CANCER HEALTH CARE CENTRE COPENHAGEN -PROCESS

Architecture & Design,
Aalborg University,
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Group 30

Theme: Healing Architecture

Project period: February 1st 2010 - June 25th 2010

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A Cancer Health Care Centre in Copenhagen is created through the concept of healing architecture, declaring that architecture can have a positive effect on the healing and health of the cancer patients.
The centre is created with inspiration in evidence based design, concentrated on the conditions and needs of cancer diagnosed people, and five cases of cancer centres in United Kingdom and Denmark provide essential experiences of the architectural effects for creating a soothing environment with an ambience suitable for people in a difficult phase of their lives.

Anette Vilstrup Nielsen

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CONTENT

PREFACE

The project is a master thesis project, carried out by group 30, Line Fogedgaard Jønsson and Anette Vilstrup Nielsen, in the department of Architecture at the institute of Architecture & Design, Aalborg University, in the spring of 2010.

An architecture competition brief from 2009 is the base of the project that deals with the design of a Cancer Health Care Centre in Copenhagen.
The centre will function as a supplement to the hospital treatment in the Danish State Hospital, Rigshospitalet, and provide a homey, welcoming environment accommodating counselling, therapy, creative and physical activities, social as well as private.

The project takes its point of departure in the theme of "healing architecture", which declares that architecture can have a positive effect on the healing and health care outcomes of its users. Different research revolving this has resulted in evidence, which prove that different architectural elements have a profound effect on health care outcomes, such as light, acoustics, relations to outdoor, social space as well as private space.
The project evolves around creating a sustainable building with a healing qualitative indoor environment through evidence based design and with special emphasis on the lighting conditions, as it has an important impact on the wellbeing of cancer patients.

READER'S GUIDE

The project is represented in two reports, the process report and the presentation report.
The process report contains an analyses section of the themes relevant for the project, a process section describing the process of developing the concept of the Cancer Health Care Centre and finally a detailing part explaining the process of detailing the concept of the building.
The presentation report presents the proposal through visualizations, illustrations and drawing material.
A cd-rom is attached containing original files of different calculations and simulations.
Indexes of literature as well as illustrations are to be found in the back of the report. Illustrations are referred to as (See ill. 2.1)(ill. + page + illustration number).
References to literature are done according to the Harvard method [Surname, year].
Appendixes are to be found in the back of the report and are referred to as (See app. XX).

PROLOGUE

The term of healing architecture represents the concept of the architecture being able to affect human wellness and thereby help strengthen or promote the healing process of the individual human being.
The architectural design can support the healing of a patient, psychologically as well as physiologically, through the integration of the architectural means of qualitative light, acoustics and atmosphere as well as through planning in the sense of creating a possibility for privacy, connection to outdoor spaces and spaces for social interaction with friends, family or other patients.
Different evidence vouch for this, either in terms of physiological measurements, statistical analysis as well as through interviews and investigations of the experiences of the individual patients, the staff or the relatives.
Hence, healing architecture implies an evidence based design process, where the evidence based architectural factors are important parameters throughout the design process.

The project takes its point of departure in the concept of healing architecture through the design of a Cancer Health Care Centre in Copenhagen, Denmark, based on the program of the architectural competition, from 2009. The centre will provide rehabilitation and counseling and be a place, where people with cancer can meet each others on various levels in a domestic, comfortable atmosphere.
The centre is not an institution like a hospital, it does not provide medical treatments and thus it is in a different category in relation to healing architecture.
However, the concept of healing architecture still seems relevant as it plays an important role in how the architecture is welcoming, has a domestic atmosphere and how it inspires, motivates or uplifts people, who are in a very difficult phase in their lives.
Furthermore evidence vouch that the architecture can help relieve stress and anxiety, which are common conditions following a cancer decease.

PROJECT BRIEF

The forces behind the Cancer Health Care centre are the municipality of Copenhagen (KK) and the Danish Cancer Society, Kræftens Bekæmpelse (KB). The centre is to help reestablish an everyday life for the cancer patient by means of counseling, therapy, social activities, physical rehabilitation through various activities, lectures and courses for the people with cancer as well as the families.
The Cancer Health Care Centre will collect these offers and it is the goal from the municipality of Copenhagen as well as from the Danish Cancer Society, that the Cancer Health Care Centre will be renowned locally, nationally as well as internationally for a rehabilitation unit with results of high quality.

It is stated in the competition program, that the centre should contribute to keeping and improving the quality of life of the cancer patients and their families with physical, psychological and social elements. It is the desire that the building will stand out through its architectural expression and create motivation and invite to social interaction, physical motion and personal transformation.
A thorough room program is laid out in the project brief. The centre will contain five main function areas, such as common functions, conversation and treatment, physical activities, courses as well as administration.

The centre is to accommodate different people: male and female; old and young; people, who are deadly ill and people, who are more or less recovered.
Thus, it needs to be a place which creates space for happiness as well as sorrow, contemplation and woriness, space for privacy and sociality, where people can be on their own, undisturbed, or be social with friends and family on various levels.
The program underlines the importance of the architecture's effect on human wellness and health, and how evidence based architectural design can help strengthen and improve the healing and health of the cancer patients.

"Be known in Copenhagen and by its unique architecture signal a non-institutional environment with spaces, where light, colors and acoustic contribute to a friendly, welcoming and relaxed atmosphere."

"Be a physical environment, which creates curiosity about the function of the place and attracts families with cancer, as well as it initiates a dialogue."

"Accommodate dilemmas such as joy and sorrow, laughter and silence, activity and relaxation, man and woman, old and young, poor and rich (cancer strikes all social layers and nationalities)"

Translated from Danish [Københavns Kommune, 2009, s. 8-9]

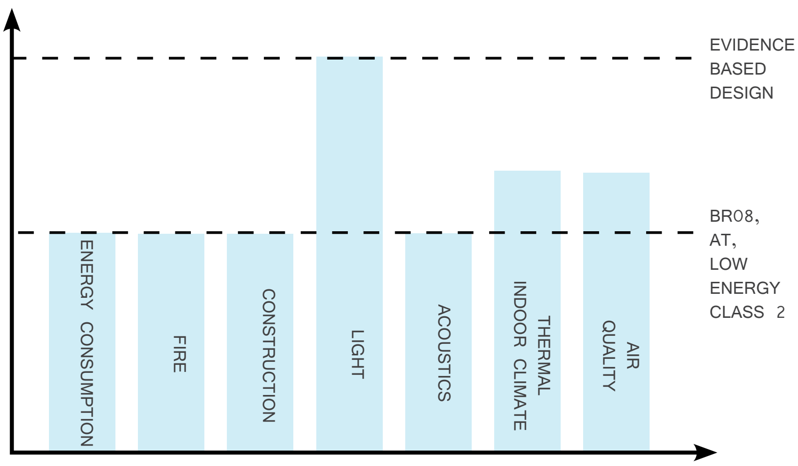
METHODS

The method used in the project is based on the Integrated Design method as used in Architecture & Design, Aalborg University.
The method builds on the phases: problem, analysis, sketching, synthesis and presentation. It is an iterative process, as the phases overlap each other and interact on different levels, as different parameters, analysis and decisions lead back and forth within the process. The Integrated Design process is inspired by the Roman architect Vitruvius, who argued that qualitative architecture was a result of three equally important aspects, utility, strength and beauty. The structural system, the sustainability, function and expression are all equally represented in the architecture and equally play a part in the design of the building. (see ill. 7.1) [Knudstrup 2005]

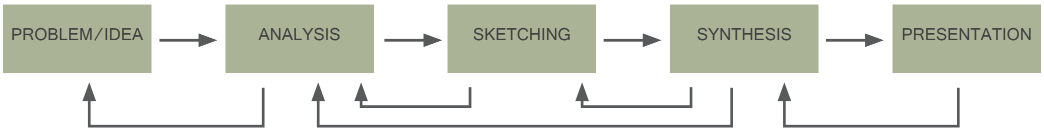
Different tools will be used in the research, analysis and design phases, such as literature, software, sketching and modelling. An excursion to Copenhagen will be carried out to see the site, and study trips to Århus as well as Scotland will be conducted to see and study different cancer centres. (see ill. 7.2)

The project revolves around the creation of a Cancer Health Care Centre in Copenhagen through the concept of healing architecture. Healing architecture is founded on evidence based design, which will be analyzed in regards of concretizing the factors relevant in this project. Other literature will be integrated to supplement the evidence basis and case studies will be carried out to gain knowledge and inspiration about the Cancer Health Care Centres. The evidence based design factors studied through healing architecture will form the base of the study of the cases, and be supplemented by the experiences gained there in regards of the architectural effects, the atmosphere and other important parameters. Together this theoretically as well as practically gained knowledge will be the foundation for the design process.

The project will primarily evolve around the technical theme of light, as it is an important factor within healing architecture and when dealing with cancer patients. The indoor climate in terms of thermal conditions as well as the air quality will play an important role, and the acoustical will also be taken into consideration.
The project will seek to meet the energy requirements for Low Energy Class 2 as a minimum, which is approximately 75% of the present requirements and will be the general energy requirement in the near future. [Erhvervs- og byggestyrelsen 2008]
However, the priority is given to the evidence based design factors, why the energy requirements should not be the crucial issues of the project. The regulatory requirements and the Low Energy Class 2 will be the goal for the other technical aspects. (See ill. 6.1)



ill. 6.1: Diagram showing the weight of different technical aspects in the project.
Light and indoor climate, followed by acoustics will be the primary themes in regards of evidence based design. The Danish Building Regulations (BR08), Danish Working Environment Authority (AT) and the Low Energy Class 2 requirements will state the base of other technical aspects.



ill. 7.1: Diagram showing the phases of the integrated design process, and how they interact and affect each other back and forth. [Knudstrup 2005]

PROJECT PHASES	TASK	TOOLS	FEBRUARY	MARCH	APRIL	MAY	JUNE
ANALYSIS	Research -project brief -thematic -contextual	Literature studies Internet research Writing Analysis Discussions Excursion/Study trip Case studies					
SKETCHING	Form development - volume studies - sketching/modelling - initial calculations	Pen + paper Photography Workshop Sketch-up Month Average Spread Sh. 24 Hour Spread Sheet Ecotect					
SYNTHESIS	Detailing - physical modeling - sketching - digital modeling - digital drawing - calculations	Pen + paper Photography Workshop Sketch-up 3DMax AutoCad Adobe CS3 Month Average Spread Sh. 24 Hour Spread Sheet B-SIM BE06 Ecotect					
PRESENTATION	Documentation - physical model - digital model - 3d visualizations - drawings - calculations	Workshop 3DMax Adobe CS3 B-SIM BE06 Ecotect					

ill. 7.2: The phases of the integrated design process, what they contain and how they are planned throughout the project period.

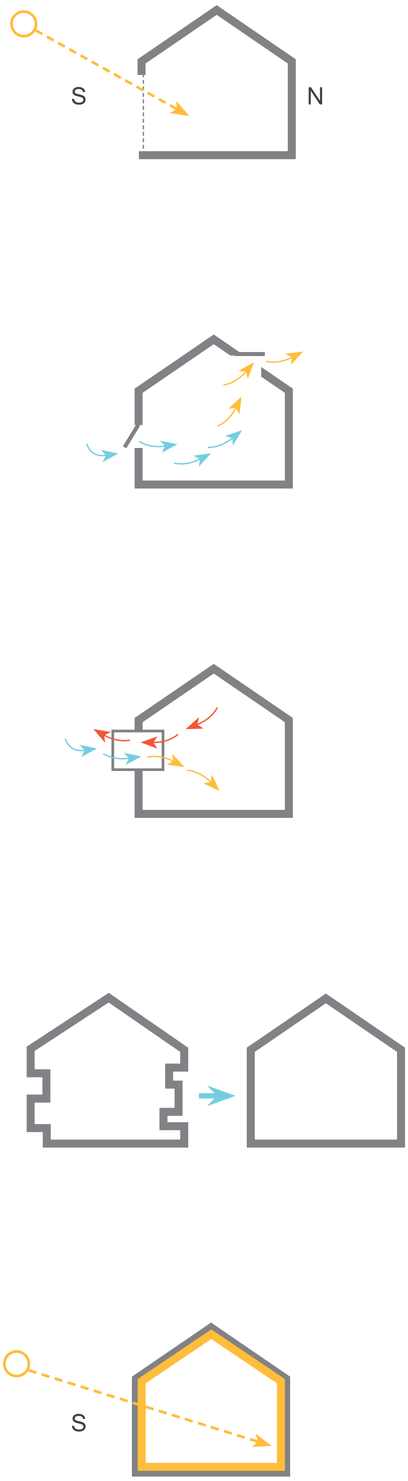
SUSTAINABILITY

It is desired in the project brief and found relevant in relation to the integrated design process, that the Cancer Health Care Centre is sustainable and as a minimum fulfills the demands of the Low Energy Class 2.

The sustainable approach in this project is described by defining sustainable design parameters to be integrated in the design process. (See ill 9.1-4)

The energy demand for Low Energy Class 2 is 75% of the present energy requirements and will be the general requirement in the near future. It implies energy used on heating, ventilation, cooling, hot water and lighting, why the project will focus on the architectural factors that can minimize these consumptions to obtain a low energy class building.

The Danish verification programme Be06 will be the software used to try the energy consumption.



Ill. 9.1-4: Diagrams of some parameters which are relevant to consider when designing for a low energy demand.

NATURAL DAYLIGHT

To minimize the energy used for lighting, natural daylight should be utilized through careful orientation and optimization of the building layout and plan. Deep rooms should be avoided and the functions should be zoned within the building, so activities requiring high illumination are placed near windows. Further it should be considered, how to avoid glare and overheating, as the daylight changes through days and seasons.

VENTILATION

Energy for ventilation and cooling can be reduced by use of natural ventilation. Different initiatives can be implemented to naturally preheat the air, such as double facades, where the air enters between two layers of glass and is heated by the sun.
Natural ventilation depends on the climate conditions, changing through days and seasons, and it can be difficult to plan the precise effect, why it can be relevant to supplement it with mechanical ventilation. The mechanical ventilation system should further be provided with a heat recovery unit, so it can utilize the heat from the exhaust air to save energy on preheating the air.

HEAT LOSS

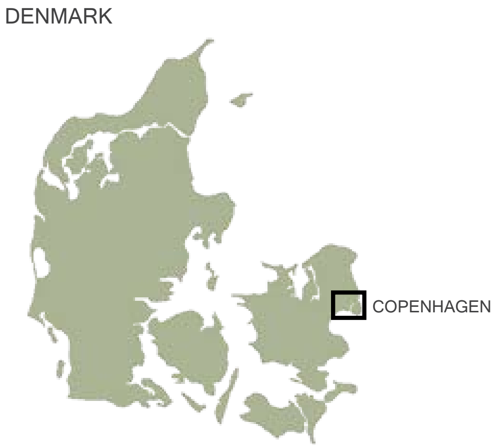
Energy used for heating depends on thermal bridges and the heat loss through components and joints, and especially window areas are responsible for the majority of heat loss in a construction. The heat loss in building components depends on the insulation thickness and materials, and thermal bridges depend on the way the components are joined and by which material. The heat loss can be minimized by considering the surface to volume ratio, where the surface area is minimized in relation to the volume, why less heat can pass through the construction.

SOLAR HEAT GAIN

Solar heat can be utilized by considering the orientation and layout of the building, so the majority of the window area faces South. Zoning is also useful in this regard as the functions requiring warmer temperatures should be placed towards South. The implementation of thermal mass such as concrete walls can further optimize this process as they absorb heat during the day and release it during night, why they assist in maintaining an equal temperature level.

The context of the building site is analyzed concerning what relations and parameters need special consideration in the continuing design of the Cancer Health Care Centre.

CONTEXT ANALYSIS



Ill 12.1: Map of Denmark

Ill 12.2: Map of Copenhagen

Ill 12.3: The site seen from the park to the North.

