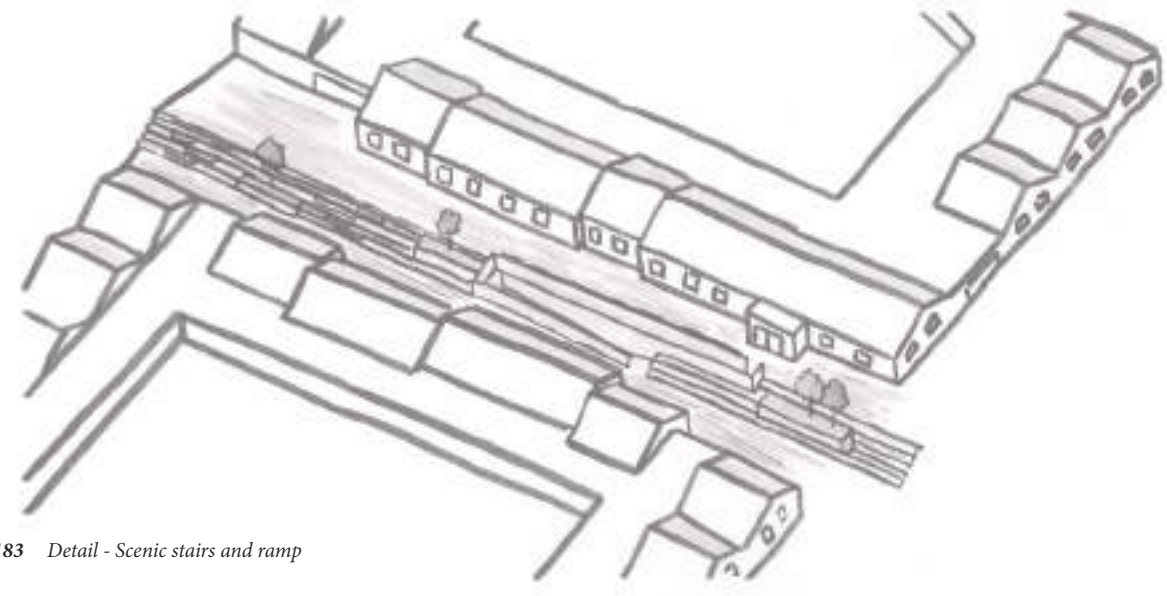
Urban Design

Parallel with the design of the housing units and day care centre, the project site has been handled accordingly to connect the complex.

The height difference of approximately four to five metres from south-west to north-east has created quite a challenge in regards of appropriately placing the different segments. This phase therefore focus on the treatment of the slope and how it relates to the complex and context as well as how the different segments are tied together.



Ill. 182 *Section - Change in levels*



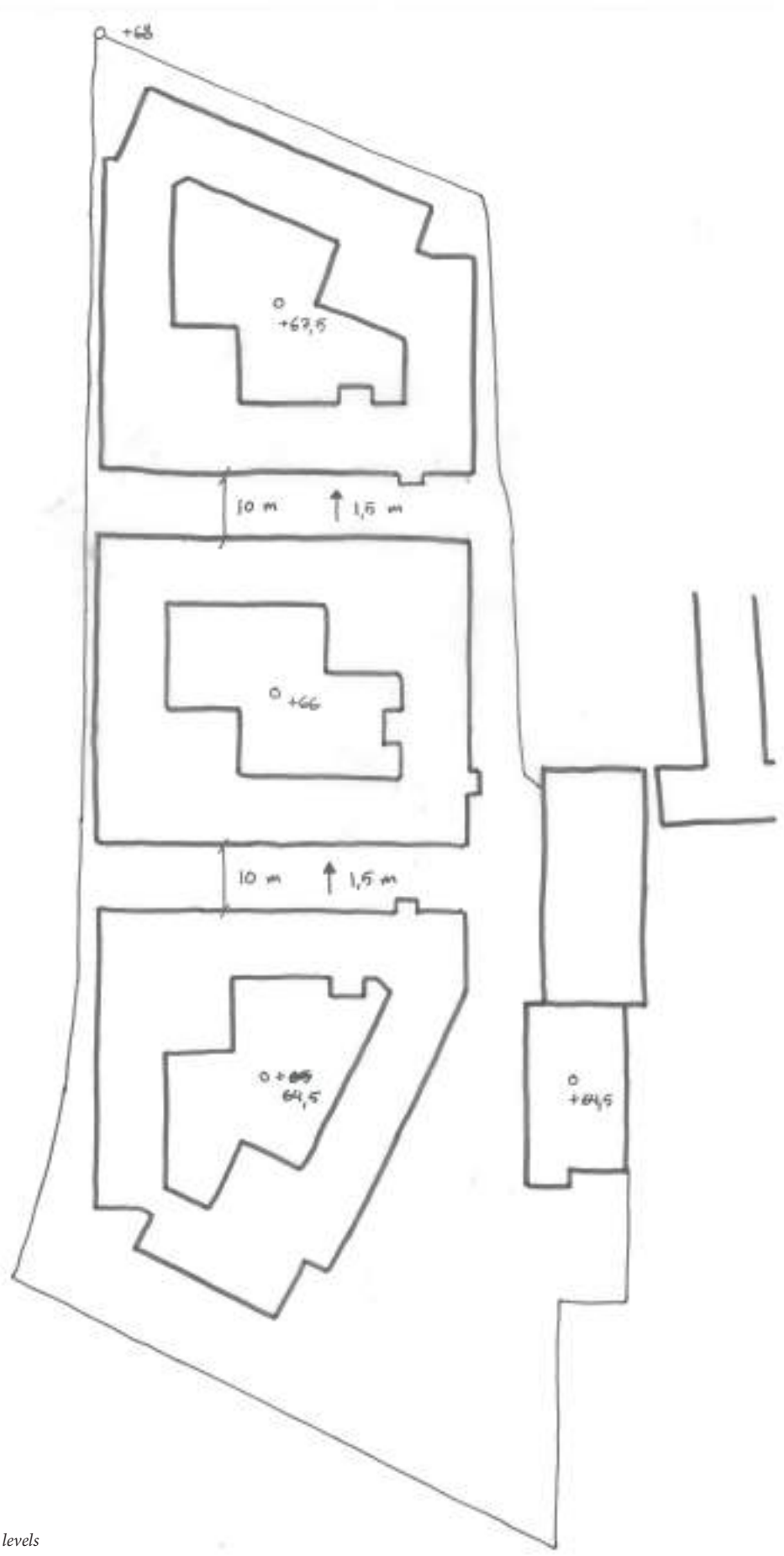
Ill. 183 *Detail - Scenic stairs and ramp*