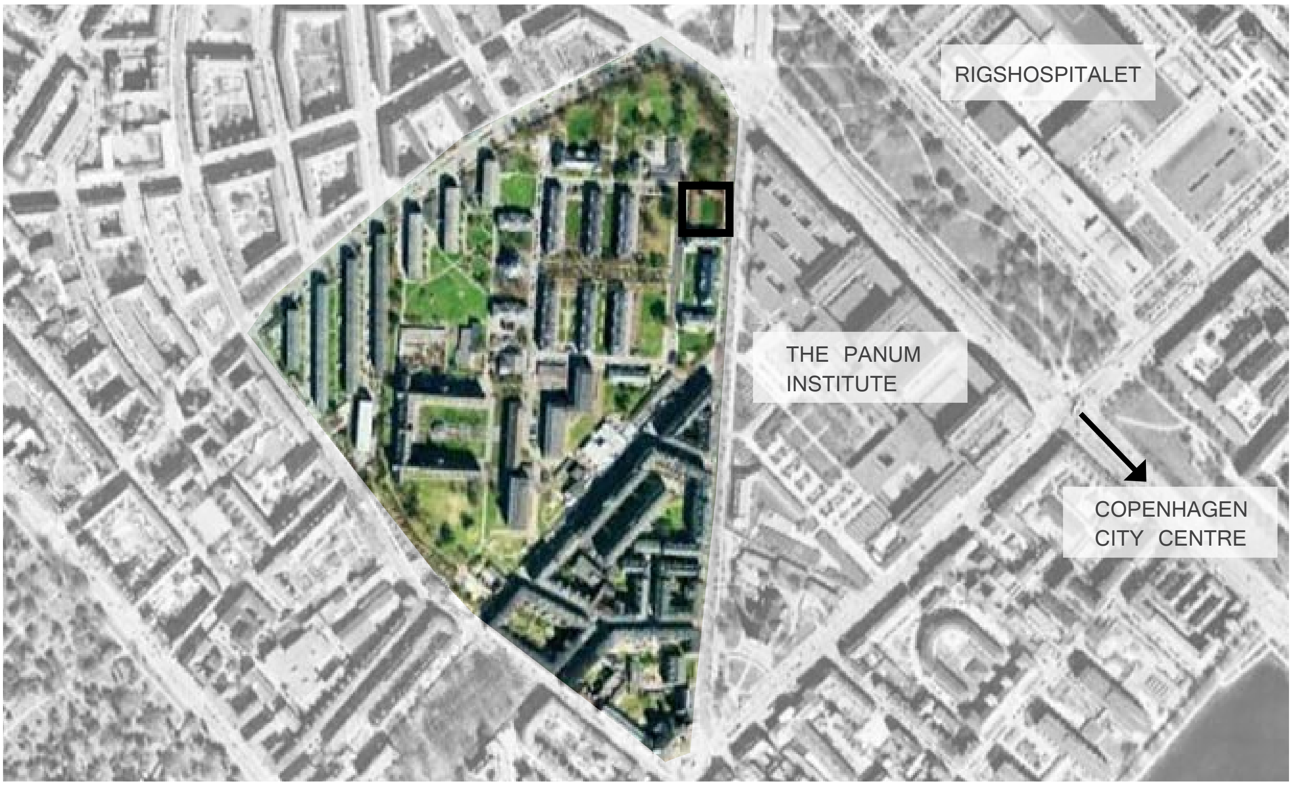
LOCATION

The Cancer Health Care Centre is to be situated on a site in Nørrebro, Copenhagen, on the corner of two main streets Tagensvej and Nørre Allé connecting the area to the inner city.

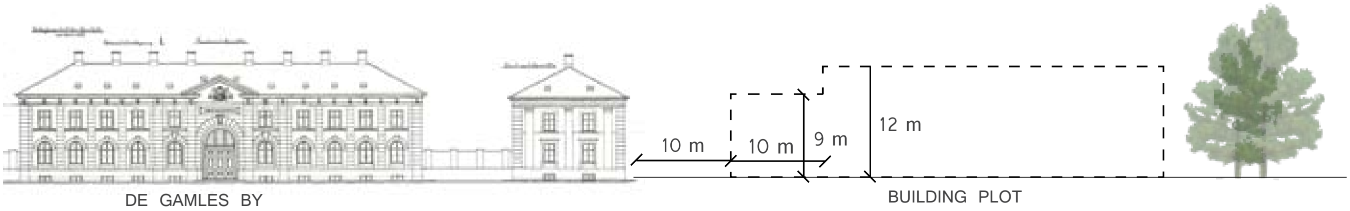
The site is located within the area of De Gamles By, which is an area of elder care and retirement homes established around the beginning of the 20th century.

It is a green oasis in the dense area of Nørrebro, with its characteristic red brick buildings set up in a classic, symmetrical layout with greenery around and in between.

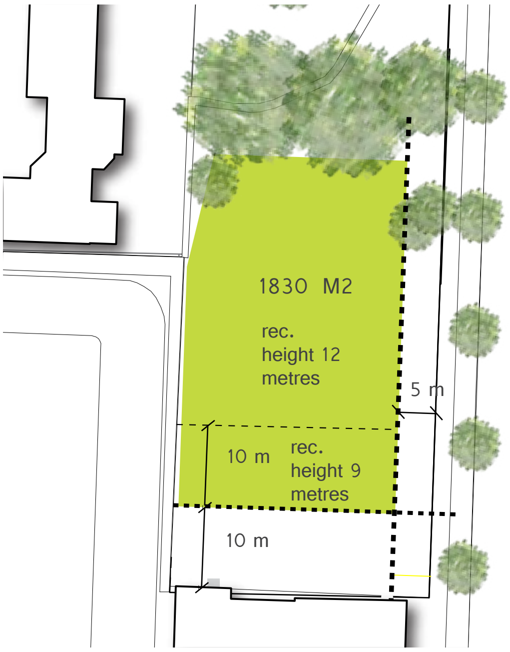
The Cancer Health Care Centre will be situated on a site bordered by De Gamles By and a green park area on one side, but bordered by the dense city and traffic on the other side, comprising the hospital, Rigshospitalet, the Panum institute and large dwelling blocks.



Ill 13.1: Map of the area of "De Gamles By"



Ill 13.2: Recommended height limitations in the building plot. The old buildings of De Gamles By are listed, why special consideration should be given to comply the new building with the context.



Ill 13.3: The building plot

THE BUILDING PLOT

As the Cancer Health Care Centre is located in an area of old, characteristic buildings, the municipality puts emphasis on the importance of new buildings having a respectful relation to the existing buildings.
Thus, the new building should respect the classic buildings of De Gamles By in relation to materials and shape.
Furthermore, a respectful distance should be kept to the existing buildings, meaning at least 10 meters. In a distance of 20 meters from the nearest gable, the height of the new building is recommended not to exceed 9 metres.
As a further reflection on this it is important to consider the shadow cast coming from the existing building.
The North side of the building plot is bordered by two large trees, which are to be preserved and thus respected by the new building. It should also be considered how the building complies with the additional context of the urban Nørrebro.

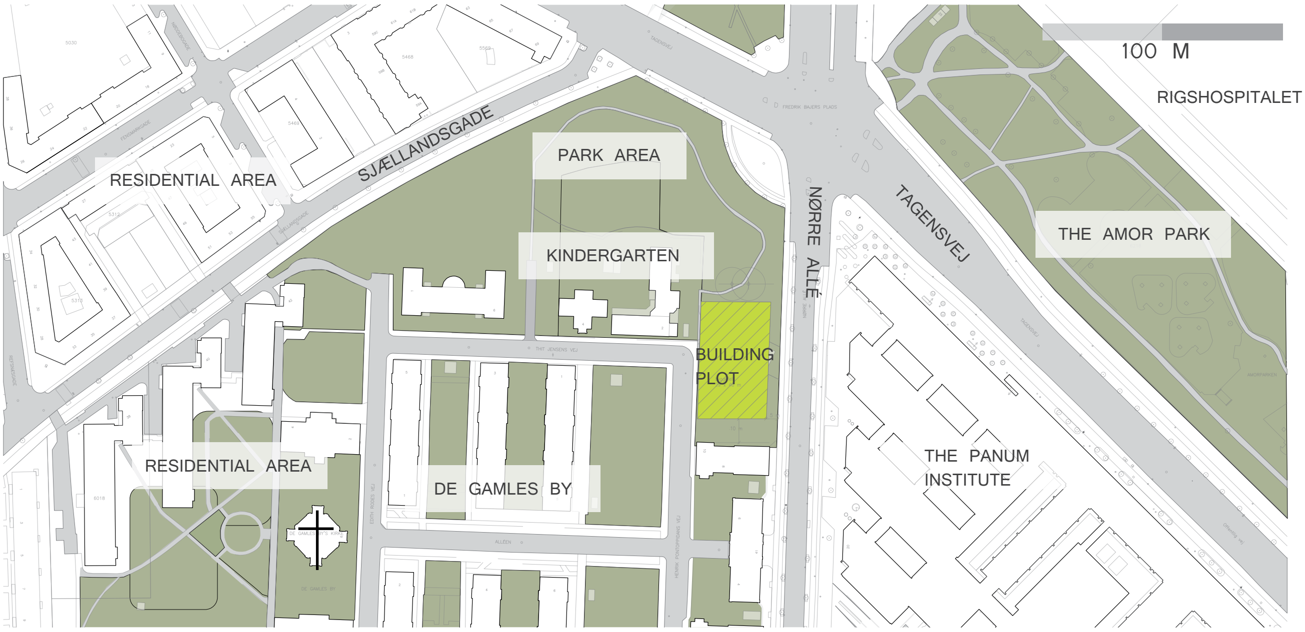
Ill. 14.1: The kindergarten situated West of the building site

Ill. 14.2: The Panum Institute to the East of the building site

FUNCTIONS

The building plot is located within walking distance from the large hospital Rigshospitalet, where many users of the Cancer Health Care Centre undergo treatments which gives reason to place the centre at this specific site. (See Ill. 14.3)
A beautiful park with old trees borders the site to the North creating a protective zone between the area of De Gamles By and the traffic junction of Tagensvej and Nørre Allé.
The green park defines a recreative and pleasant atmosphere in the middle if the busy urban context of Nørrebro, why the connection between this active and the new building should be explored in the further process.
The park is open for all people living in or visiting the area of De Gamles By why special consideration should be giving to the connection between the park and the new centre concerning views, access and privacy for the users of the centre.
To the West of the site there is a kindergarten in a one storey red wooden barrack like building differentiating from the other buildings of De Gamles By in both design and scale. (See ill. 14.1) To the East of the site the relatively large grey concrete building containing the Panum Institute is situated creating a massive wall that dominates the view to this side. (see ill. 14.2) This large concrete building as well as the Rigshospitalet are two massive volumes in the overall urban environment of Noerrebro contrasting the smaller, scenic scale of De Gamles By, and it should be considered how the Cancer Health Care Centre relates to both.

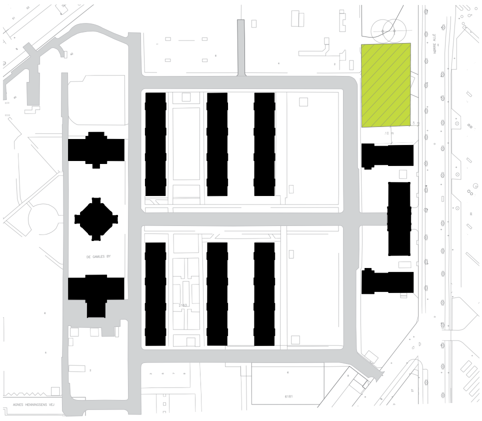
Ill. 14.3: Functions surrounding the building site



Ill. 15.1: The hospital, Rigshospitalet, located in walking distance from the site to the North East.

Ill. 15.2: The church in the axis of the entrance avenue of De Gamles By.

Ill. 15.3: The classical red brick buildings of De Gamles By.



Ill. 15.4: Diagram of the symmetrical building layout of De Gamles By, situated next to the building site.

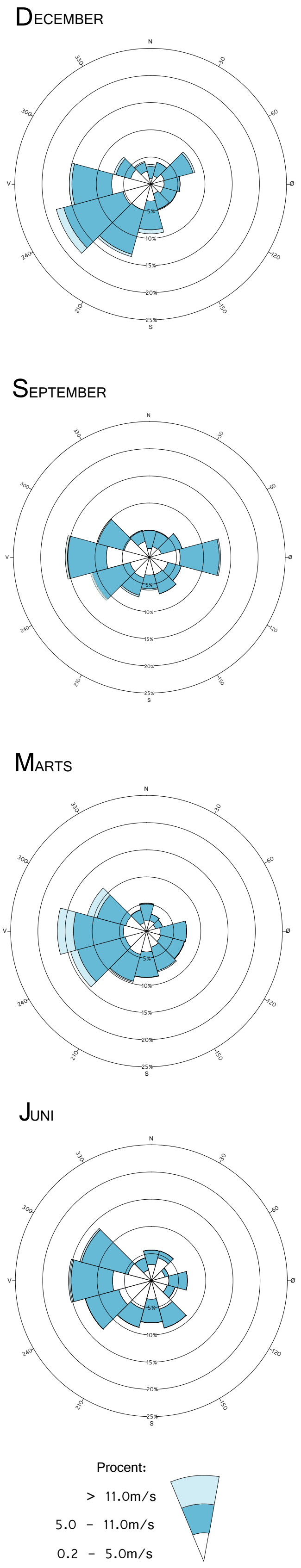
DE GAMLES BY

To the South the building plot is bounded by a two story red brick building with slate roof in a classic style. The building is part of the stringent symmetrical building layout of De Gamles By, built up on a clear axis leading from the entrance gate through the main building to the church of De Gamles By. Around the buildings as well as in between them there are recreational green areas.

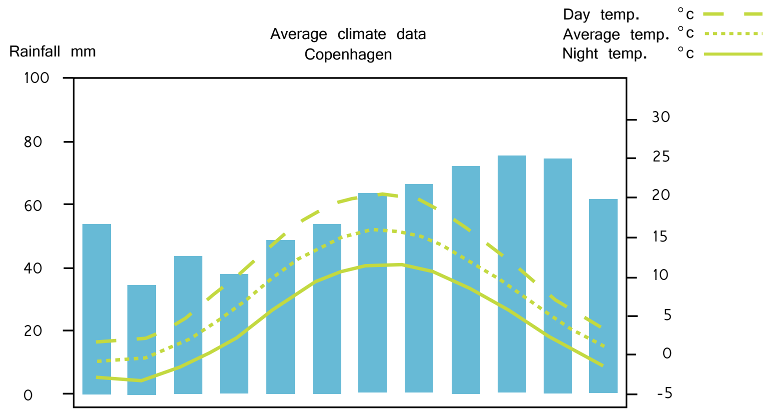
As the entrance to the area goes through the main building, the area gets a semi private atmosphere and it needs to be taken into consideration, how the public Cancer Health Care Centre will be a part of this. Also the centre will be situated a little outside the symmetry of the existing buildings, why the relation between them needs to be considered.

CLIMATE

The building site is situated near the centre of Copenhagen in a relatively busy and congested area.
The area is characterized by wind from West more or less all year round. But as the area is rather dense the surrounding buildings will break parts of the wind, sheltering the site.
The climate is temperate with rather cold summer temperature of about 16 degrees and mild winters with an average temperature of 0,5 degrees characteristic of the Danish climate.
The Northern latitude entail a relatively changing position of the sun throughout the year.
During winter months there is only sunlight for 4 hours, which often cause the need for supplementing with electric lighting to obtain a suitable amount of illuminance in buildings.
Furthermore the sun is low in the sky creating long shadows (see ill. 17.3). The site will be shaded most of the winter months by the two storey building bounding the site towards South implying a need for large window areas towards other directions as well to obtain a suitable amount of daylight.
The low sun additionally creates risks of glare implying a need for implementing suitable solar screens in the new building.

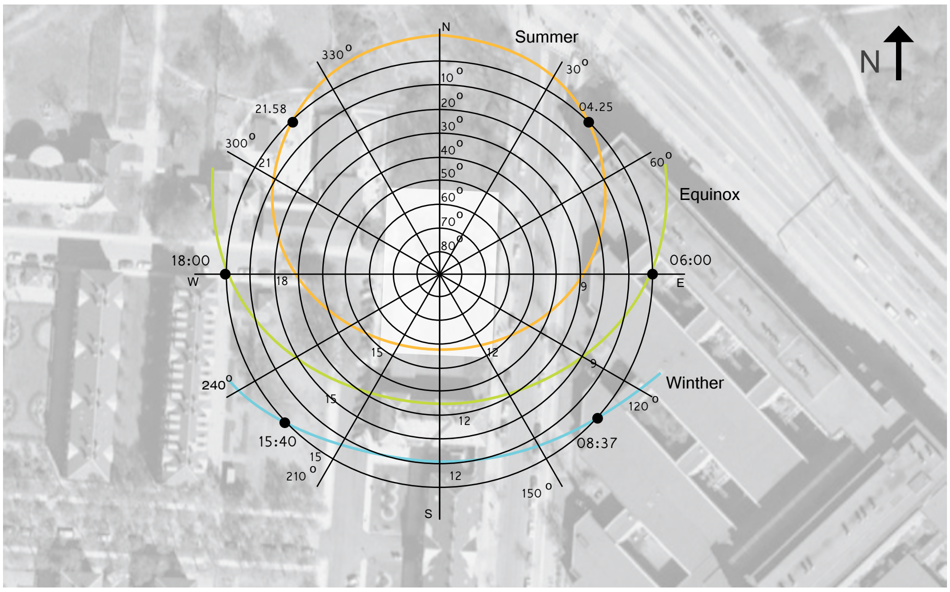


Ill. 16.1: The main wind directions in a specific period of the year in Copenhagen.

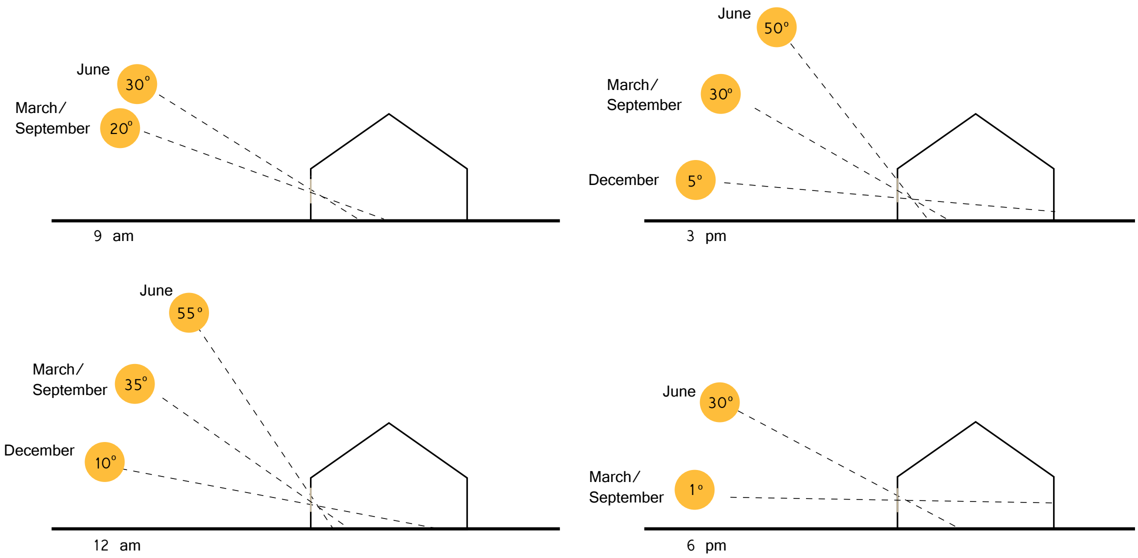


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall mm	46	30	39	39	42	52	68	64	60	56	61	56	613
Rainfall days	10	8	9	8	8	8	10	10	10	9	12	11	113
Day temp.	1,9	2,0	4,8	9,5	15	19,2	20,4	20,3	16,7	12,1	7,1	3,7	11,1
Average temp.	0,1	-0,1	2	5,7	10,9	15,1	16,4	16,3	13,2	9,5	5,1	1,8	8,0
Night temp.	-2,0	-2,4	-0,6	2,3	7,2	11,3	12,9	12,6	9,8	6,7	2,7	-0,5	5,0

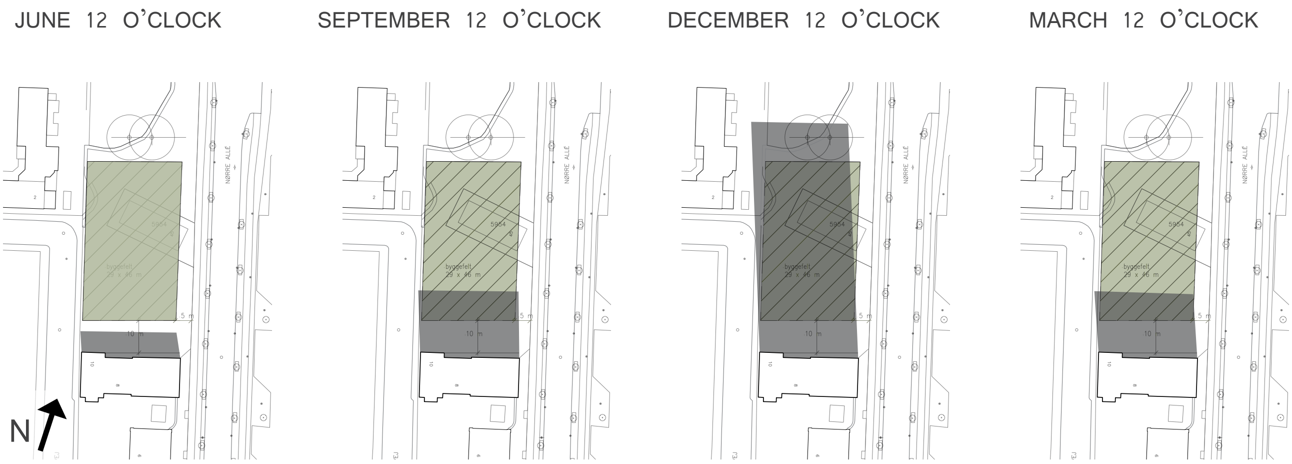
Ill. 16.2: The average temperatures and rainfall in Copenhagen.



Ill.17.1: Sun path diagram of Copenhagen



Ill. 17.2: Angle of the sun at 9am, 12am, 3pm, 6pm



Ill.17.3: Diagram showing the shadow casting on the site through the year.

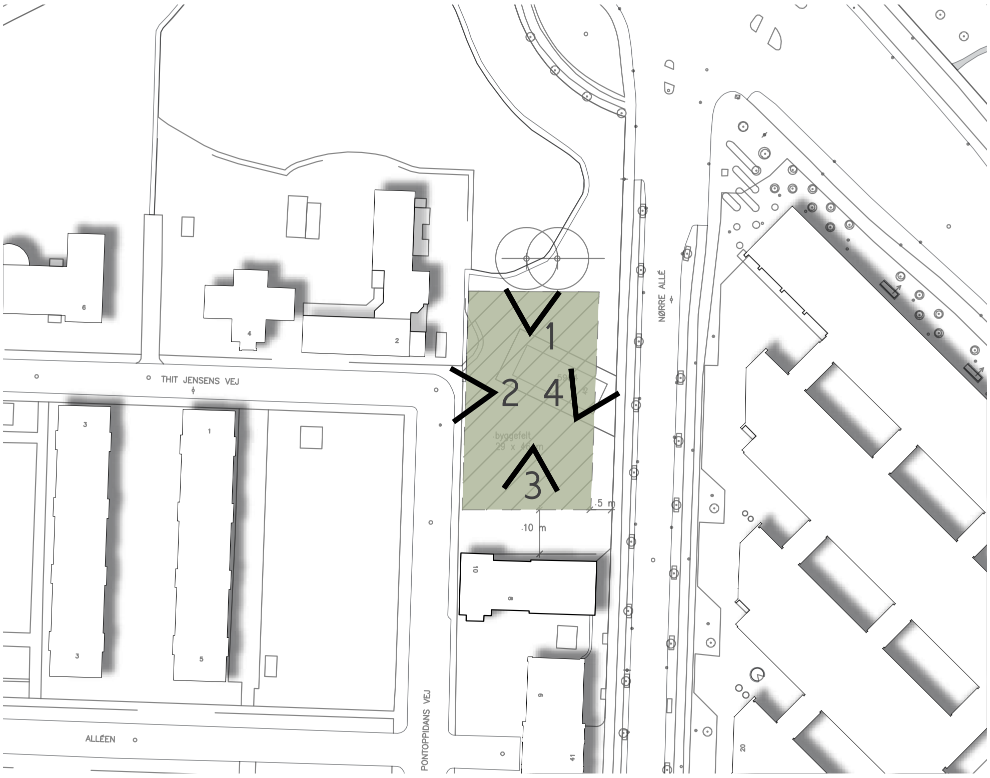
Ill. 18.1-4: Pictures from the site.

1 GREEN PARK AREA

2 VIEW OF CLASSICAL RED BRICK BUILDINGS

3 THE SITE IS BOUNDED BY A RED BRICK BUILDING IN 2 STORIES

4 THE 5 STOREY PANUM INSTITUTE IS SITUATED TO THE EAST OF THE SITE



Ill. 19.1: Illustration of the views from the site.

VIEWS

1: A park area is enclosing the building site to the North. The park is surrounded by large luxuriant beeches forming a protective shell from the heavy traffic at Nørre Allé and Tagensvej.

2: To the East there is a view of the classical old buildings of De Gamles By containing functions connected to the Health and Care administration of Copenhagen.

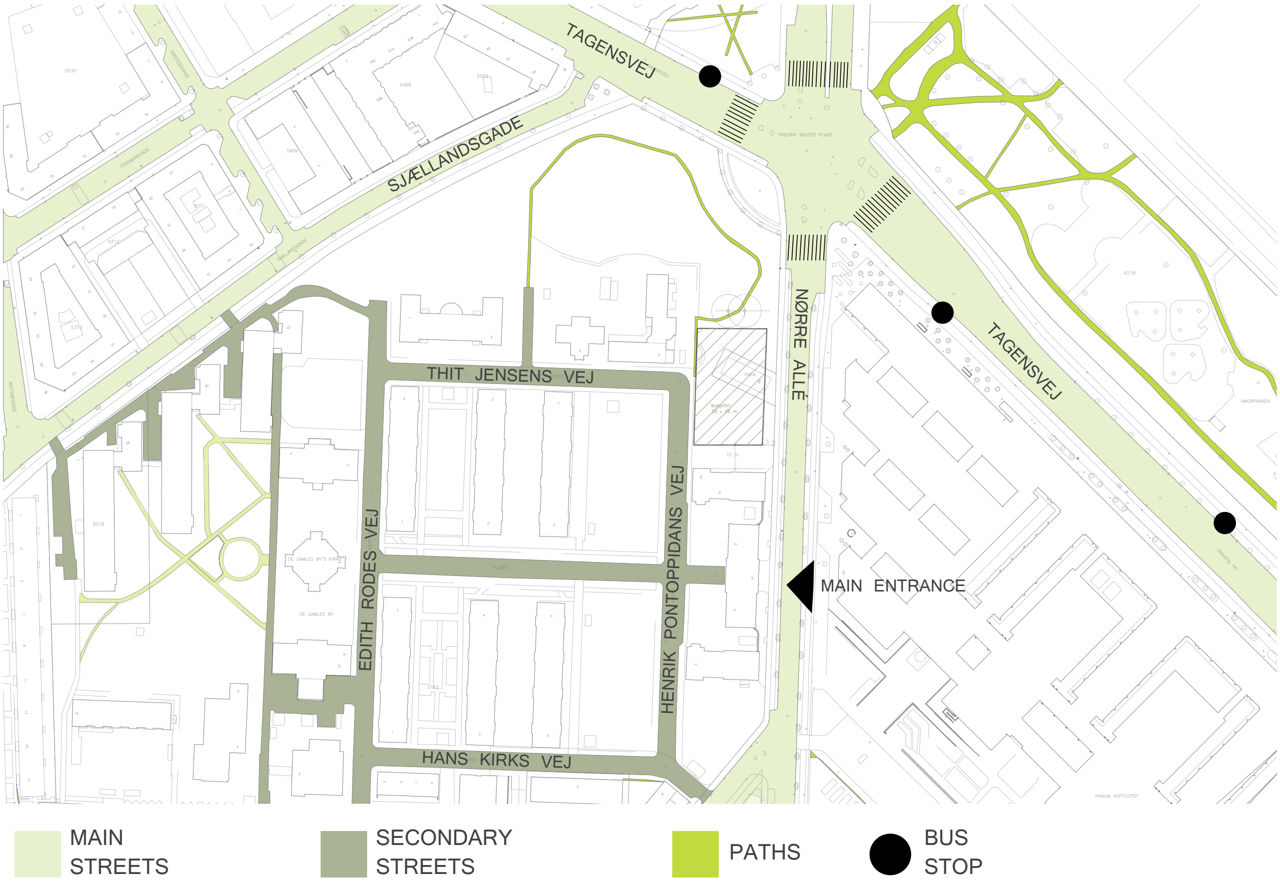
3: To the South the site is bounded by a two storey red brick building in consistence with the rest of the area of De Gamles By. The Cancer Health Care Centre will be situated relatively close to this building, which requires special attention in the design process in relation to daylight conditions, privacy and views in and out.

4: To the East the large concrete building of the Panum Institute is situated.
This requires special awareness as to which scale the Cancer Health Care Centre should relate and to which areas the view from the center should be directed.

INFRASTRUCTURE

The building site is defined by the main street Nørre Allé to the East that intersects the other main street of the area Tagensvej to the North of the site. The two roads lead into the center of Copenhagen, and to the North of Copenhagen respectively, why the site is easily reach-able both by car, food, bicycle or collective traffic.
The close location of the building plot next to a main street implies special consideration in the continuing design phase relating the protection from traffic noise and limitations in the building plot that has to be pulled back from the road.
The Rigshospitalet is placed in walking distance across from the building site. However the site and the green park to the North is currently enclosed by a tall steel fence meaning the only way to enter and leave the area of De Gamles By and the site is trough the main entrance of De Gamles By.
This requires a reconsideration of the access to and from the site in regards of both cars and pedestrians also considering the desire of making the building ap-pear welcoming and easily accessible.

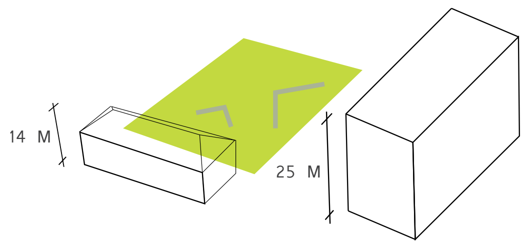
Ill. 20.1: View of the current main entrance to the area of "De Gamles By" at Nørre Allé



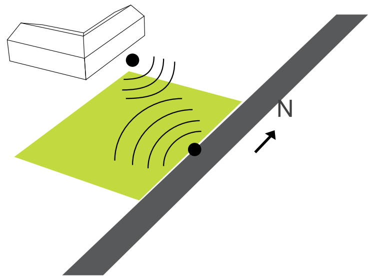
Ill. 21.1: Illustration showing the infrastructure of the area.

Ill. 21.2: View of the traffic junction of Tagensvej and Nørre Allé.

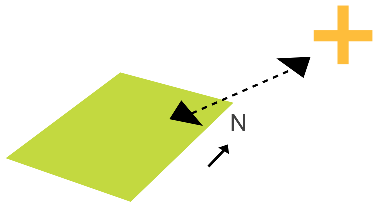
CONTEXTUAL PARAMETERS



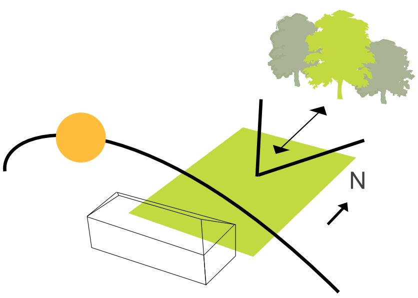
THE BUILDING SHOULD RESPECT THE SMALL SCALE OF DE GAMLES BY AS WELL AS MARK ITSELF IN THE BIG SCALE OF THE URBAN CONTEXT.



THE PROTECTION FROM **TRAFFIC NOISE** SHOULD BE IMPLEMENTED IN THE BUILDING DESIGN



SEPARATE ENTRANCE FACILITATING A CLOSER CONNECTION TO "RIGSHOSPITALET"



THE RELATION TO **THE PARK** SHOULD BE IMPLEMENTED CREATING BOTH VIEWS AND ACCESS.

Ill. 22.1-3: Diagrams of the contextual parameters.

The analysis of the project site has clarified several parameters that needs to be considered and implemented in the further design process of the Cancer Health Care Centre.
The building site is located in the borderline between De Gamles By, a pleasant and peaceful area characterized by greenery and classical red brick buildings and the busy urban area of Nørrebro, large main roads and tall concrete buildings.
These two contrasting scales in the area of the site needs to be considered carefully, as the building on one hands needs to comply with the small scale of De Gamles By and on the other hand also needs to mark itself in the urban context, as it relates to Rigshospitalet and neighbours the Panum Institute.