Level Difference

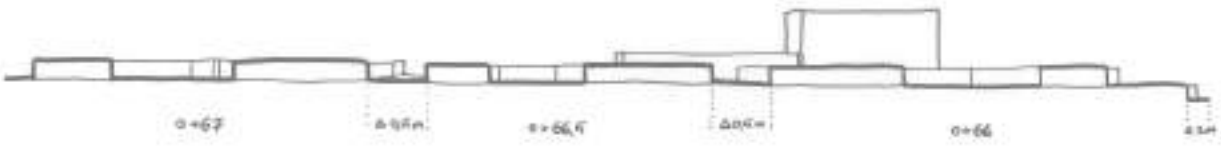
Most of the design process, the project site has been processed as having level differences, sloping down, following the context. The spacing between housing units would here be 10 metres wide with a height difference of 1.5 metres. This distance in length could be used for integrated, scenic installations such as staircases with plinths and plant boxes.

As shown on ill. 183, the southern-most housing unit would match up with the day care centre which is levelled with Skovvangsvej.

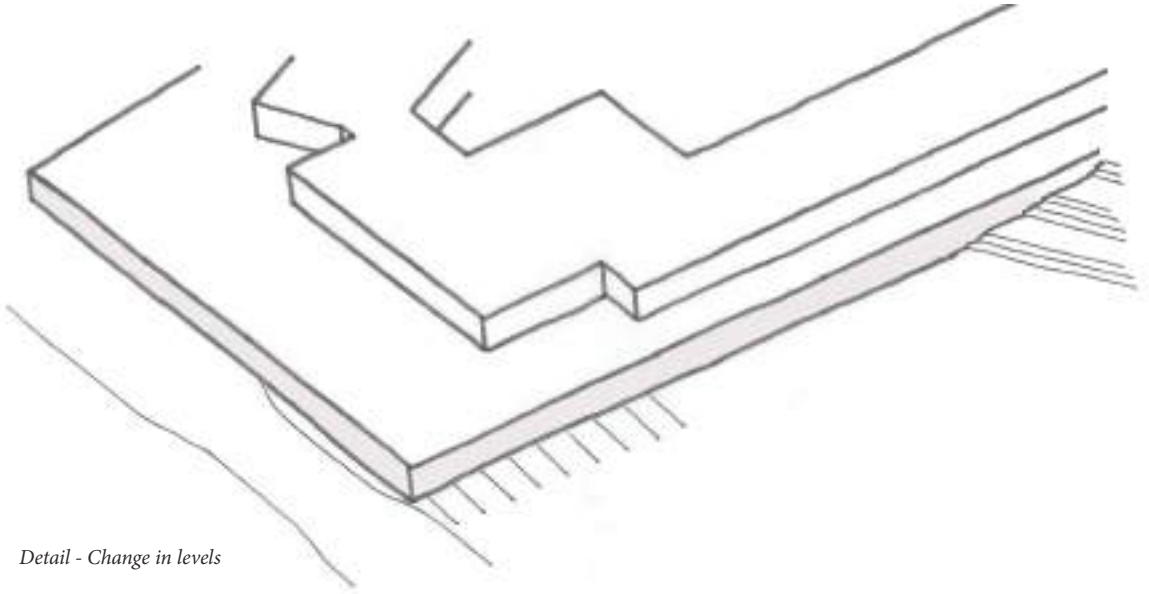
However, not only does it seem inappropriate and uninteresting for the residents facing north to look onto a staircase, research also support the challenges demented face when dealing with vertical travel of this steepness.



Ill. 184 *Plan and levels*



Ill. 185 *Section - Plateu*

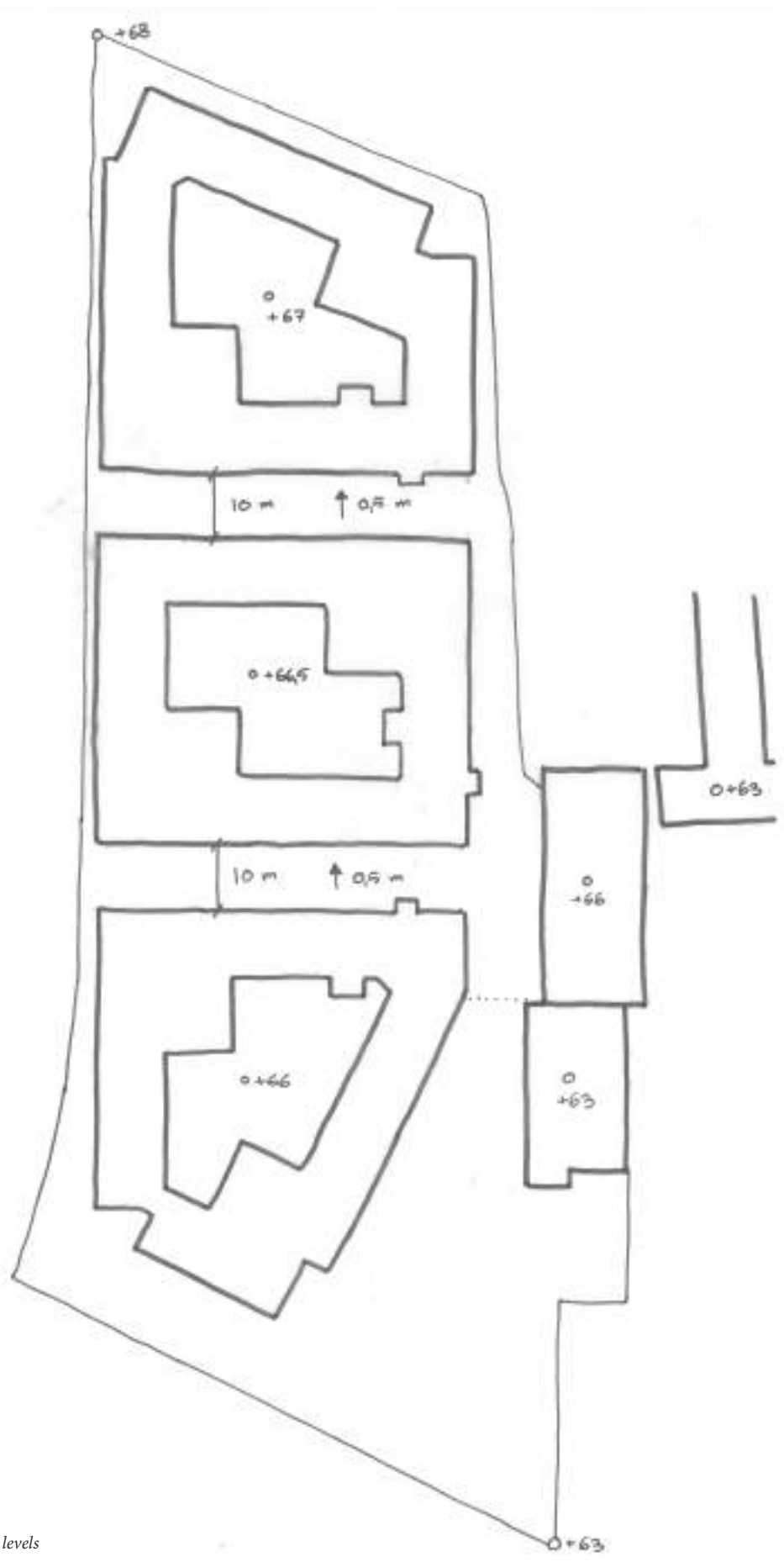


Ill. 186 *Detail - Change in levels*

Plateau

In relation to the lifted day care, a plateau could be implemented to level the housing units with each other and the centre itself. The plateau would also prevent noise nuisance from the road and potentially the parking area.

To consider the context, the plateau slants 1 meter over the length of the whole site, to avoid making a massive barrier for pedestrians walking alongside it on its southern part.
The level difference between the parking units and the housing units would then be 3 metres.



Ill. 187 *Plan and levels*

N

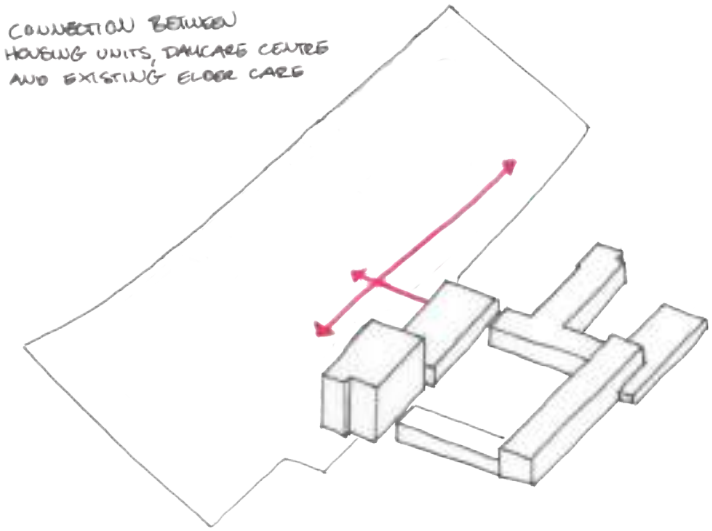
The Basement

The housing units, the day care centre and the Abildgaarden is all connected by a hallway in the basement as showed on ill. 188-190.

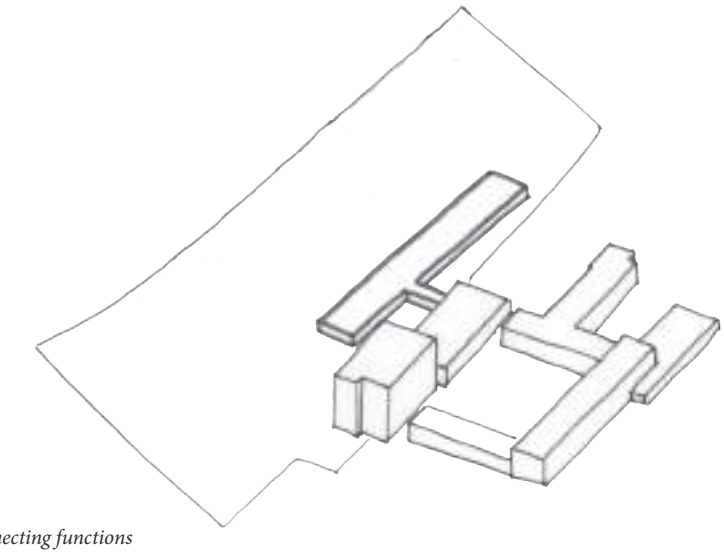
By lifting the day care centre and implementing a basement for changing rooms, the hallway from Abildgaarden can run straight through and connect to the housing units. This will create easy transit when distributing meals from the industrial kitchen in Abildgaarden to the individual housing units.

The basement acts as the connecting link to the whole complex. This is where patients are transferred between units when they enter the third phase of dementia, and this is where the personnel distributes from the administration into the different housing units.

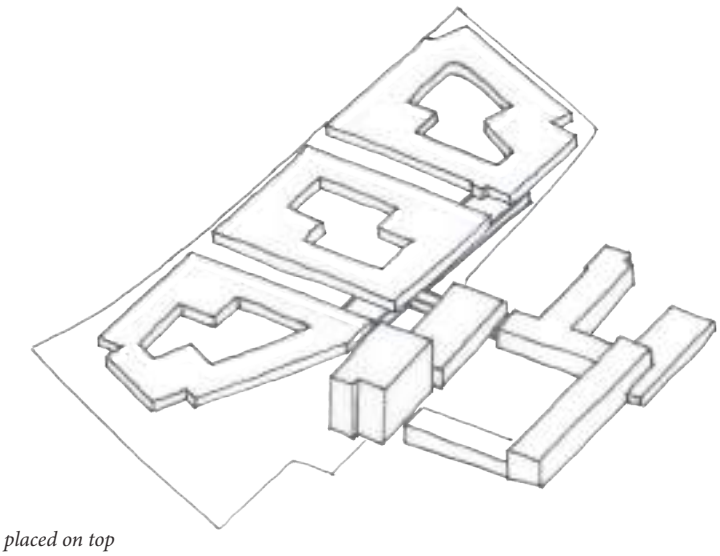
By placing the housing units on a plateau, no digging is required since the basement can run straight through.