The close location next to Nørre Allé brings limitations in the design considering noise and disturbance from the heavy traffic. However, the location of the site close to the road also makes the centre visible in the area. Additionally thoughts needs to be given to the relation between the new centre and the existing red brick building bounding the site to the South considering expressions in materials and shape, obtaining and preserving privacy and furthermore gaining an adequate amount of daylight in the new centre.
The arrival to and from the site is currently through a gate in the an existing red brick building of De Gamles By, which seems semiprivate and thus not very inviting for new visitors, why the design of a separate entrance to the centre that additionally facilitates the connection between the centre and Rigshospitalet seems necessary. A separate entrance will furthermore give the centre a character of its own and let it stand out from the collected, reclusive unit of De Gamles By.
A green park area is bounding the building site to the North with tall trees. The park area is a green breathing hole in the middle of the busy area of Nørrebro, why special consideration should be given to connecting the centre to the park area in terms of views and access.

The site is bounded by an existing, two storey red brick building of De Gamles By, why special consideration should be given to the shadow cast from the building and thus how to obtain a suitable amount of natural daylight in the new building.

The themes of healing architecture and evidence based design will be analyzed in order to understand the concept. The cancer patients, their disease and the side effects as well as the role of the Cancer Health Care Centre is investigated to understand the users and their needs and how this relates to the theme of healing architecture.

THEME ANALYSIS

HEALING ARCHITECTURE

In recent years it has become more evident, that the environment and the architecture have a great effect on human wellbeing, and that it in relation to health care and hospital design can have an important effect on the healing and health of the patients.
Before medical science has become as elaborate and accurate as it is today, the main tools which the medics had was to provide comfortable, soothing surroundings for their patients. Light, fresh air and tranquility were important factors in any treatment, meaning that the hospital design evolved around creating beautiful architecture, which could provide these important elements.
As medical science has become more elaborate and the medics have been provided with better medical tools, such as x-rays, surgery, medicine, vaccinations and other cures to treat their patients, the basic elements of comfort, tranquility and beauty seems to have become obsolete in the hospital and health care architecture, and the architecture has instead become a matter of creating functional, robust spaces that can accommodate as many patients as possible.
This has resulted in many insensitive spaces with hard, cold materials, a maze of long corridors, artificial light and less daylight, bad acoustical conditions, limited views outside and limited consideration for the privacy and individuality of the patients. [Dirckinck-Holmfeld et al. 2007]

Today, the course within hospital and health care architecture is changing and the old values are returning as different evidence proves their importance.
Also the need for the architecture to be de-institutionalized and be a comfortable, qualitative and beautiful space is becoming more evident alongside the need for function, infrastructure and construction.

”Architecture can affect the senses positively or oppositely, consciously or unconsciously of the one who meets it. Indifference is in general not possible, not even if the architecture itself pretends to be so. The one, who finds oneself in a space cannot turn of the senses, but will be affected.”

Translated from Danish. [Dirckinck-Holmfeld et al. 2007, p. 116]

The concept of healing architecture is still a new field within building design and has so far mainly been focusing on hospital environments, meaning it is not yet investigated much in other fields of health care architecture.
Healing architecture implicates not only the wellbeing of the patients, but also their relatives and the staff around them. Creating architecture, which provides a qualitative workspace for the staff, which can improve their work, their social relationships and motivate them to give their best effort, is an important factor in the healing of the patients as well. A happy, motivated staff in most cases produces happier, satisfied patients. The relatives of the patients are often not taken into consideration when designing hospitals or health care spaces. However, it is a known fact that their relation to the patient, their social support, their participation in the course of the illness and the treatment, plays an

important role in the healing of the patient. Creating architecture, which also accommodates the relatives, is therefore an important part of healing architecture.

The concept does not conclude that the architecture heals on its own, but it suggests that the architectural design through elements such as daylight quality, atmosphere, coloring, sound, privacy, sociality and safety can improve the healing of a patient, physiologically as well as psychologically.

The research concerns investigations within the building structure and its detailing, as well as the physiology and psychology of the human being. The research shows a common pattern, that architectural factors, as for instance light, acoustics and planning affect the human beings, as it can be measured in the levels of stress and anxiety, it can be seen in the statistics of hospitalization, medicine consumption, the duration of recovery, staff effectiveness as well as it can be observed in the wellbeing of the patients, their relatives and the staff. [Frandsen et al. 2009]

Ill. 25.1-2: Östra Sjukhuset by White Architects, Gothenburg. A psychiatrical ward, where light, privacy and sociality as well as close relations to the outdoors have been important design criterias.

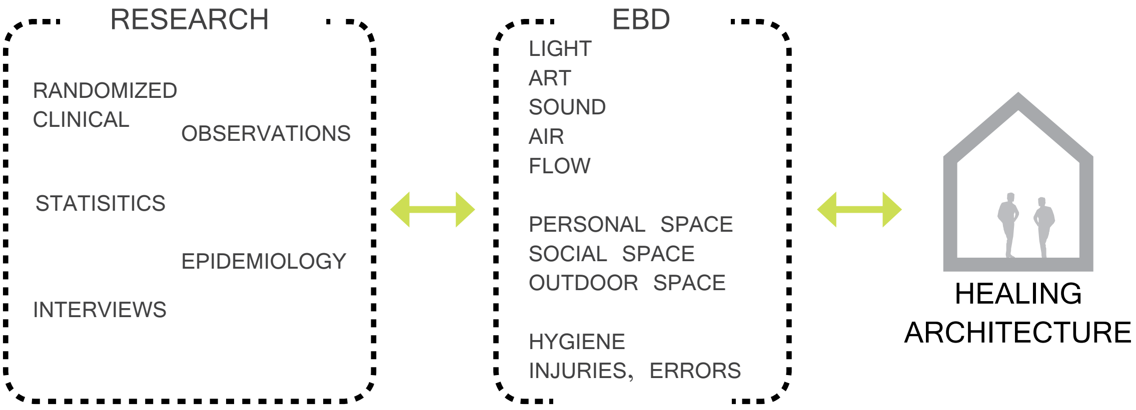
EVIDENCE BASED DESIGN

The concept of healing architecture is founded on the evidence based design method, meaning the design of health care environments is increasingly guided by research linking the physical environment to healthcare outcomes.
Thus the term of evidence based design describes a method for qualifying and developing qualitative architecture based on scientifically proved knowledge that has come out of many different investigations, analyses and statistics. Evidence based design does not only comprise a design concept but also includes the measurable effect of the built environment. [Frandsen et al. 2009]

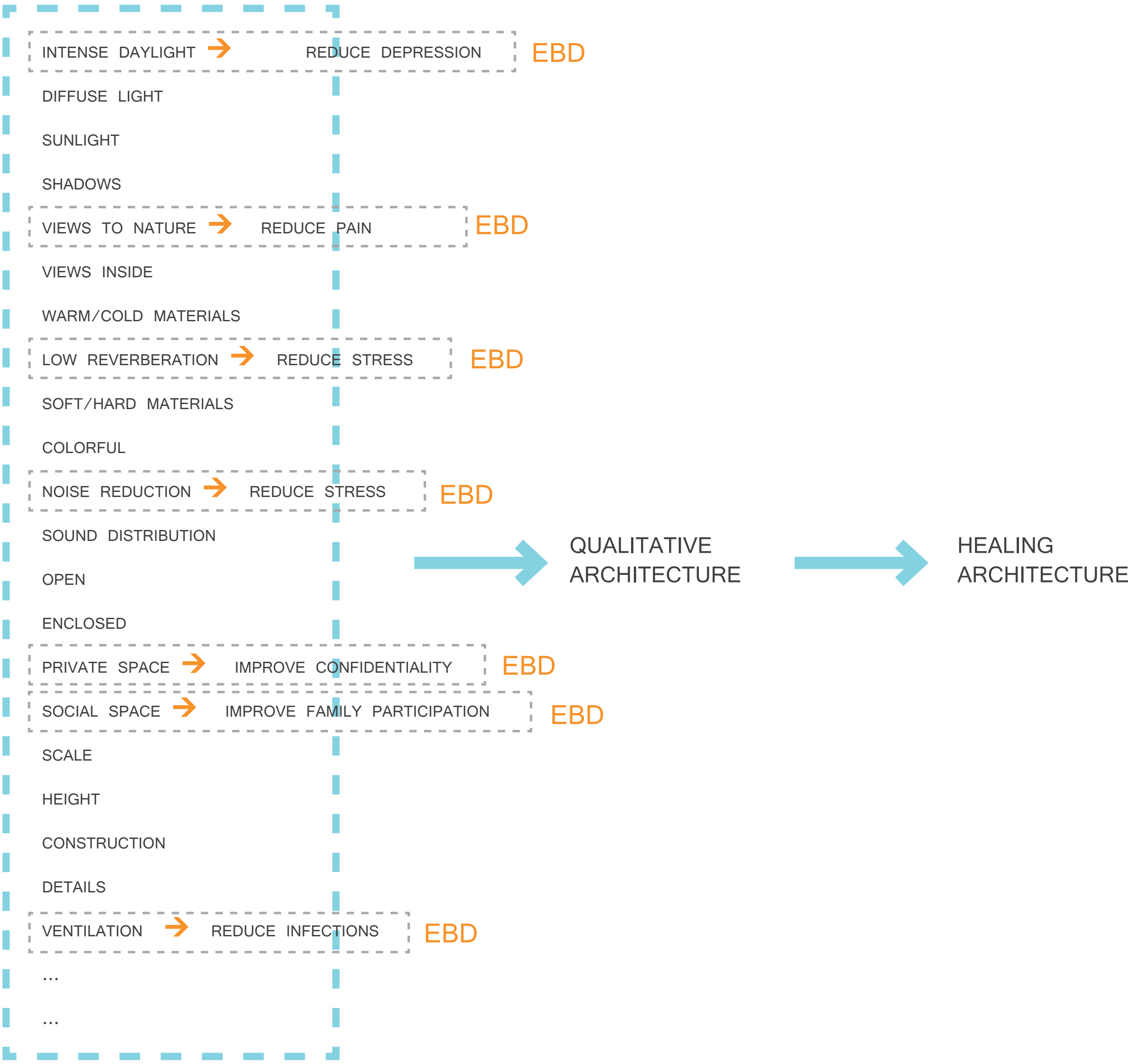
The research done within the field of healing architecture is of various qualities, done by different professions and disciplines, and not all can be described as generally credible empirical evidence, as it is not generated through randomized clinical trials or experiments, and will be defined merely as quasi-experimental research, epidemiological investigations or as observational studies. [Ulrich et al. 2008]
However, the research paints a reliable, joint pattern of certain environmental factors having an influence on the health care outcomes, and it confirms how a range of design characteristics and interventions, meaning evidence based design, can help improve healthcare architecture. The research reliability seems further strengthened, as the results are consistent and agrees with hypotheses based on earlier knowledge. Four general types of outcomes, that categorize the research, can be listed: The patient safety, in relation to infections, medical errors, and falls; The patient's and relatives' wellbeing, such as pain, sleep, stress, comfort, depression, navigation, privacy, communication, social support, and satisfaction; Staff outcomes, such as injuries, stress, work effectiveness and satisfaction. [Ulrich et al. 2008]
In regards of this project the outcomes relating the patient's and relatives' wellbeing as well as the staff will be of primary concern.

The evidence from most of the research within the field of healing architecture comes from hospital architecture. Much evidence relates to in-patient situations, and in this matter it can be difficult to transfer the evidence to a situation within a rehabilitation centre, as in the Cancer Health Care Centre.
Furthermore it always needs to be taken into consideration, when dealing with evidence based design that the different research relies much on the specific types of patients, their specific situation and the specific hospital unit, meaning it cannot be transferred directly to other cases, as for instance the cancer patients in this project. For this reason it is an important aspect, that the evidence is looked upon with critical eyes and interpreted critically in relation to the specific design task. [Frandsen et al. 2009] Evidence based architectural elements in relation to this project will be described further in the following and it will be considered how they relate to this project and what effect they may have.

Architecture is difficult to measure, as it affects the human being on multiple levels, through multiple senses, empirically and phenomenologically. The aspects of aesthetics play a role in the overall experience of a building, whether it is perceived as attractive, comfortable, pleasant, relaxing or the opposite. As a supplement to the evidence based design, it will be necessary to integrate other theories and cases of architecture to obtain the desired atmosphere and ambience in the architecture in relation to creating a Cancer Health Care Centre. [Dirckinck-Holmfeld et al. 2007]



Ill. 27.1: Different research of various disciplines form a joint pattern of evidence that certain architectural elements can improve health care outcomes. Evidence Based Design form the base of Healing Architecture. The Evidence Based Design factors listed are from the report "Helende arkitektur" by Frandsen et. al. [Frandsen et al. 2009]



Ill. 27.2: Evidence Based Design integrate certain architectural elements and form the base of Healing Architecture. Other architectural values also need to be taken into consideration in relation to construction, sustainability and atmosphere and aesthetics. The diagram is an exemplification and should not be seen as a complete picture.

CANCER PATIENTS

In relation to the project theme of designing a Cancer Health Care Centre the following section seeks to define the users of the Centre and their psychological and physical reactions to their illness in order to be able to concretize which factors within healing architecture that can have a beneficial influence on the users.

THE IMPACT OF CANCER

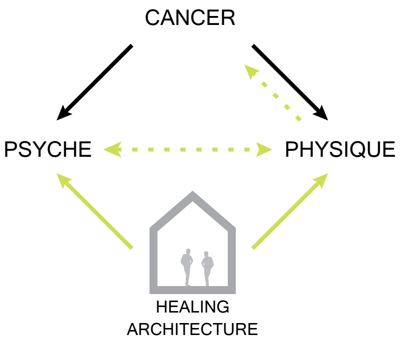
Cancer is a widespread and often feared disease because it can affect all people, old as young, healthy as unhealthy and because of the often harsh treatment course and the sometimes deadly outcome.
Consequently, being diagnosed and living with cancer bring many unpleasant psychological emotions and reactions alongside physical side effects from the treatment and illness.

"People diagnosed with cancer may experience physical vulnerability, loss of control over ones life, social isolation and a threat to the identity of one self.
These problems may reduce the quality of life in several years after the diagnosis."

Translated from Danish [Københavns Kommune, 2009]

Physical side effects from the cancer decease and the treatments affects people individually, but common physical reactions are: loss of hair, pain, fatigue, breathing problems, nausea, loss of appetite and weight. [Hansen, 13-01-2010]
However the psychological reactions to the illness and the treatment course can be just as severe as the physical reactions in such.
Previously, cancer has been seen as something "impure", why some cancer diagnosed people experience dissociation or stigmatization from the near surroundings making them feel unclean and tabooed. [Arkitema, 2007]
Furthermore, the uncertainty surrounding the disease and the treatments often bring other psychological reactions such as anxiety and worry which can be expressed through grief, anger, fear and despair. These emotions may also bring physical reactions such as increased heartbeat, difficulties to breathe, dizziness and tensions in the body. [Hansen, 26-01-2010]
The reactions usually continue to affect the patient in a greater or less extent many years after the cancer treatment due to the uncertainty related to the risk of a renewed outbreak of the cancer.
An investigation from the Danish Cancer Society presented in 2005 shows that people diagnosed with cancer are at great risk of becoming severely depressed up to ten years after their treatment. This also indicates that many cancer patients in general are more despondent and suffer more from mild depressions than the rest of the population. [Foghsgaard, 2005] The physical and psychological reactions to cancer and cancer treatments moreover commonly result in an increased level of stress hormones which may be affecting many cancer patients. [Dirckinck-Holmfeldt et al., 2007]

Ill. 29.1.



Ill. 29.2: The implementation of the healing architecture design concept in the new Cancer Health Care Centre.

Cancer brings along several side effects, psychological as well as physiological from the disease itself, from the harsh treatment and from the emotional processes that follow it. The main issues are fatigue, pain, stress, anxiety, depression as well as low self esteem, emotional vulnerability and low quality of life.
The Cancer Health Care Centre is to provide a healing environment that can reduce, improve and relieve these conditions.

CANCER AND STRESS

Stress is provoked both through inner psychological stressors, which can be caused by the cancer patients' fear concerning future treatments, possible pain, possible complications and external physical stressors caused by sensory perceptions from for instance the new hospital environment in which the patient suddenly finds itself.

Stress can be described as an instinctive survival strategy triggering feelings like anxiety and worry. These can be caused by outer stressors affecting the senses, eyes, ears, skin and nose, that are the human version of an alert system. Outer stressors can be unpleasant visual perceptions, galling temperature levels, unfamiliar noise or smells. Signals perceived by the senses are sent to the brain that decides whether the situation is dangerous or not. If perceived as threatening the response will be an increased level of stress hormones affecting the individual both physically and psychologically.
The external factors have a greater impact on the development of stress, than previously recognized, why the environment surrounding the patient can be an important issue in the health care outcome.
If the factors effecting the stress level are not altered it can result in a chronic condition of stress which is damaging to the body and the immune system, decreasing the ability to lower the stress levels in the body and return to normal life.