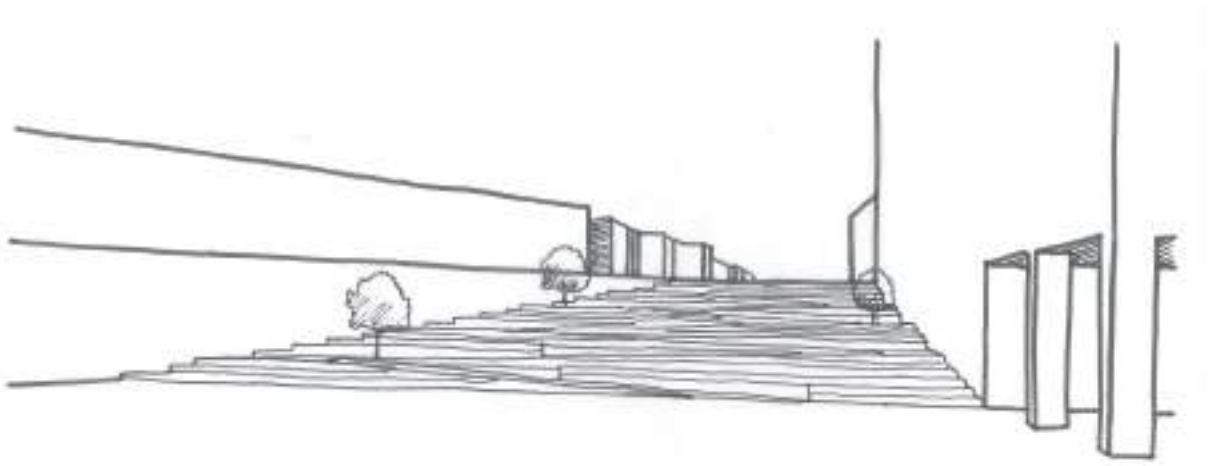
Ill. 188 *Flow lines*



Ill. 189 *Hallway connecting functions*



Ill. 190 *Housing units placed on top*



Ill. 191 *Exterior View Arrival from parking to day care centre*

Arrival

Because of the height difference between the parking and the housing units, there has been iterations on the arrival to the day care centre.

A large staircase, running the length of the administration, will bring the visitors onto the plateau either step by step or via a ramp alongside trees planted sporadically to soften the massive volume and draw parallels to a classic inner city ally.

Administration is accessible on ground floor and the main elevator can be accessed from here, transporting visitors directly to the day care if needed.

Partial Conclusion

By placing the housing units and day care centre on a plateau 3 metres above ground floor, the complex has formed a synthesis through a physical connection, which strengthens the flow between each individual segment of DBC Aarhus.
The residents in the housing units can also now benefit from a reduction of noise nuisance from the road and parking and are able to access the day care centre without having to traverse the project site vertically.

Epilouge

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Conclusion

A proposal for the future Dementia and Brain Centre Aarhus has been developed in this project. The project is based on the actual plans for the future development of the existing Abildgården nursing home in the district of Christianbjerg, situated in the northern part of Aarhus. The site is characterised by extreme diversity in the context both in the functions and the typologies. The focus of the project has been to develop a proposal for a dementia friendly nursing home and day care centre together making the basis of the new centre for the joined effort against dementia in Aarhus. The nursing home focuses on the health and well-being of the residents living there. One of the ways of doing so is to ensure a good and healthy indoor climate, both in terms of the acoustic, thermal, visual and atmospheric indoor climate.

The main part of the nursing home consists of three housing blocks, that adapts to the context by mimicking the typologies, scale and materials. Each of housing blocks 24 residences making a total of 74. The residence itself is one of the key elements in the project being spacious and flexible enough to accommodate different needs of care and personal preferences, due to different cases and stages of dementia. The hallways in each of the housing blocks passes through the two housing units making up the block. The private residence is closely connected to the hallway by placing a personal niche together with every residence, which creates a private space along the hallways, enabling the entrance to be personalized to help navigation of the housing block. In front of every entrance to the private residences an opening is made in the hallway to provide an immediate and strong visual connection to the courtyard placed inside each housing block. The courtyards are the centre in each housing block and all circulation is staged around it. By having the courtyard enclosed in the centre of the housing block it provides a sheltered outdoor area in which the residents can roam freely without supervision. Each courtyard is arranged to support wayfinding of the housing block and stimuli of the residents. The courtyards are arranged with different landscape elements such as a trickling pond, covered seating raised flower beds and different paving.

In terms of energy the complex is within the building class 2020, a goal that have been reached through the implementation of passive strategies. A main factor has been to reduce the electricity consumption used for ventilation, by reducing the pressure loss in the ducts and single components. Besides lowering the electricity sage for air transport, the building utilizes natural ventilation when the outside temperature allows it. This is done using a skylight window that together with tall windows in the façade provides an average daylight factor of 5%. Besides providing daylight to the building, the windows are placed low and deep to utilize the window sill for both storage and sitting in.

Besides the nursing home, the project includes a proposal for a day care centre, housing cultural offers for both the residents living in the nursing home as well as the citizens outsid.
Furthermore, the centre supports all the administration of the DBC Aarhus, educational facilities and 16 short term residences. These residences can provide relief to people or partners living elsewhere for short periods of time, a graduate transition of the life in the nursing home and accommodation for visitors and relative to the residences. Lastly the day care centre includes 12 residences for patients suffering from a severe case of dementia, often resulting in a constant need for care. These residences are placed especially sheltered from the surroundings, in very close proximity to the nursing staff.
Finally the entire complex is tied together by an underground connection covering every housing block, the day care centre and the existing nursing home.

Relflection

Designing a dementia friendly care home has proven to be a challenging project. Different aspects of the matter have been examined through guidelines, numerous theoretical articles and studies alongside interviews with people working in the field, which have impacted the project greatly. Whereas the procedure of the integrated design process, as known from earlier semesters, has been executed through deductive studies of form via sketching, physical modelling both analogue and digital, this project has been mainly driven by applied theory. The design of architecture specialised for dementia patients is a new topic and new theories, knowledge and guidelines is still being published. With much of the available empiricism contradicting each other on different subjects, it puts heavy demands on the designer to make the right design choice for the given problem. Where the theoretical foundation for some nursing homes built ten years ago stated that differentiating colours for better wayfinding should be incorporated, interviews have however made it clear that it did not seem to have the desired effect, and should perhaps be applied in another way. It should however be noted that the interviews and case studies made throughout this project is not enough to provide representative empirical data on which a quantitative theory could be build.

Dementia patients are a very specific user groups with equally specific needs to their architectural environment and indoor climate, which has made for an interesting base point for a synergy between the architectural and engineering aspects. This project has in other word been a great and very concrete example of the importance of being able to perform integrated design, simply to make better architecture.