It is widely recognised that stress can cause damage to the immune system due to a release of stress hormones adrenalin and noradrenalin in the body that binds to the natural killer cells of the immune system and lowers their activity critically. However opinions are split in the question of stress and the effect it has on the healing process of cancer patients. Some investigations are verifying the hypothesis of stress provoking a return of cancer whilst others are dismissing it. [Dirckinck-Holmfeldt et al., 2007] [Jølving, 2008] [Antoni et al. 2006] [Kolata, 2005] [Ritzau, 2006]. The question arises because many investigations show that the immune system actually recognises and tries to defeat cancer cells, however the cancer cells seem to have an ability to turn off the killer cells meaning the natural immune system is not able to defeat cancer. [Hansen, 2009], [Jølving, 2008].

Despite the fact that surveys prove different results, scientists have through the last century been searching for a link between the immune system and cancer. The natural immune system is most likely unable to defeat cancer, but treatment improving specific parts of the system focusing on defeating cancer have proved successful, and thus it has become part of the treatment course for many cancer diseases. [Hansen, 2009]
Some surveys even suggest that the natural immune system plays an important part in the recovery of cancer patients after surgery, as the operation releases many small cancer cells that are not resistant to immune killer cells, why the natural immune system will be able to defeat the remaining cancer, avoiding a renewed outbreak. [Jølving, 2008]

After all, stress in general is a severe negative condition and it affects or implies other health care outcomes both directly and adversely such as heart conditions and instability in other major organs. In addition to afflicting patients, stress is furthermore a major burden for the relatives, and likewise it has proven to be a major problem amongst health care environment staff. [Ulrich et al, 2008]

Ill. 31.1. Cancer patients in a relaxation class. [Københavns Kommune, 2009]

It is not evident that stress directly causes cancer. However, the link between stress and a decrease in the efficiency of the immune system has proven to exist. Surveys show that a specific improvement of the natural immune system is useful in the treatment course of some cancer diseases, and some suggest that after surgery the natural immune system is able to defeat the remaining cancer cells. Subsequently it can be assumed that it would be beneficial for the cancer patients to obtain a healthy and functioning natural immune system, why the damaging effect of stress should be avoided. This implies a removal of the external stressors in the design of the Cancer Health Care Centre, which is proposed within the concept of healing architecture and evidence based design.

CANCER HEALTH CARE CENTRES

The term Cancer Health Care Centre with focus on cancer rehabilitation is relatively new in a Danish context. However the need for such a place and the beneficial effects experienced by visitors is widely recognized in other countries such as Great Britain, USA and Hong Kong. The fundamental idea of the Cancer Health Care Centre in Copenhagen is that it should accommodate a rehabilitating environment and be a breathing hole and through healing architecture, activities and counselling help the users and their relatives in dealing with the disease and maintaining quality of life and an active lifestyle. Therefore the centre will focus on the psychological, familiar and social situations of cancer diagnosed people and will function as a supplement to the physical treatment provided at the hospitals. This philosophy on which the idea of the centre is build originate from Maggie Jencks, the founder of the Maggie's Centres in United Kingdom, which will be described further in page 51-65. [Københavns Kommune, 2009]

As mentioned in the previous section, stress can be caused by physical stressors caused by sensory perceptions of the hospital environment in which the patient suddenly find itself. Many visitors of the new Cancer Health Care Centre will undergo their physical treatment in the new part of Rigshospitalet from 1970. The building is like other hospitals from this period build in tune with the predominant opinion of the time; modernism and functionalism, that brought rationalizing into architecture, mass production principles and a purely mechanical and technical approach to treatment methods, leaving the impression, that the individual and psychological needs of the patient has been forgotten in this large building complex. (See ill. 33.1-2) [Dirckinck-Holmfeldt et al., 2007] [Keiding, 2007] Consequently, the relevance and importance of the design of a welcoming place offering a relaxing, soothing and caring environment seems evident.

The new Cancer Health Care Centre will function as a drop-in-centre for cancer patients and their relatives and the physical treatment of the illness will be conducted at the hospital. Implementing healing architecture in the design of the Cancer Health Care Centre is relevant considering the removal of external potential stressors. Even though the users are not hospitalized in the centre and that the use of the Centre will be individual depending on gender, age and stage of disease, the senses of the human body react instantaneously to the surrounding environment. The senses are directly linked to the brain, which immediately will begin the producing of stress hormones if the environment in any way is perceived as unpleasant.
Thus a soothing and relaxing environment designed from knowledge of the specific factors implicit in healing architecture and their impact on the human being, will affect the body positively and help prevent the production of stress hormones. [Dirckinck-Holmfeldt et al., 2007]. Additionally, many cancer patients are at risk of developing a serous depression, why for instance an optimisation of the lighting in the centre will be beneficial for the users.

In relation to the staff, the concept of healing architecture concept can also have a great impact on the working environment, as it can improve the psychosocial environment and increase the productiveness. This has proven to further have an improving effect on the well-being of the patients and their relatives, which again has a positive effect on the staff. [Frandsen et al., 2009]

Ill. 33.1: The cancer treatment unit at Rigshospitalet is in the basement, why light only enters from the top, creating a diffusely lit space with dark corners.

Ill. 33.2: Interior view from Rigshospitalet. Hard, rough materials and dull, grey tone colors characterize the space. The space is poorly lit and the dark, low ceiling gives a suppressing, heavy expression.

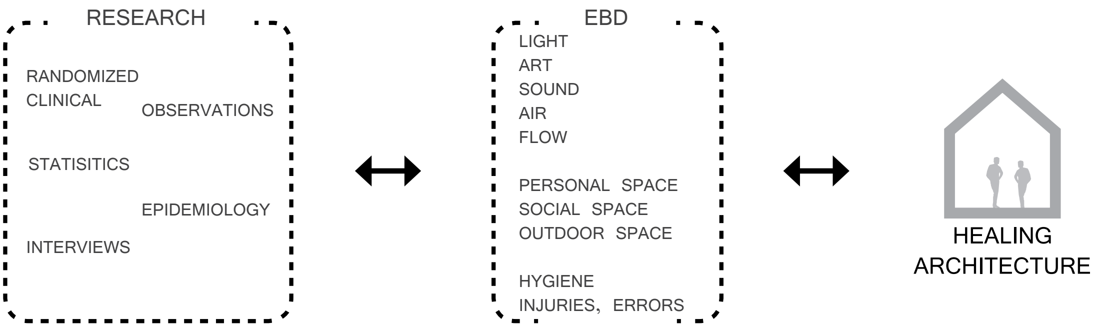
Ill. 33.3: Exterior view from the Maggie's Cancer Caring Centre, London. The centre is designed by architect Richard Rogers.

The cancer patients receive their medical treatment at Rigshospitalet, which is a typical, insensitive hospital environment. The Cancer Health Care Centre will be a retreat from this and be a place for the cancer patients to go before, after or in between treatments, why a uplifting, inspiring environment that can relax and sooth the patients and reduce and relieve their stress, anxiety and depression seems to be a relevant and important aspect in their overall course of recovery.

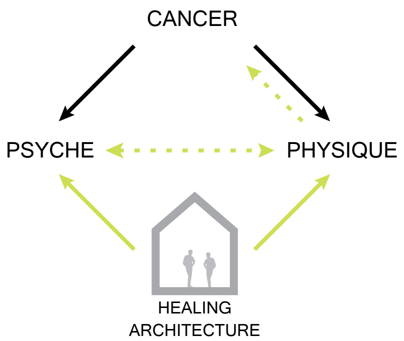
Ill. 33.4-5: Interior views from the Maggie's, London. The spaces are well lit from several sides and with qualitative materials creating a warm, bright atmosphere.

THE CANCER HEALTH CARE CENTRE AND THE CONCEPT OF HEALING ARCHITECTURE

Cancer patients suffer from psychological and physical conditions, such as stress, depression, fatigue and pain.
This worsens their quality of life and has negative impacts on their recovery.
Is seems evident that the patients will benefit from a Cancer Health Care Centre as a supplement to the hospital treatment. Here the environment will relax and stimulate the senses positively, and counselling, therapy, courses, creative and physical activities will be offered focusing on rebalancing the patient and the relatives in order to help them deal with the disease and maintain quality of life.
Healing architecture is a relatively new concept and most surveys focus on hospital situations. Yet, they paint a joint picture and imply a way to obtain improved results that are also highly relevant considering the rehabilitation of cancer patients.



Ill. 34.1: Different research form the foundation of evidence Based Design that forms the base of Healing Architecture. [Frandsen et al. 2009]



Ill. 34.2: Diagram showing the idea behind the implementation of the healing architecture design concept in the new Cancer Health Care Centre.

The evidence based design factors are analyzed and elaborated in the following pages, in relation to determine, if and how they can have a positive effect on the cancer patients in the Cancer Health Care Centre.

DESIGN FACTORS

EVIDENCE BASED DESIGN FACTORS

In the following pages different factors from evidence based design will be analyzed in relation to a Cancer Health Care Centre.
Frandsen et al. have in their report about Healing Architecture, listed some architectural factors, which can be altered and influenced through the architectural design and which have been proven on various levels to have an effect on the healing process of patients within health care facilities.
Initially, a diagram from the review of "Helende Arkitektur" by Frandsen et al. is used as a model to gain an understanding of how the factors interplay with the needs of the cancer patients and which architectural settings have an influence on this. From the analysis of the cancer patients different issues are listed, psychological as well as physical side effects and which needs they will imply. (See app. Architectural factors on the cd-rom.)

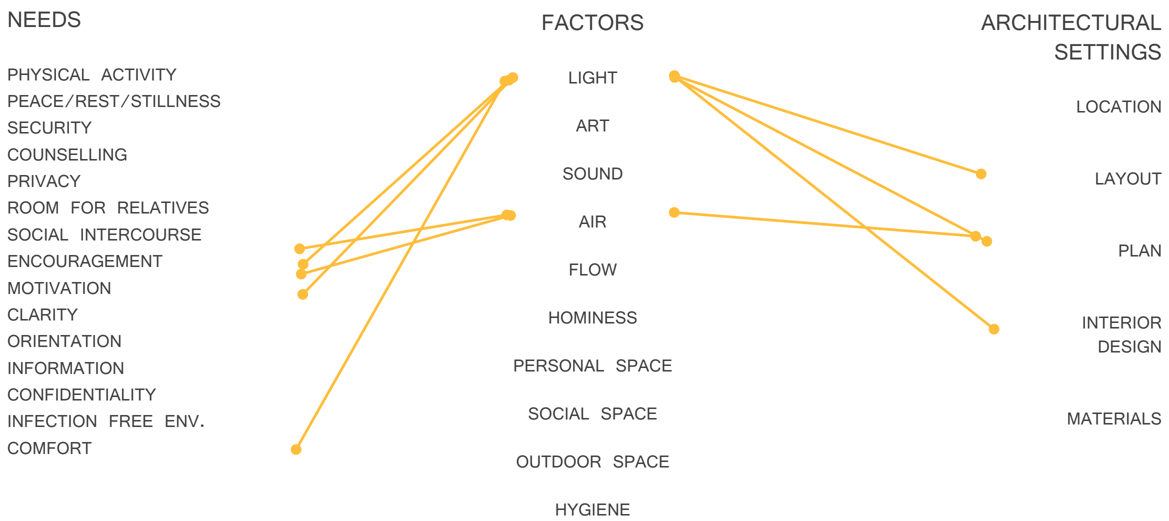
The analysis of the factors results in a delimination, where the factors, which do not seem to have much influence in the regards of the Cancer Health Care Centre, and which do not seem relevant in relation to the level of design in this project, are deselected for further analysis.
The factors of art and hygiene seem of less relevance in this project and are deselected from further analysis.
Art is a factor which accompanies the architecture on a further level, meaning the more detailed interior design phase. Hygiene is also a topic which relates much to hospital environments, where it is of crucial importance. In relation to a rehabilitation centre it seems less important, and also it again relates to a later phase in the design process.

INDOOR CLIMATE

Air is a topic within healing architecture and evidence based design, which is less dealt with and mainly considers the risk of airborne infections in hospital environments or the use of therapeutic odors, which is also outside the level of design in this project.
However, naturally, air in relation to indoor climate, thermal climate and atmospheric climate is of great importance in all buildings in order to create a comfortable indoor environment, and it is also recognized to have a considerable effect on health care outcomes as well, though poorly dealt with in the research.
The indoor climate is of high importance in especially school buildings, and it is a known fact that unfortunate thermal conditions such as too high or low temperatures and bad air quality can cause fatigue, decrease concentration and work performance, and cause headaches, muscle and joints pain as well as reduced mussel function.
For this reason the indoor climate will be treated in the project along with the evidence based design factors, and it will be sought to fulfill the highest level of the indoor climate categories to obtain a comfortable, healthy indoor environment in the Cancer Health Care Centre. This will be further elaborated in the room programme on page 66-69 as well as the appendix 2, page 148-151.

The factors of light, acoustics, flow, personal space, social space and relation to outdoor spaces as well as the indoor climate are found relevant for the project as they all seem to have an influence on the physiological as well as the physical health of cancer patients. They can contribute to creating a calm, secure, comfortable and motivating environment, and help relieve the stress, the anxiety and the depression the cancer patients may feel. These factors will be analyzed and described in the following pages, followed by a summary of the design parameters of this project.

Ill. 37.1: Factors that may positively meet the needs of the users experiencing stress.



Ill. 37.2 Example of light. Diagram of the factors and which needs and architectural settings they have an influence on.

LIGHT

Observational and interview based surveys have proven the fact, that daylight, not independent of windows, is of high importance in health care settings. Patients, relatives and staff all appreciate well lit spaces and daylight plays an important role in their wellbeing and satisfaction and the overall experience of a physical environment. [Frandsen et al., 2009] Much research revolve around how daylight seems to be pain reducing, mood elevating and sleep improving, and in many cases result in lower duration of hospitalization, reduced use of pain medicaments and less experienced stress. Furthermore, improved daylight qualities in hospitals have proven to have a significant effect on medication and journalization errors as well as injuries among patients and staff. [Frandsen et al, 2009]
Cancer patients often suffer from increased stress, depression, insomnia or fatigue as well as an impaired immune system. Hence, the evidence based design in relation to light quality in the Cancer Health Care Centre will mainly concentrate on results in relation to these health conditions, but naturally also the work conditions of the staff.

Light affects the human being through the eye and through the skin.
Skin exposure to light is related to the vitamin D production in the body, thereby affecting several mechanisms within the body, such as strengthening the immune system, the memory and the cognitive ability.
Eye exposure to light has an effect on the human being, physiologically as well as psychologically. Light affects the circadian rhythm, meaning the 24 hour cycle of the human body, as the retina's exposure to light is directly connected to the melatonin suppression in the body. The light exposure can be said to be what synchronizes the body to the day cycle and assures the timings of physiological rhythms. Less light increases the melatonin level, or in other words fails to suppress it, and one feels sleepy, lazy and ineffective. The light exposure during the day has proven to have a major effect on the sleep quality during the night. Also it is becoming more and more evident, that light/dark cycles regulate many human behaviors including seasonal depression, sleep patterns, body temperatures, brain activity and performance. [Rea 2002] When it comes to the psychological effect of light, is has not been fully understood how eye exposure to light can improve mood and help work as a treatment against depression. There are assumptions that the circadian rhythm is closely related to the systems in the body that control the levels of serotonin and neropinephine, which are implicated in depression and often are what antidepressant medicaments need to increase. [Sloane, Figueiro & Cohen 2008] [Rea 2002]

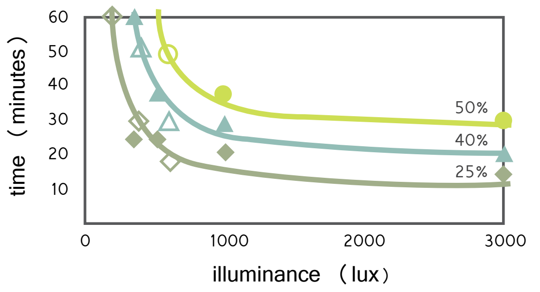
Two aspects occur, when dealing with light: light for vision and light for therapy. (See ill. 39.2) Investigations show, that where certain levels of illuminance is adequate for vision, it has no therapeutic effect, meaning it is not light enough to suppress the melatonin level and synchronize the day cycle, or improve the mood and decrease depression. The light conditions in the Cancer Health Care Centre is to consider work conditions for the staff as well as for visitors, but also to consider the light as a therapeutic factor in the building. [Rea, 2002]

In general, the recommended minimum light therapy is 2500 lux of white, broadband light at the cornea for a 2-hour exposure or as much as 10,000 lux for a 30-minute exposure. [Sloane, Figueiro & Cohen, 2008, *Dose and Application*]

As with other research within the field of healing architecture, the studies made are of various qualities and they should be considered from the fact, that they together show a pattern, that through exposure to intensive, bright light at certain durations a day, the patients sleep rhythm improves as well as mood disorders such as depression progresses positively. It is important to consider the risk for glare and discomfort, in which case it is most likely to lose its effect, as people would squint, hence become tense and feel uncomfortable. [Sloane, Figueiro & Cohen 2008]

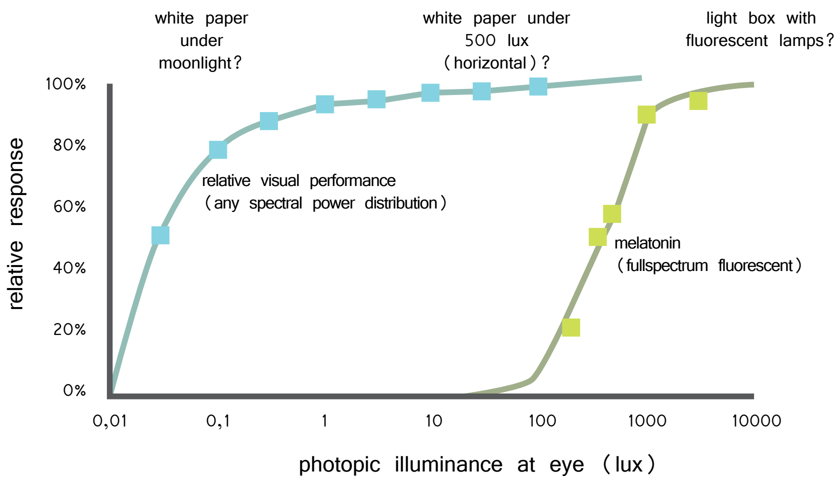
Some surveys state, that the timing of the light plays an important role in the effect. Light in the morning, following the daily rhythm of the patient, can increase the mood and shortens the time for the antidepressant to work. [Franden et al. 2009]
Light therapy is in most studies treated from the perspective of artificial lighting however it is also found that natural daylight can have a large effect. Some surveys state, that a half hour walk outside can also have positive results. [Sloane, Figueiro & Cohen 2008]
Retrospective surveys further describe how patients living in East facing or very bright rooms have turned out to have shorter hospitalization periods. Also in terms of pain and stress, it has been described in a survey, how patients in east facing rooms compared to west facing rooms, used less pain reducing medicaments and had less experienced stress. [Franden et al. 2009]

In regards of cancer patients it should be taken into careful consideration, that some may be sensitive to large amounts of direct light, why it is important to avoid this in the building.



Ill. 39.1: The amount of time required for the melatonin level to be suppressed by 25%, 40 % or 50%, as a function of the illuminance level at the eye. [Rea 2002]

The surveys paint a common picture, that exposure to high intensity light, natural as well as artificial, for a few hours a day, will have a positive effect in relation to mood disorders and sleep rhythm. The timing of the light will be difficult to take into consideration in the Cancer Health Care Centre, as it is a drop-in centre, where people would come a different hours in the day. However, it can be assumed that bright light during the hours spent in the centre will have an improving effect on the cancer patients feeling of fatigue, insomnia, de-motivation, depression and woriness.



Ill. 39.2: Relative visual performance for high contrast reading material, and relative melatonin suppression by light as a function of the illuminance at the eye. [Rea 2002]

LIGHT QUALITY

Light has been investigated as an evidence based design factor and it has been described how it has a healing effect on fatigue, pain and depression, commonly experienced by cancer patients. Accordingly, the following section seeks to define qualitative aspects of light in order to obtain a general understanding of qualitative lighting in architecture in relation to atmosphere and expression.

Light is highly influential in our perceptions of space. The exact same light can accentuate very different expressions trough a change of light, openings and position. [Rasmussen, 1989]
There are two sources of light in architecture; natural daylight (including skylight and reflected light) and artificial light. The last is controllable whereas the first is ever changing. Daylight has an ability to bring life into an environment through a constant change from morning to evening, throughout the year in color as well as in intensity, creating an infinite variety of movements and effects such as color, textures and contrasts. Surveys suggest that people generally prefer rooms with windows indicating that daylight creates a more pleasant and satisfactory interior than electric light. [Stidsen et al, 2009] [Rasmussen, 1989] [Major et al, 2005]

LIGHT AND COLORS

Daylight or solar radiation includes several colors defined by their wavelengths. The color characteristics of light is described through color temperatures in Kelvin and the color rendering index (Ra-index). The color temperature of a particular light represents the temperature a black surface should have in order to emit light precisely matching the color of the particular light.
A blue sky seen from shadow has a temperature of approximately 11000 K, average sunlight has a temperature of 5000 K, indicating that warm colors of light does not equal high color temperatures. The color rendering index represents, how easy it is to recognise color in the examined light and has an index of 1-100, where daylight has 100 because it includes all colors of the spectre.
[Johnsen & Christoffersen, 2008] [Wikepedia.org, *farvetemperatur*]
Colors have proven to have a great psychological effect on human beings.
The color red can cause an increase of the blood pressure and stimulate the brain whereas blue has the opposite effect. Green and orange are associated with cheerfulness and vitality and often chosen as the preference color for physically and psychologically exhausted people. [Major et al, 2005]
A survey conducted at a hospital recommends a pleasant in-house-lighting for patients which in most cases include color temperatures not higher than 3000K and a fairly good light color index higher than 80, meaning a rather warm colored light with good color renderings.
Another survey concludes that designing artificial light to represent natural daylight through variations over day and year induced satisfaction amongst the working staff, and significant energy savings. [Stidsen et al,2009]
However the lighting color and strength should be adjusted to the specific functions taking place in the room as low illuminations levels are preferred in warm lighting colors and high levels are preferred in light with cold colors.

Langen Museum By Tadao Ando

House 205 by H architects

"No space, architecturally, is a space unless it has natural light", Louis Kahn. [Major et al, 2005]

Simonkappeli chapel by K2S Architects LTD.

Kunstmuseum by Peter Zumthor

ill. 41.1-41.4. Pictures showing examples of different atmospheres created through various colors of daylight illuminating the rooms. The color of the light is both influenced by the time of day, the season and the materials in the rooms reflecting the light.

ill. 42.1. Church of light by Tadao Ando. The room is defined by contrasts created between the bright crucifix in the back wall of the church and the dark materials on the floor and walls.

ill. 42.2. Can Lis by Jørn Utzon. Thick walls break the sunlight, and lets in soft, diffuse light, contrasting the clear ray of sunlight revealing the course of the day.

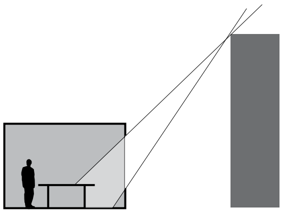
ill. 42.3: Chapel of reconciliation, by Reitermann & Sassenroth. The golden color of the daylight illuminating the chapel is created by the soft materials wood and clay. The direction of the light emphasizes the rough texture on the clay.

LIGHT AND MATERIALS

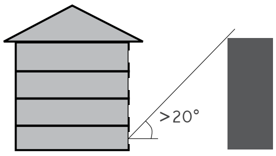
Additionally to the color of the light, surfaces struck by light affect the quantity and quality of light through textures and colors. Neither is visible to the human eye until light and materials come together, which makes them inseparably interconnected.
Color is determined by three aspects; hue, value and intensity. Value determines how much light is absorbed by the material and how much is reflected. A white wall reflects about 82 percent, as opposed to a dark green or blue of only 7 percent. Hue is the color, and when light strikes colored surfaces it adopts the hue, changing the color of the reflected light. Intensity is the brightness of the hue, which is changeable by adding white or black.
Consequently, materials can change the color of the light and the level of illumination and alter the experience completely, and the experience of materials may change through the day as light quantities change.
The texture of the surface has an impact on the reflection of light. Glossy finishes reflect light like a mirror, whereas matte surfaces usually reflect light in all directions. Rough surfaces both reflect and create contrasts of light and shadow, emphasizing the depth of the material. This however requires that the light strikes the material from the sides. [Millet, 2006] [Rasmussen, 1989]

SHADOWS

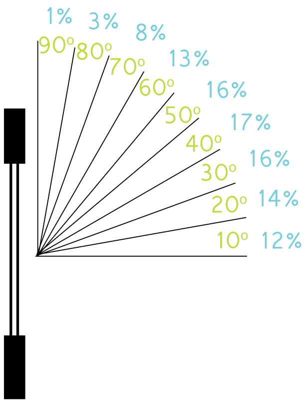
The definition of qualitative light is light that allows one to experience and perceive shapes and spaces, meaning the optimal light creates lighter and darker areas that emphasize the shape of a room or an element. Thus light should provide a room with shades for optimizing the perception of shape. Shade provides several visual informations of time of day and climatic conditions, direction, intensity and movement of the light. Light is always present within shadows, which have the same possibilities as light to create variety, texture and expressions. Shadows can create the feeling of privacy and anonymity, why it can be a powerful tool to obtain certain atmospheres within architecture.
The Church of Light by Tadao Ando is an example where contrast between light and darkness creates an atmosphere of contemplation and stillness, directing all focus towards the lit cruciform, defining the space and varying the expression through time of day and season. (see ill. 42.1)
The contrast of light and shadow should be related to the functions and the activities taking place. The eyes are adaptable to minor sudden changes in light intensity and it is possible to see in low levels of light such as moonlight as well as high levels, as in sunshine. The adaptation process is relatively slow, and a room with high contrast would blur the lighter as well as the darker parts of the room possibly causing strain and glare, which should be avoided in the design of the architecture. [Rasmussen, 1989], [Major et al,2005]



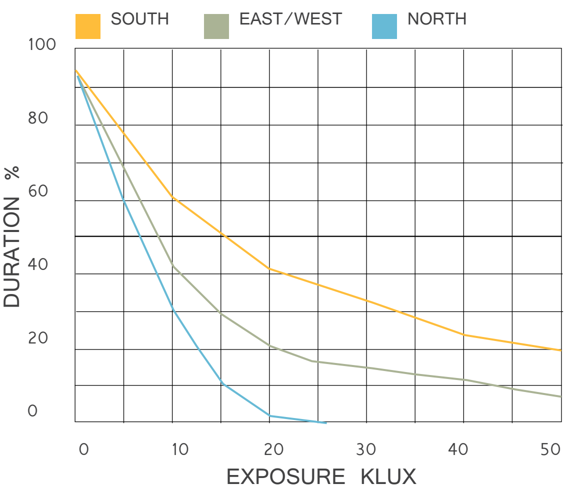
Ill. 43.1 Sky limit plane. Diagram showing the area of the room that will receive direct light. The area behind the sky limit plane will often seem dark and unsatisfactory lit.



Ill. 43.2 Angle of height. If the angle is above 20 degrees to the opposite buildings roof top the access to daylight will be significantly reduced.



Ill. 43.3 Diagram of the contribution from every angle sector of the sky to the total transmitted sky light from a CIE-overcast sky striking a vertical surface.



ORIENTATION

To utilize daylight in architecture it is important that an adequate amount of light reaches the openings of the building, depending on the orientation, the layout, window sizes and shadow cast from surrounding buildings or elements.

The surrounding built environment has a profound impact on the amount of daylight entering a room, especially if the light enters through vertical windows. 2/3 of the skylight entering vertical windows is in the angle of 0 to 45 degrees. If surrounding buildings block the sun in this range, the daylight income will be severely lowered. (see ill. 43.1-3)

The depth of a building has great impact on the possibility to utilize daylight. A slim building layout with openings in each side will have a greater utilisation of daylight compared to a compact building layout, where the daylight cannot reach the middle of the building, resulting in high contrasts and enabling glare.

High placed windows allow the possibility for the daylight to reach further into a room creating more equal lighting levels. However, high windows also often imply risk of glare, why shading is necessary, which again reduces the incoming light. Rooms lit from vertical openings are often preferred as the light slates downward and reflects in the exposed surfaces, creating a mixture of diffuse and direct lights, easing the perception of space and shapes. Accordingly, implementing reflecting surfaces in side lit rooms will help illuminate greater parts of a room and soften the direct light entering from the windows.

Skylight can be implemented to ensure an adequate amount of light and an even illumination level.

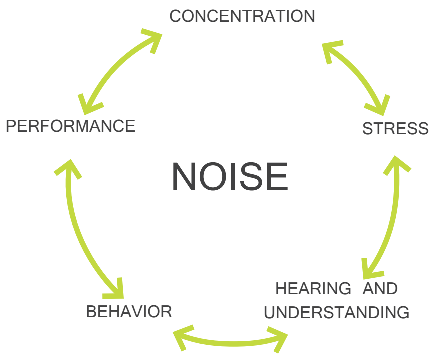
Yet, the implementation of skylights should be moderate as they produce diffuse light that blurs shadows and creates a plastic effect.

The amount of light exposure is dependent on the orientation of the windows and the time of year. East and West orientated windows will receive approximately the same amount of light, whereas Southern orientated windows receive the largest amount of incoming daylight. An implementation of solar screens towards especially South will be necessary to control the solar heating. North facing windows receive the smallest amount of light and the light is diffuse lacking shadow casts and character. However, this light is suitable for functions requiring even illumination, such as offices, ateliers and museums, and furthermore it needs no shading. (See ill. 43.4) [Johnsen & Christoffersen,2008]

Ill. 43.4 Diagram of the average duration a year of the global illuminance on a vertical plane of different orientations in the period 8am-6pm. A South facing plane is illuminated 10000 lux 60% of the time, whereas a North facing one is lit only 30% of the time. [Johnsen & Christoffersen, 2008]

ACOUSTICS

Hearing is one of the senses that constitute the human alert system and contrary to the eyesight it cannot be turned off. Accordingly, unpleasant noise has a negative effect on people bringing psychological reactions such as irritation, fatigue, inattention and low pain threshold.
Consequently, it has been found highly relevant to implement sound or the reduction of noise as a design parameter in the process of designing a Cancer Health Care Centre considering the impact cancer has on the users of the new centre concerning both physical and psychological reactions entailing a need for a relaxing and soothing environment that helps reduce stress and anxiety (see ill. 44.1).



Ill. 44.1: Diagram showing some of the negative effects noise may have on people.

NOISE AND STRESS

Noise affects all people, well as unwell, and it has been proven to negatively affect the immune system.
Surveys suggest that noise of more than 50 dB activates the production of stress hormones, thus implicitly affecting the efficiency of the immune system, which especially for cancer patients is assumed to be an important part of the recovery process. Additionally, noise has been proven to provoke the experience of pain through a lowering of the pain threshold.
Ill. 44.2 shows a diagram of different sound levels and the physical damage they may cause, starting at 65dB which is a little higher than other surveys suggest, however is can be concluded that the noise levels at a minimum should be kept under 65dB to obtain a relaxing and stressless environment.

There are different types of noise prompting different psychological reactions. The body relatively quickly gets accustomed to constant noise, whereas sudden noises such as telephones ringing, load speaking or yelling immediately will cause an activation of stress hormones. However, the exposition to constant noise still has a negative psychological effect on the body inducing irritation, fatigue and despondency which for staff working at hospitals has been proven to affect the psychosocial working environment and efficiency. The working environment in hospitals is generally more hectic than in the Cancer Health Care Centre.
Furthermore, the machinery and alarm systems contributing to creating high noise levels will not be present in the centre. Yet, noise may just be caused by bad room acoustics creating long reverberation times for speech which often implies louder speech or by the lacking of implemented building acoustics allowing external noise such as traffic to enter the building. [Dirckinck-Holmfeldt et al., 2007]

NOISE LEVEL	DAMAGE
150DB	PERMANENT LOSS OF HEARING
130DB	PAINFUL AND SHOULD BE AVOIDED
110DB	SHORTER INTERTVALS CAUSE DEFECTIVE HEARING
90DB	INTERVALS FOR SOME TIME GIVE TEMPORARY DEFECTIVE HEARING
65DB	INTERVALS FOR SOME TIME GIVE TIREDNESS

Ill. 44.2: diagram showing the damaging consequences of noise. [Kirkegaard, 2004]

CONFIDENTIALITY AND STRESS

In hospitals, surveys conclude that background noise and sound from sound sources irrelevant to the patients may affects both the patient and the relatives prompting feelings like anxiety, stress, worry and lack of privacy. Furthermore patients may withhold important information due to the possibility of being overheard by other patients. [Frandsen et al., 2009] Correspondingly, confidentiality and privacy are very important parameters concerning the Cancer Health Care Centre. The environment of the building should be suited for the wide range of emotions characterizing cancer diagnosed people and their relatives. Additionally, the centre comprises a workplace for the many counsellors enabling the activities provided which implies the need a suitable working environment fulfilling the needs of the employees. This implies an office area separated from the additional activities open for the users of the centre where work related problems or solutions may be discussed undisturbed by the users of the centre. Thus the design of the centre implies an implementation of several different acoustic environments underlining these different possibilities and functions in the centre. [Københavns Kommune, 2009]
Acoustical considerations in relation to the design of the Cancer Health Care Centre are presented in the appendix. (See app. 1, p. 146-147)

Ill. 45.1-2 Radium Hospital, radiation therapy, Oslo.
Pictures showing an example of sound absorbing materials implemented in the walls complimenting overall design of the building.