The architectural solutions have sought to distance themselves from an institutionalized atmosphere and instead focus on spatial qualities which expresses homeliness and familiarity. Here, it has been of great importance not to force anything into the architecture and onto the residents but instead set the framework by giving them a flexible living environment, where they have the possibility of leaving their personal touch on the interior. Here it is also important to emphasize that dementia is a deteriorating illness which affects patients in various ways, which makes it difficult to arrange a residence that accommodate every thinkable need. To cater this deterioration, flexibility of the residence also proved to be the best answer, since designing a static and bespoke residence for a patient suffering from a dynamic decease would just result in moving the patient as it progresses.

The general approach to the integration of both the energy consumption and indoor climate, were to include them as early as possible. This was the goal to use the technical aspects of the project as a mean of evaluating and supporting the design process, instead of it being an obstacle that has to be overcome later in the process. This meant trying to apply simple, rough calculations in the early phases and increase the level of detail further on. This was as a generally successful approach in most aspects. Finding a simple way of controlling the indoor climate did however turn out to be difficult, and on this matter a transition had to be made from the early calculations of the minimum and maximum comfort temperatures to detailed simulation, without any subsets in-between. The final result did however turn out to be satisfying in regards of the Danish building regulations.

The final energy frame of the project is made for the entire project, but the level of detail behind the input varies between the different buildings. This have of course resulted in varying accuracy in the final results as some of the inputs are based on conjectures and interviews, as it was an active decision to put the focus of the project elsewhere. This will in the end of course result in potential for sources of error. On the note of energy consumption in the building, new experiences have been gained by investigating the actual background of dimensioning and designing an efficient ventilation system and seeing the impact is has on the resulting energy frame.

As far as the objective of challenging the indoor environment by letting it be the subject of the changing seasons and the day, it has proven to be partially achieved. Contrary to the stable indoor climate of the residence, the common areas seem to follow the outdoor temperature as expected. However, the room needs to be fit for use and require ventilation to keep the concentration of CO2 below a certain point. With varying periodically high internal loads it has been very difficult to try and control the indoor climate in the common rooms. This could have been further developed by implementing rooms specifically for this type of use, and with more predictable internal loads. The input used for the user patterns in the simulations is based on the studies made on the daily life at a nursing home and the interviews made during the various visits. It is however paradoxically to state that a dementia patient is a very unpredictable user, and generalize that persons' behaviour via a schedule to simulate how that given person will influence the indoor climate.

It is not only the project that have been developing thought the process but also the overall aim of the project. The initial plan of the project was to do dementia specialized nursing home very close to an actual project. This did however develop when getting into contact with the municipality of Aarhus which meant that the aim of the project developed into including a day care centre and associated tasks. After studying numerous theory on the topic of dementia, the project then developed further from answering the request of the municipality to instead challenge the initial idea to come up with a better alternative. This inclusion of the day care centre and numerous other functions in the project has of course added to the workload, and meant that some parts of the project have had to be down-prioritized. The project represented in this report of course have unresolved problems in the housing blocks still to be processed, and parts of the programme have yet to be applied, such as the specific layout of the outdoor area which have not been thoroughly integrated in the process of the housing blocks, the use of artificial lighting etc. alongside a spatial and material quality in the day care centre that haven't been processed as much as preferred.

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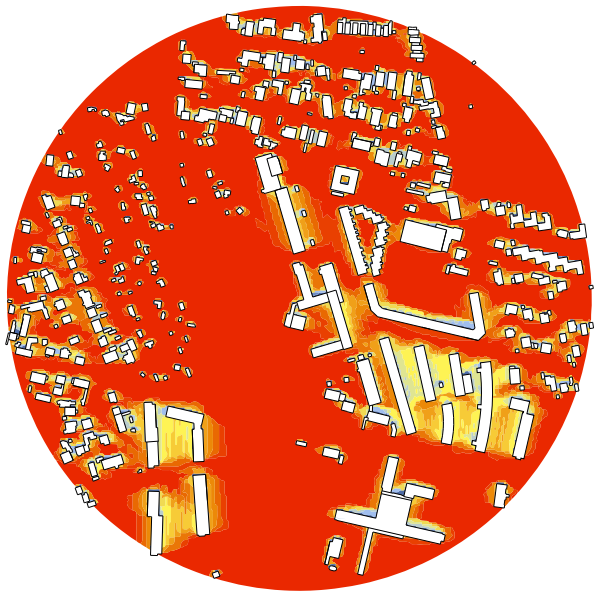
Illustrations

Unless otherwise stated, visual content used in this report is the property of MSc04 ARC group 8 consisting of Anders Brusen Jensen, Jonas Wittrup Laursen and Mathis Lauridsen Gerlich.