Noise affects the physical as well as the psychological state complicating the healing process of patients, as it induces stress and affects the psychosocial working environment for the staff. Thus the importance of implementing noise reduction in an early stage of a building design has been found highly relevant in this project of creating a Cancer Health Care Centre, that can support the healing process of cancer patients through a soothing and relaxed environment, suppressing anxiety and stress and helping to maintain quality in life despite cancer.

RELATION TO OUTDOOR AREAS

The possibility to see or to stay in a green environment has been proven to affect the psychological and physical well being of humans positively in relation to several factors, why it has great relevance to this project theme of designing a new Cancer Health Care Centre. [Frandsen et al., 2009]

REDUCING STRESS

Several studies of people in non health care situations indicate that real or simulated views of nature produce substantial restoration from stress. This hypothesis has been verified through psychological surveys concluding positive emotional, psychological, and physiological changes and a reduction of negative emotions such as anxiety, worry and anger.
Furthermore, the theory has been documented through physiological investigations proving among others a reduced nervous system activity, an increase of alpha rhythms in the brain, longer time interval between heart beats, and a lowering of the pulse and blood pressure. The positive physiological effects are present within three minutes or as fast as within few seconds in certain systems, indicating the relevance of implementing this parameter in the design of the new centre where the amount of time used in the centre is individual. [Frandsen et al, 2009], [Ulrich et al., 2004]
A study of female cancer patients furthermore show a reduction of anxiety and symptomatic distress by providing them with a virtual nature walk, while in bed or in a hospital room. [Ulrich et al., 2004]
The resistance towards stress and the ability to overcome stress have been proven to be increased for people watching pictures or videos of nature compared to people watching videos of urban environments. [Frandsen et al, 2009]

Other surveys suggest a beneficial restorative effect of providing access to gardens for stressed patients, their relatives and staff working at hospitals. [Ulrich et al. 2008]
Well designed gardens implying peace, the possibility to be private, and areas encouraging to social interaction not only provides restorative views of nature but also induce other mechanisms, such as fostering access to social support, restorative escape, and control with respect to the often stressful clinical environments at hospitals. [Frandsen et al, 2009], [Ulrich et al. 2008]. Furthermore surveys suggest that the implementation of water, green foliage, grassy spaces with trees together with practical things such as chairs, tables and canopies increases the use and the pleasure of using them. [Frandsen et al., 2009]

REDUCING PAIN

Studies additionally indicate that viewing nature may reduce patients pain through increasing the production of positive emotions, reducing stress and distracting patients from focusing on their pain. The theory of distraction indicate that the experience of pain requires extensive conscious attention thus if patients are diverted by a pleasant distraction such as nature views, their attention will not be solely focussed on their pain, why the experienced feeling of pain is reduced. The more engaging the environmental distraction the greater the pain reduction [Ulrich et al. 2008]
Several surveys both psychological as well as physical are emphasizing the theory of nature views lowering pain indicated through less use of pain medication and higher pain thresholds in patients.

Ill. 47.1 Radium Hospital, Oslo by Henning Larsen Architects. Here there is a close relation to the outside nature creating a calm and relaxing view.

The view of nature has a positive effect both psychologically and physically on all people in relation to stress and pain reduction why the implementation of view and access to nature is highly relevant in this project. Especially considering the course of creating a soothing and relaxing environment for both users, relatives and staff reducing the stressful emotions often following in the wake of the diagnosis. Many cancer patients suffer from physical side effects from the disease or treatments such as pain and swelling of the legs, feat, arms and hands together with joint and muscle pains causing discomfort indicating the importance of implementing views to nature as a natural pain distraction easing the pain experiences. [Hansen, 2010]
The building layout should be focused on emphasizing the connection to the green recreational area bounding the site to the North creating several possibilities for access encouraging the use of it. Additionally, the view of nature should be provided in most rooms increasing the soothing effect of the surrounding nature.

FLOW

Research regarding flow and locomotion in relation to healing architecture is mainly relevant in hospital architecture, as it is often large, complex buildings with extensive navigation systems of signs and numbers.

Way finding problems have proven to cost much time and thereby money in health care buildings, as the staff often needs to show visitors and patients the way around. Moreover, it often results in stress and disorientation for the visitors and patients, which only underlines the distress already felt from being in a busy hospital environment. [Ulrich et al. 2008] A simple and uncomplicated plan can ease the navigation within the building. Plans with many 45 degrees corners tend to be more complicated to navigate in, than plans based on parallelism with a clear main orientation direction. [Frandsen et al. 2009]

The Cancer Health Care centre is a small building compared to a hospital, but it is still relevant to consider the level of clarity and transparency in terms of navigation in the building and more specifically the entrance of building, in order to ease the visit to the centre and avoid that the visitors feel distressed and uncomfortable. These issues have much focus in the project brief, as the centre should be inviting and welcoming. The visitors should be comfortable to enter and not feel disoriented or exposed, why the entrance area should be visible, give an overview of the building and not be institutional. [Københavns Kommune, 2009]

Ill.48.1: Hospital in Vestfold, Norway by C. F. Møller The entrance hall gives a clear overview of where to go, as it provides a vertical view within the building.

PERSONAL AND SOCIAL SPACE

The discussion about privacy and sociality in relation to healing architecture mainly focuses on hospital wards being designed with single – or multi bed rooms.
In relation to the Cancer Health Care Centre it is, however, relevant to understand the importance of privacy and confidentiality as well as social interactions.

Personal space describes the privacy a patient and the relatives can feel within a health care facility, either because it is physically bounded by walls or because it is a space, where one can be alone, where one can be in control and keep ones belongings. [Frandsen et al. 2009]
The possibility for privacy is important in order to build up a confidential, faithful relationship between the patient, the relatives and staff. Additionally, the social relationship between a patient and the relatives plays an important role in the healing of the patient, as well as in the recovery of the whole family. As mentioned in the section of acoustics, privacy in relation to consultation and counseling is of high importance, as many patients withhold information, if they feel others can hear them. It can likewise cause distress to hear others'

personal conversations and to gain unwanted medical information which may also apply for oneself. [Ulrich et al. 2008]

Social space describes the communication and social interactions within a health care environment between patients, relatives and staff.
For the relationship between the patient and the relatives to be optimal, the health care settings need to provide private spaces for the family to be alone together and to do everyday things together.
Social interactions among the patients have proven to be important, as conversation with others in the same situation can help reduce stress, anxiety and fear.
It has further been proved through research, that social interactions involving social activities such as cooking and dining have had a great impact on patients' energy level and healing process. [Frandsen et al. 2009]
Relations between the staff and the patients are important, as the staff can help reduce anxiety and stress among the patients. It has been concluded that it is of high importance to the patients, that they can easily get in touch with the staff and that they seem present and available. [Frandsen et al. 2009]

The planning and the interior decoration are important in relation to optimize the health care settings for privacy as well as social interactions.
It is important to create spaces for people to be private, facilities, where they can keep their belongings and spaces, where they feel a bit in control. Private spaces also comprise spaces to be alone with one's relatives or closest friends.
Furthermore it is important to create common spaces for social interactions, for smaller or larger groups. The common spaces should reflect and accommodate everyday activities, as these are easy to access and take part in even if people are unfamiliar with each other. Also casual arrangements with movable furniture, carpets and an overall homey atmosphere seem to foster social interactions in a positive manner. [Frandsen et al. 2009]

INDOOR CLIMATE

The indoor climate, comprising thermal as well as atmospheric conditions, has a great impact on the wellbeing and comfort as well as the experience of a building.
It is poorly dealt with within evidence based design and healing architecture, but it is stated, that it is of high importance. Furthermore it seems likely, that poor indoor climate conditions would interfere with the effect of the other evidence based design factors, as one cannot turn off the senses and would feel uncomfortable in the wrong conditions no matter the qualities of other architectural factors.
Unfortunate indoor conditions, such as uncomfortably high or low temperatures or bad air quality can affect work performances, mood as well as the physical wellbeing.
This is of even further importance, when dealing with cancer diagnosed people, who as a result of their disease already suffer from multiple conditions.
For this reason, the Cancer Health Care Centre should provide a healthy, comfortable indoor climate, why the indoor climate category A is chosen as a design demand, as it is the highest and most qualitative, and the ventilation rates are based on the CO^2-pollution in the different rooms, giving a more precise estimate of the need for ventilation in regards of the activity, occupation and room volume of the particular room. (See app. 2)

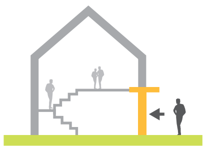
EVIDENCE BASED DESIGN FACTORS IN THE CANCER HEALTH CARE CENTRE

Cancer patients suffer from side effects from the cancer disease and the treatment, and the conditions are psychological as well as physical comprising stress, fatigue, depression, pain and anxiety.
It is found highly relevant that the Cancer Health Care Centre is designed so it can relieve these conditions and help the patients in their healing and recovery from their disease.
Evidence from different research within healing architecture proves certain architectural elements' effect on health care outcomes. The factors of light, acoustics, relations to nature flow, personal and social space as well as a qualitative indoor climate are important in relation to the Cancer Health Care Centre, as they have proven to relieve and decrease conditions like those experienced by cancer patients.
From the analysis of the factors some design parametres are listed forming the base for the design process.

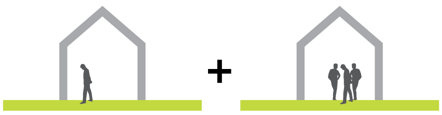
VIEWS AND ACCESS TO NATURE RELIEVES STRESS AND PAIN.

GOOD DAYLIGHT QUALITY, MIN. 500 LUX, CREATES A GOOD WORKING ENVIRONMENT.

HIGH INTENSITY LIGHT, 2500 LUX FOR 2 HOURS, RELIEVES DEPRESSION AND FATIGUE.

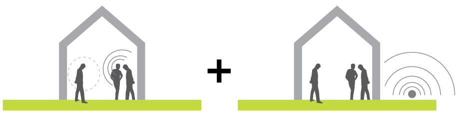


CLEAR PLAN, VISIBLE ENTRANCE AND GOOD OVERVIEW MAKES THE PLACE INVITING AND MANAGEABLE, REDUCING STRESS AND ANXIETY.



PRIVATE SPACE IMPROVES CONFIDENTIALITY AND RELIEVES STRESS AND ANXIETY.

SOCIAL SPACE IMPROVES SOCIAL INTERACTIONS AMONG PATIENTS, FAMILIES AND STAFF, RELIEVING STRESS, ANXIETY AND DEPRESSION.



LOW INTERNAL NOISE LEVEL IMPROVES CONFIDENTIALITY AND PRIVATE SPACES, REDUCING STRESS.

LOW NOISE LEVELS FROM EXTERIOR SOURCES REDUCES STRESS AND ANXIETY.

Ill. 50.1-5: Diagrams of the evidence based design factors integrated as design parametres in the project.

Five cases of cancer centres are studied in the following: Four Maggie's Cancer Centres in Scotland and the Danish Cancer Counselling Centre of Hejmdal, Århus.
The centres are studied together in relation to the evidence based design factors and the architectural settings described in the previous pages, in order to gain an understanding of how different parameters are integrated to obtain a healing environment and a relaxing, soothing atmosphere.

CASE STUDIES

CANCER CARING CENTRES

The vision of the Cancer Health Care Centre in Copenhagen is build on the concept of the Maggie's Centres, founded by landscape architect and cancer patient Maggie Keswick Jencks. She found the need for a place of a domestic atmosphere, that could help cancer patients deal with other, not medical, aspects of their disease, where they could take an active role in their course of disease, get help with information, stress reducing strategies, psychological support as well as get social support from other cancer patients. [Jencks, 1995] Some general parameters characterise the architectural brief of the Maggie's Centres. The centres are located closely to the hospital making them easily accessible. They are flexible and have a homey atmosphere with versatile, movable furniture, a fire place, and domestic functions, such as a kitchen, serving as the main social space, where people can meet casually, as well as a sitting room. They have office space, easily accessible but not dominating, an information search area with a computer and library, a therapy room for lectures and relaxation classes as well as counselling rooms. The spaces are bright, accomodate privacy and confidentiality as well as sociality, and there is close connection to the outdoors, as in a garden or terrace.
The Maggie's centres are of small scale, making them intimate and underlining the domestic atmosphere. The Cancer Health Care Centre of Copenhagen will be of a much larger scale, why the intimacy can be difficult to obtain. The Cancer Centre of Hejmdal, Denmark, is an example of a centre of bigger scale, why it is an important reference.

MAGGIE'S EDINBURGH

THE CENTRE IS FROM 1996, BASED ON AN EXISTING STABLE BUILDING ON THE WESTERN GENERAL HOSPITAL GROUNDS, AND HAS BEEN FURTHER EXTENDED IN 1999. DIFFERENT STYLES ARE EXPRESSED IN THE CENTRE THUS IT LACKS A CLEAR ARCHITECTURAL CHARACTER. THE CENTRE OPENS UP TOWARDS NORTH AND IS MORE ENCLOSED TO THE SOUTH, BECAUSE THE BUILDING SITE IS SMALL AND ENCLOSED. BECAUSE OF THE EXISTING BUILDING LAYOUT, THE SPACES ARE NOT VERY FLEXIBLE, BUT THE KITCHEN IS OPENED UP VERTICALLY AND HORIZONTALLY AND GATHERS THE BUILDING.

MAGGIE'S DUNDEE

THE CENTRE IS THE FIRST NEW BUILD CENTRE FROM 2003, DESIGNED BY ARCHITECT FRANK GEHRY. THE CENTRE HAS A SOFT EXPRESSION AND A PLAYFUL CHARACTER FROM THE WHITE, CURVED WALLS AND THE SPECTACULAR FOLDED ZINC ROOF, WHICH TOGETHER WITH THE LIBRARY TOWER GIVES THE CENTRE A SIGNIFICANT SILHOUETTE ON THE HILLTOP OVERLOOKING THE TAY ESTUARY AND NORTH FIFE. THE CENTRE IS DESIGNED FROM ITS FUNCTIONS AND THE PLAN IS SIMPLE AND FLEXIBLE, WITH THE SPACES NATURALLY FLOWING FROM THE CENTRE OF THE BUILDING, CURVED, LIGHT AND ALL GATHERED UNDER THE SIGNIFICANT WOODEN ROOF STRUCTURE.

MAGGIE'S FIFE

THE CENTRE IS DESIGNED BY ARCHITECT ZAHA HADID AND OPENED IN 2006. IT IS LOCATED ON THE EDGE ON A STEEP SMALL VALLEY, ENCLOSED BY TALL HOSPITAL BUILDINGS.
THE EXTERIOR IS A DARK SHARP FORM, OPENING UP WITH ENTRANCE WAYS AND GLASS FACADES TOWARDS SOUTH AND NORTH. THE INTERIOR CONTRASTS THE EXTERIOR, AS IT IS BRIGHT AND THE SPACES DIVIDES WITH CURVED WALLS WITHIN THE SHARP TRIANGULAR SHAPE. THE PLAN IS SIMPLE AND DIVIDED INTO TWO: AN OPEN FLEXIBLE SPACE AND AN BACKBONE OF ENCLOSED ROOMS.