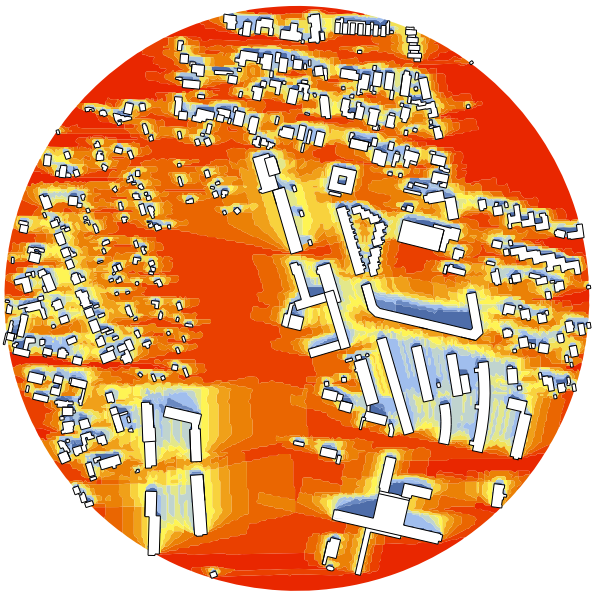
Appendix

App. 1 - Daylight

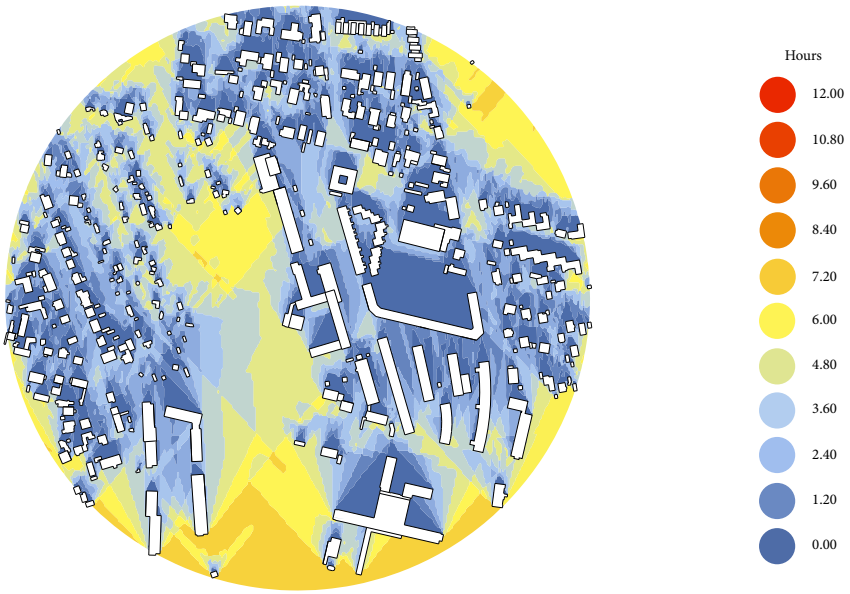
The illustrations below show the results of a simulation of the access to sunlight in the area. The scale for the colours indicate the number of hours during the day with access to direct sunlight. The calculations are made for summer and winter solstice and spring and fall equinox.



Number of hours with direct sunlight during summer solstice



Number of hours with direct sunlight during equinox



Number of hours with direct sunlight during winter solstice

App. 2 - Natural Ventilation Potential

The potential for natural ventilation in the residence, with wind as the driving force, has been calculated for with the wind coming from north, south, east and west, to make sure that the needed ventilation requirements can be met. The residence on which the calculations is based is facing south, but as the wind directions are altered throughout the calculation, the same results could be applied to any of the other residences.

$V_{ref} = V_{meteo,10} * k * h^{\alpha}$

Windspeed at 10 m	$V_{meteo,10}$	4,20	m/s	(The Danish Meteorological Institute)
Building height	h	5,00	h	
Terrain factors	k	0,35		(surburban areas)
	α	0,25		
V_{ref} =		2,20	m/s	

Internal Pressure

$$P_i = \frac{1}{2} * \rho * V_{ref}^{\ 2} * \frac{A_{in}^{\ 2} * C_{p,in} + A_{out}^{\ 2} * C_{p,out}}{A_{in}^{\ 2} + A_{out}^{\ 2}}$$

Air density	ρ	1,25	kg/m^3
Opening area windward	A_{in}	3,75	m^2
Opening area leeward	A_{out}	1,50	m^2
Pr*essure coeficient windward*	$C_{p,w}$		
Pr*essure coeficient leeward*	$C_{p,l}$		

Wind direction	$C_{p,w}$	$C_{p,l}$
South	0,25	-0,45
West	-0,50	-0,70
North	-0,30	-0,49
East	-0,20	-0,41

P_i =

Wind direction	P_i
South	0,46
West	-1,59
North	-0,99
East	-0,69

Pressure Difference

$$\Delta P_{v,w} = \frac{1}{2} * C_{p,w} * \rho * V_{ref}^{\ 2} - P_i$$

$$\Delta P_{v,l} = \frac{1}{2} * C_{p,l} * \rho * V_{ref}^{\ 2} - P_i$$

Wind direction	$\Delta P_{v,w}$	$\Delta P_{v,l}$
South	0,29	-1,82
West	0,08	-0,52
North	0,08	-0,49
East	0,09	-0,55

Airflow

$$Q = C_d * A * \sqrt{\frac{2 * \Delta P}{\rho}}$$

Discharge coeficient	C_d	0,70	(Regtangular openings)

Wind direction	Q_w [m^3/s]	Q_l [m^3/s]
South	1,79	1,79
West	0,96	0,96
North	0,93	0,93
East	0,98	0,98

App. 3 - Specific Electricity Use for Air Transport (SEL)

Part of the strategy to reduce the energy consumption in the building has been to decrease the SEL, to do so, the pressure loss in ventilation system should be as low as possible. Past experience with working with low energy buildings showed how much the electricity consumption what ventilation and especially the SEL value means to the overall energy frame. The pressure loss is directly linked to the air speed in the ducts, higher air speeds results in increased pressure loss and vice versa. As a rule of thump air speed in the duct system is classified as follows:

Connecting v < 3 [m/s]
Distributing v < 4 [m/s]
Main Distrub. V < 6 [m/s]
Main Duct v < 9 [m/s]

As an experiment to decrease the SEL value, three calculations on the same stretch of ducting was made. The stretch calculated is the longest stretch that ocours in the housing blocks, which is estimated to be the most critical stretch. Each calculation has a defined maximum speed, which defines the duct diameter:

S: max 4 [m/s]
M: max 5,5 [m/s]
L: max 7 [m/s]

The pressure loss is calculated as a sum of the loss in ducts and the loss in the components. This is expressed as follows:

$$\Delta p = \Sigma \Delta p_l + \Sigma \Delta p_e$$

$$\Delta p_l = R * L$$

$$\Delta p_e = \xi * \frac{1}{2} * \rho * v^2$$

The resistance in the duct loss is a result of a function of the duct dimension/geometry and the air flow going through it, ultimately the air speed (the used values in this calculation is from SBI-nomogram 10). The resistance coefficient is a coefficient for the individual component. The total pressure loss for the in- and outlet is summarised and together with the fan efficiency, the total SEL value can be calculated. The ventilation unit used in the project is found through System air and has a fan efficiency of 79%.

$$SEL = \frac{\Delta p_{in} + \Delta p_{out}}{\eta_t}$$

	S	M	L
SEL duct [J/m^3]	644,83	527,89	361,32
SEL [J/m^3]	984,83	867,89	701,32

This results in a difference of almost 50 % between the small and the large ducts. The difference is however decreased when adding the SEL for the ventilation unit it self, but is still very significant at about 30 %..

App. 4 - Ventilation Requirement

The requirement for ventilation has been calculated in accordance to the building regulations, DS/EN 15251 and 1752. They all define different requirements and guidelines, some by law and others as an instruction. The outcome of the calculations are used both or calculating the energy frame, dimensioning the ventilation unit, dimensioning of the duct system and how it branches out.

The many different methods for calculating the ventilation requirement are made after which the most critical result is used as the dimensioning factor. Some results are only used within a certain area, such as the energy frame, while others are used to dimension the ventilation unit. For the indoor climate the results here are used as a basis on which a more arcuate simulation is conducted. This is however not influencing the energy frame, unless the results then demands another type of ventilation unit.

The example here is based on one of the housing blocks, similar calculations have been made to the others and the day care centre. The results for the day care centre is however only used to dimension the ducts and ultimately decks between the floors.

General information on each calculated zone:

Room	Area [m^2]	Height [m]	Volume [m^3]	Number	Metabolic rate [Met]	Sensory load [olf]	People	Toilets/Bath	Kitchens	Basements/Scullery
Residence	39,00	2,50	97,5	24,00	1,00	1,00	1,00	1,00	1,00	0,00
Common Areas	85,00	3,50	297,5	2,00	1,00	1,00	2,00	1,00	1,00	0,00
Hallways	436,00	2,50	1090	1,00	1,00	1,00	0,00	0,00	0,00	0,00
Remaining	91,00	2,50	227,5	1,00	1,00	1,00	0,00	2,00	0,00	0,00

Bulding Regulations 2015:

Function	Airflow [l/s/unit]	
Building Area	0,30	§ 6.3.1.2 par. 1
Toilet/Bath	15,00	§ 6.3.1.2 par. 4
Kitchen	20,00	§ 6.3.1.2 par. 2
Basement/Scullery	10,00	§ 6.3.1.2 par. 4

Room	Airflow [l/s]	Airchange [h^{-1}]	Airflow rate [$l/s/m^2$]
Residence	46,70	1,72	1,20
Common Areas	60,50	0,73	0,71
Hallways	130,80	0,43	0,30
Remaining	57,30	0,91	0,63

DS/EN 15251 - Method B.1.2:

$$q_{tot} = n \cdot q_p + A \cdot q_B$$

Buildingclass II - PPD 20%		
Pollutant	Airflow [l/s/unit]	
Building low	0,70	P. 33
Buiding v. low	0,35	P. 33
People	7,00	Table B.1

Room	Airflow [l/s]	Airchange [h^{-1}]	Airflow rate [$l/s/m^2$]
Residence	34,30	1,27	0,88
Common Areas	73,50	0,89	0,86
Hallways	305,20	1,01	0,70
Remaining	63,70	1,01	0,70

DS/EN 15251 - Method B.1.4:

$$q = 19 * n_p * M \qquad c = \frac{q}{n \cdot V_R} + c_i \Leftrightarrow n = \frac{-q}{(c_i - c) \cdot V_R}$$

Buildingclass II - PPD 20% - 500 PPM above outdoor concentration	
Fresh Air Consentration Ci [PPM]	350
Consentration Goal C [PPM]	850

Room	CO_2 Production q,v [l/h]	CO_2 Production q [m^3/h]	Airchange n [h^{-1}]	Airflow [l/s]	Airflow Rate [$l/s/m^2$]
Residence	19,00	0,02	0,39	10,55	0,27
Common Areas	38,00	0,04	0,26	21,11	0,25
Hallways	0,00	0,00	0,00	0,00	0,00
Remaining	0,00	0,00	0,00	0,00	0,00

Perceived Air Quality DS/EN 1752:

$$V_i = \frac{10 * (n_p * q_p + A_b * q_b)}{(c_i - c)}$$

Buildingclass II - PPD 20% - 1,4 dp		
Pollutant	Sensory Load [olf/unit]	
People	1,00	Table A.6
Building	0,1	Table A.8
Pereived air quality goal c [dp]	1,4	
Fresh air quality c_i [dp]	0,1	

Room	Load people [olf]	Load Building [olf]	Airflow [l/s]	Airchange Rate n [h^{-1}]	Air Flow Rate [$l/s/m^2$]
Residence	1,00	3,90	37,69	1,39	0,97
Common Areas	2,00	8,50	80,77	0,98	0,95
Hallways	0,00	43,60	335,38	1,11	0,77
Remaining	0,00	9,10	70,00	1,11	0,77

App. 5 - Transmission Coefficients

To calculate the transmission losses as a part of the energy frame, the U-values of the envelope has been calculated. The calculations have been performed on seven different parts of the envelope and tested with multiple different construction types during the design process. In this section, two different constructions will be shown, one homogenous and one inhomogeneous.

All calculations are made in accordance to DS 418 and based on the following formulas:

$$R = \frac{d}{\lambda}$$

$$\frac{1}{U'} = R_{si} + R_{se} + \sum R_i$$

$$U = U' + \Delta U$$

Example 1 – Flat green roof over hallways
The construction is build up by:

1	Cavity	335 mm
2	Plywood	22 mm
3	Insulation kl. 33	350 mm
4	Plywood	22 mm
5	Green Roof	60 mm

Thermal insulance R [m2K/W]:						
	d [m]	λ [W/mK]	R [m2K/w]	Δ t [k]	Temperature [c]	
					20,000	
Rsi (Vertical)			0,000	0,000	20,000	(DS/EN418 s.23)
Cavity			0,16	0,458	19,542	(DS/EN418 6.4.3)
Plywood	0,022	0,12	0,183	0,525	19,017	
Insulation	0,350	0,033	10,606	30,377	-11,360	
Plywood	0,022	0,12	0,183	0,525	-11,885	
Green roof	0,06				-11,885	
Rsu (Vertical)			0,040	0,115	-12,000	(DS/EN418 s.23)
Total	0,454		11,173	32,000		

U'=1/R:	0,09	[W/m2°K]	
ΔU:	0,002	[W/m2°K]	(DS/EN 418 Appendix A Table A.2)
U=U'+ΔU	0,0915	[W/m2°K]	

Example 2 – Pitched roof with high ceiling

This construction is inhomogeneous in its build-up. This means that the U-value varies depending on were in the construction you are. To calculate the combined U-value each possible U-value in the construction are weighted proportional to how often that specific case occurs in the total construction.
The construction is as follows:

1	2 x gypsum boards 13mm
2	Insulation with wooden studs 45x45 cc600
3	Vapour Barrier
4	Insulation kl 32 between wooden posts
5	Insulation kl 32 between rafters
6	Plywood 19mm
7	Wind Barrier mambrane
8	Ventilated Cavity between furring strips 25x50mm
9	Brick shingles on furring strips 35x55mm cc 130mm

The construction has a four different U-values, that are calculated the same way as a homogeneous construction, but also noting the area over which the U-value occurs:

	U-Value	Area
a1	0,154 W/mK	0,004 m^2
a2	0,096 W/mK	0,070 m^2
a3	0,062 W/mK	0,092 m^2
a4	0,050 W/mK	1,500 m^2

$$U = \frac{U_1 * A_1 + U_2 * A_2 + U_3 * A_3 + U_4 * A_4}{\sum A}$$

Total U-Value	0,053 W/mK

App. 6 - Fire Strategy

The DBC Aarhus is subdivided into four application categories following the provisions and guidelines of the Danish building regulations (Bygningsreglementet 2012):

Category 1: Offices and agricultural buildings. This category regards users with substantial knowledge of the building layout and capability of escape unaided. Every office is its own fire cell with escape openings to terrain. From other rooms, terrain can be accessed via several openings along the hallway.

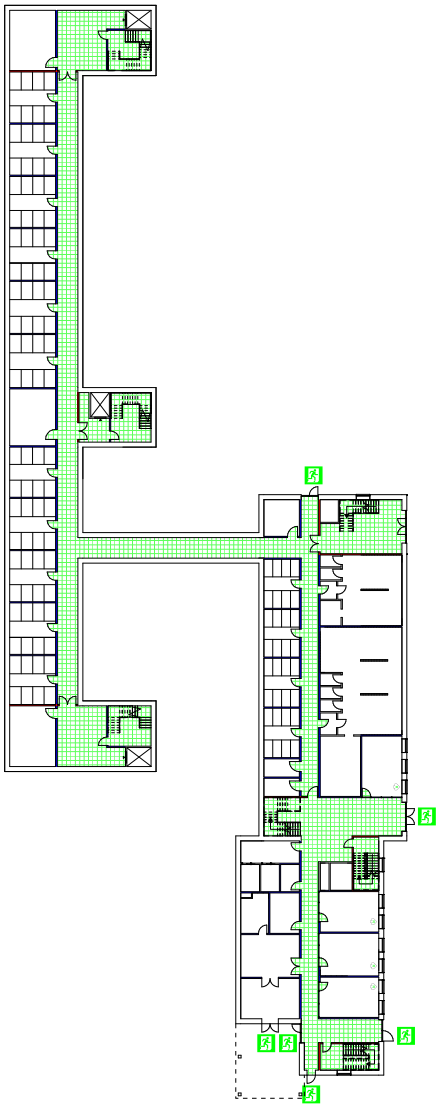
Category 2: Lecture rooms and day cares dimensioned to a maximum of 50 people. This comprise of building sections for stay during the day, where users do not necessarily know the building.
Every room in connection to the café is its own fire cell and leads directly out to the café which has access to terrain. This also regards lecture rooms and alike on the floor above, which has connection to the café via staircases in both direction. The café is arranged with focus on overview for easy exit in case of emergency.

Category 3: Assembly rooms and cafés dimensioned to more than 50 people. Same aspects of category 2 applies for category 3. The café in the day care centre works as its own fire cell with direct access to terrain through several escape openings.

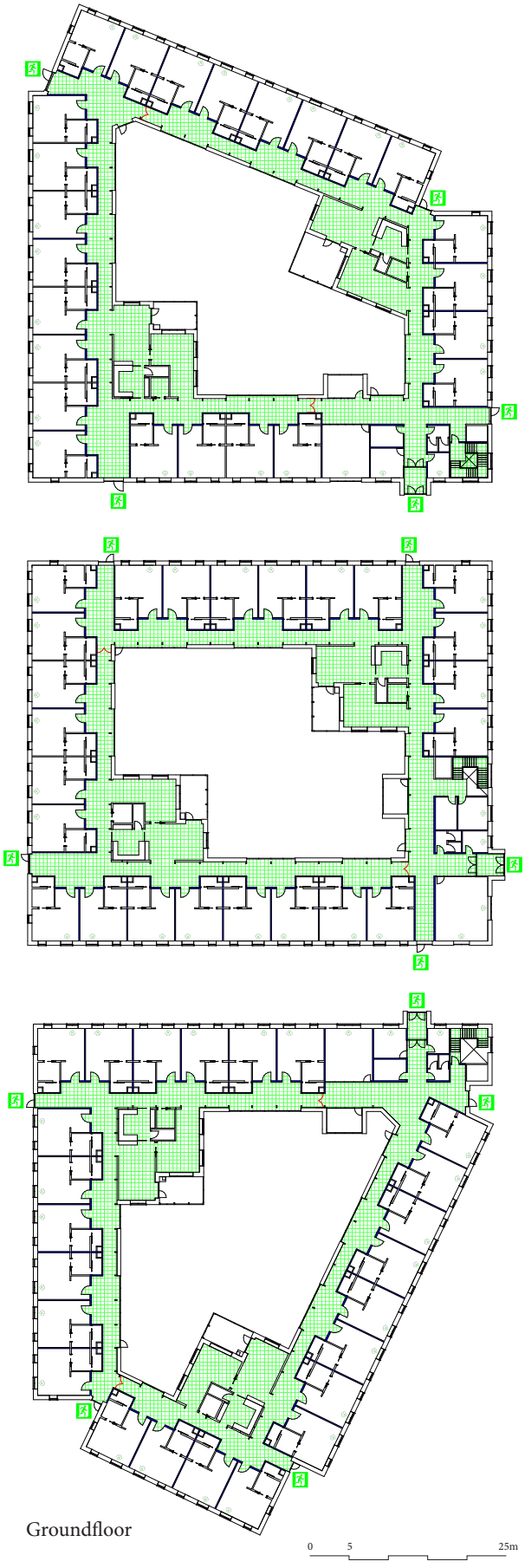
Category 6: Elder-residences and elder-cares. This regards people who are not themselves capable of escaping the building during and emergency.
To secure that the residents can exit the housing units easily, an emergency exit is placed at the end of every hallway to encourage wayfinding and to direct them outside, preventing bottlenecks.
The top floors of the multi-storey building are divided into their own fire sections connected to two staircases. Fire trucks can reach both sides of the building if needed.

The diagrams show the fire emergency strategy for each floor where green represents the escape route for each floor, blue indicates fire cells and red indicates fire sections. Every escape opening is accessible within a radius of max 25 metres as provisioned by the Danish building regulations.

Ground floor 1st floor 2nd floor 3rd floor



Basement



Groundfloor