MAGGIE'S HIGHLANDS, INVERNESS

THE CENTRE IS DESIGNED BY THE ARCHITECTURAL OFFICE, PAGE/PARK AND OPENED IN 2005.
IT IS LOCATED BETWEEN THE HOSPITAL AND A MAIN ROAD, BUT BUFFERED BY A GARDEN.
THE EXTERIOR IS CHARACTERIZED BY THE GREEN COPPER FACADES AND A CURVED, SPIRAL SHAPE. THE INTERIOR IS OF WOOD, BRIGHT AND WARM, WITH CURVED SPACES IN A SIMPLE LAYOUT. IT MELTS TOGETHER WITH THE EXTERIOR, AS WALLS CONTINUE AND SPACES REACH IN AND OUT, WOOD AND COPPER MEETING. A SCULPTURAL GARDEN RESEMBLE THE CURVES OF THE BUILDING, UNDERLINING THE EXPRESSION.

COUNSELLING CENTRE HEJMDAL, ÅRHUS

THE CENTRE IS A COUNSELLING CENTRE AND IS BASED ON THE IDEA FROM THE MAGGIE'S CENTRES. IT OPENED IN 2009 AND IS DESIGNED BY ARCHITECT FRANK GEHRY. IT IS TWICE AS BIG AS THE MAGGIE'S CENTRES, AND IS BASED ON AN EXISTING PORTER HOUSE. THE INTERIOR HAS BEEN REPLACED BY A THREE STOREY WOODEN STRUCTURE CHARACTERIZED BY LARGE WOODEN TRUNKS IN A IRREGULAR SYSTEM THAT GIVE SHELTER AND REFLECT THE LIGHT FROM THE GLASS ROOF. THE SPACES ARE IRREGULAR AND OVERLAP EACH OTHER DIFFERENTLY, CREATING INTIMATE AS WELL AS DOUBLE HIGH SPACES. THE CENTRE HAS A LESS SIMPLE PLAN, BUT THE VERTICAL SPACES THAT CONNECT THE FLOORS GIVES AN OVERVIEW.

DUNDEE ▶

FIFE ▲

EDINBURGH ▼

HEJMDAL ▲

INVERNESS ▶

LIGHT

Qualitative daylight conditions is of high importance regarding the experience and atmosphere of a room. Furthermore daylight affects the physical health of people as it can be pain reducing, mood elevating, sleep improving and reduce experienced stress.

LOCATION & LAYOUT

The orientation of the different Cancer Health Care Centres have a great influence on the lighting qualities and experience of the varying rooms. The centres in Five and Dundee both have rather large window areas facing South creating a bright and well light environment characterized by changing lights and shadows. However the spaces have a tendency to be overheated mainly during winter months when the sun is low in the sky. This is especially a problem in the centre in Fife as the whole South facade is in glass with a relatively small overhang leaving the common room facing South fully exposed to the sun all day during winter.(See ill. 55.5-6) In Dundee the windows are smaller and have larger overhangs shielding from the sun and creating a pleasant and well lit environment. (See ill. 55.3) The centres in Inverness and Århus differ in orientation as the daylight enters from all sides through smaller and larger windows creating a character full lighting environment. (See ill. 55.1 & 55.4) In Edinburgh the building site is rather narrow leaving no room for windows facing South. The only light income is from North facing windows and a skylight creating a need for electrical lighting also during daytime. (See ill. 55.2)

PLAN ARRANGEMENT

The interior plan arrangements of the centres have a great impact on the light income and the quality of light. In Five and Dundee the closed rooms containing counselling, activities and toilets face North and the common rooms face South. This creates high contrast in the lighting qualities where the Northern side is fairly dark and the Southern side is very bright creating a possibility for glare and high temperature differences.
In Inverness all closed rooms are facing South and the open common area is facing North, East and West creating a more even and pleasant lighting between the different open and closed functions.
The Hejmdal centre differs in planning and layout from the other centres as the building volume is in three floors connected through double high rooms near the facades. The closed rooms are placed both in the bottom and top floor, but as the light enters from all sides and from a large skylight, they do not seem to interfere with the lighting distribution. However the closed rooms in the bottom floor containing offices all appear rather dark as they are placed in the middle of the room far from the facades. The same applies for the offices in Fife that only have one window facing North towards the entrance gallery, why they appear very dark compared to the rest of the rooms.

MATERIALS

The materials chosen for the centres are very different emphasizing the influence materials have on the lighting qualities of the different rooms.
The interior materials in the Five centre are bright with smooth white walls and polished light concrete floor reflecting the bright light entering the Southern facing common room making it appear almost too bright and on the border to unpleasantly glaring when the sun is shining from a clear sky. (See ill. 55.5-6) The Edinburgh centre is also in bright materials and colors. However, in this case it is an advantage as the rooms are not very illuminated in which bright materials help reflecting the light further into the room. (See ill. 55.2) The centres in Dundee, Inverness and Århus are all in raw wooden materials that seems to diffuse the reflected light as well as giving it a warm glow creating a pleasant lighting environment. (See ill. 55.1, 55.3-4)

ill. 55.1: In Inverness the spaces are well lit from different sides.

ill. 55.3 The Maggie's Centre in Dundee. The light entering from South is diffused by the wooden material creating a warm atmosphere.

ill. 55.4 The Cancer Health Care Centre in Århus (Hejmdal) has light coming from several sides, and open plans letting the light flow.

ill. 55.2 In Edinburgh there is limited daylight.

The cases show the difficulties there can be regarding a North South orientation of a building in relation to temperature differences and contrasting lighting conditions, why it is more appropriate to have light from different sides, which creates a more even intensity.
The interior materials affect the quality of light through reflection why brightly light rooms benefit from wooden materials diffusing the reflected light, and darker rooms benefit from bright colors reflecting the light and brightening the room.

ill. 55.5-6: Maggie's, Fife: There is a very large contrast of light in the building, as the North part is very dark, whereas the common room is very bright, and also there are large temperature differences between the closed rooms facing North and the common room facing South.

ACOUSTICS

Bad acoustic qualities have a large effect on the well being of humans bringing psychological reactions such as irritation, fatigue, inattention and low pain thresholds why this parametre is of great importance regarding Cancer Health Care Centres.

MATERIALS, LAYOUT & LOCATION

The acoustics in terms of reverberation time are generally good in all of the centres.
This mainly has to do with the relatively small scale of the building volumes where furniture and carpets are sufficient to keep the sound reverberation in a pleasant level, regardless off the varying materials.
The location of the centres varies from quiet green areas to more busy urban areas next to a road or a large parking lot. However, none of the centres had problems with external noise entering the buildings, why it must be assumed that sufficient sound reduction was implemented in the building components.

PLAN ARRANGEMENT

The counselling rooms can be closed of in all centres creating privacy and confidentiality.
However, the centre in Fife has problems with the sound distribution, as many of the closed rooms are made flexible meaning the walls can be moved implementing the rooms in the larger common room to the South. The flexibility of the sliding walls and doors have created small gaps allowing sound to pass through the walls decreasing the privacy. (See ill. 57.2) This is especially a problem regarding the toilet and the offices, where the doors are facing the gathering area in the kitchen. There has also been additional changes made in the common room as large curtains have been implemented shielding part of the common area visually as well as acoustically, to allow different activities to take place in the common area at the same time. (See ill. 57.1)
The centre in Inverness has a flexible room used for varying activities such as counselling, art class or sports. The room can be separated from the rest of the common area by thick wooden walls that can be pulled together. (See ill. 57.4)

Ill. 57.1: The Maggie's Centre in Fife. A curtain has been hung up, to make it possible to have group meetings in the common room. However, this does not ensure a sound proof, private space.

Ill. 57.2: The Maggie's Centre in Fife. The flexible walls and doors decreases the privacy in the closed rooms, as they leave small gaps in which the sound can travel.

The relatively small size of all the centres implies a need for flexibility in the room organizations. However the flexibility in doors and walls require special consideration in relation to avoiding sound traveling through the walls, preventing a creation of privacy and confidentiality.

Ill. 57.3: The Maggie's Centre in Dundee. The counselling rooms that can be closed for private conversations

Ill. 57.4: The Cancer Health Care Centre in Inverness. The "walls" can be pulled together creating a more private room for varying activities.

RELATION TO OUTDOORS

The view of nature has a positive effect both psychologically and physically on all people in relation to stress and pain reduction why the implementation of view and access to nature is highly relevant.

LOCATION & LAYOUT

The centres in Dundee, Inverness and Århus (Hejmdal) all have external gardens in close connection with the centres creating a view and the possibility to use the garden during summer months extending the area of the centre.
The main gardens in Inverness and Dundee are sculpture like both underlining the shape of the centres. However, they do not provide shelter or spaces to sit, why they seem more like a piece of art. (See ill. 59.2 & 59.5)
The garden in Inverness is supplemented with a private courtyard, enclosed by a wooden fence providing a quiet buffer zone from the busy road outside, and it is the plan to design a recreational garden in there. Both the centres also have terraces that seems to be in frequent use during summer months as they provide shelter and seating areas in close connection to the interior activities. (See ill. 59.1)

The main garden at Hejmdal is secluded creating privacy for the users of the centre. Furthermore several seating areas are implemented in the garden creating an amphitheater like expression. However the garden is placed to the North of the building, why it will be in shadow most of the time.

The centre in Edinburgh only has a small front garden with a terrace, but it is not of much use as it faces North and furthermore only provides views to the parking lot and the hospital. (See ill. 59.4)
The centre in Fife does not have much space around it as tall hospital buildings surround it. The access is directly from the parking lot and there is no transitional space before entering the centre. However there is a nice view towards South to a small deep valley, and it is the plan to create a garden here. A small balcony is on the South side of the building, but it is also part of the entrance way, why it does not seem very usable in relation to indoor activities. (See ill. 59.3)

Ill. 59.1: The Cancer Health Care Centre in Dundee. A small terrace is placed in close connection to the centre overlooking a scenic view.

Ill. 59.2: The Cancer Health Care Centre in Dundee. The garden is very sculpture like providing no shelter or seating areas

Ill. 59.3: Fife, there is no garden connected to the centre, only a small terrace that also functions as entrance way.

An accessible garden in close connection to the centre, creates a buffer zone between the centre and surrounding functions. Seating areas and shelters in the garden creates a feeling of privacy and can increase the use of the outdoor space.

Ill. 59.4: The Cancer Health Care Centre in Edinburgh. The small garden in front of the centre.

Ill. 59.5: Inverness, the garden is very exposed to a large road, and offers no seating areas.

FLOW

A clear plan, a visible entrance and a good overview makes a building inviting and manageable, why it can reduce stress and anxiety among patients.

LAYOUT

The Maggie's Centres are mainly in one storey enabling a clear overview, but in Edinburgh and Inverness, the offices are located on half second floors overlooking the centres. The centre in Hejmdal has three storeys, why it can be difficult to get an overview.

PLAN

The centres of Edinburgh and Fife have more entrances and there is no clear main entrance, making it confusing where to go in. In both cases the doors lead directly into the open spaces, such as the kitchen, lounge and dining area, leaving the visitor exposed without a chance to get an overview. In Fife the doors are heavy and cannot be opened by weak cancer patients, who often leave thinking the centre is closed. One entrance in Fife has the quality of a small enclosed wardrobe zone, easily leading into the centre. (Ill. 61.1-4)
In Dundee, a path leads from the hospital and the parking lot to the entrance, making it obvious where to go. The centres of Dundee and Inverness are characterized by one clearly marked main entrance leading through a wardrobe room, a transition zone, enabling one to collect oneself and get an overview. (Ill. 61.5-7)
The Hejmdal centre has its main entrance through a staircase and it is confusing to see which floor to go to, if one is a first time visitor, because there is no transitional entrance area.

The Edinburgh centre is in an existing building and is less flexible, but the kitchen is opened up and gathers the centre. In Fife, the plan is divided into the open space towards South and enclosed rooms to the North, with the kitchen in the centre, creating a good clarity of the space.
In Dundee and Inverness the plans are simple and flow naturally from the central entrance area, why it is easy to get an overview (see ill. 61.5). The kitchens are on one side of the entrance, making it possible to choose whether to join the activities here. (See ill. 63.1) The libraries are right ahead from the entrance easy to access, and it is easy to enter and quietly sit in the lounge or by the information desk.
Hejmdal has three floors of open plans with irregular niches and spaces. (See ill. 60.1). The division into several floors seems necessary, as it provides a sense of intimacy to the building, which is of a larger scale than the other centres. Having the vertical open space along the facades further gives a possibility to overlook the activities and by this get an overview. The flow, however, is a bit obstructed, as one needs to go to the lift shaft outside the actual building to get upstairs, which seems unsuitable for disabled people.

Ill. 60.1: In Hejmdal, overlapping floors create vertical connections between the functions, making the building seem smaller in spite of it's larger amount of square metres.

Ill. 61.1-4: Maggie's Fife has three entrances, which is confusing. Two lead bluntly into the centre, but the third one is unexposed.

Ill. 61.5: An open plan with flowing spaces, visible from the entrance room.

A clear visible entrance makes it obvious where to enter. A wardrobe area creates a transitional zone, where the users can collect themselves before entering the building. Not entering directly into the social zones further seems qualitative, as it gives a chance to get an overview of the centre, its people and its activities before choosing whether to participate. Open floor plans and flowing spaces create a clear and transparent arrangement of the building volume.

Ill. 61.6-7: Dundee has a clear path and main entrance with a wardrobe room giving one a chance to collect oneself, unexposed.

PERSONAL AND SOCIAL SPACE

It is stated from the evidence based design factors, that personal and private space improves confidentiality and relieves stress and anxiety, and that social space improves social interactions among patients, families and staff, relieving stress, anxiety and depression.

LAYOUT/PLAN/INTERIOR DESIGN

All the centres have small places for people to sit alone or two or two, but in Edinburgh they do not provide much privacy, as they are very exposed towards the entrance and the kitchen area.
In Fife, there are small sitting areas close to the kitchen and dining, so people can sit alone but still take little part in the activities there. (See ill. 63.1) Also Dundee and Fife have niches close to the entrance area, serving as a buffer zone, where people can easily sit down and get a view of the centre, when entering.

Hejmdal has an irregular plan with many niches, and the three floors disperse the activities in the centre, enabling many private, quiet spots for conversations or contemplation. In Inverness there are no small niches, but in stead two lounges, and toilets facilitated with chairs that function as a private spot where one can go for a cry. The centre lacks spaces that fit in between the very private toilet and the semi social lounge.

People need privacy, when using the information or computer desk. In Inverness it is exposed, placed in the centre of the building. In the other centres it is put aside, in the library or in a corner, where one is sheltered and unexposed.

The kitchens are the main space of the centres, and they are all designed as open, bright spaces with a large dining table. In Edinburgh and Fife as well as Hejmdal, the kitchens are centered in the building why it is difficult to choose whether to participate in the social activities there. However, smaller sitting groups are created around it, enabling one to take part in the social activity on various levels. (See 63.2)
In Inverness and Dundee the kitchens are in one side of the buildings, so people can choose to go in. (See ill. 63.3) This seems comfortable for first time users, but does not offer different levels of participation.

Fife and Hejmdal has small enclosed offices, which seem a bit intimidating to access. In Inverness and Edinburgh, the offices are upstairs, creating a place for the staff to overlook the centre, be alone together and be confidential, but still easily accessible. In Dundee the staff does not have much possibility to retreat or be confidential, as the office is open into the entrance area, like a reception desk, also making it a bit institutionalized.

Ill. 63.1: Fife, seating near the entrance easily gives a chance to enter and unenforced take part of the building, unexposed.

Ill. 63.2: Fife's kitchen, seen from the entrances, is centralised in the building, but has sitting niches close by.

Ill. 63.3: In Inverness the kitchen is set a bit aside from the entrance, and one can choose whether to go in.

Ill. 63.4: Inverness, the lounge is open, but can be closed off for therapy class.

Ill. 63.5: The library in Dundee is a cozy, undisturbed lounge a bit away from the kitchen but close to the entrance.

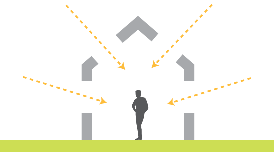
The implementation of small niches near the entrance provide a transitional zone, where people can collect themselves before participating in social interaction.
Seating areas near the kitchen provide various levels of participation in social activities.
In relation to the staff an unexposed staff workstation provide confidentiality for the staff and a place to retreat.

EVIDENCE BASED DESIGN GUIDE

RELATION TO OUTDOORS

AN ACCESSIBLE GARDEN IN CLOSE CONNECTION TO THE CENTRE.
SEATING AREAS AND SHELTERS IN THE GARDEN.

LIGHT



DAYLIGHT INCOME FROM ALL WORLD CORNERS

DARKER WOODEN MATERIALS IN BRIGHTLY LIGHT ROOMS

BRIGHT COLORS IN DARKER ROOMS

AVOID NORTH-SOUTH ORIENTATION

PREVENT GLARE THROUGH SOLAR SHADINGS.

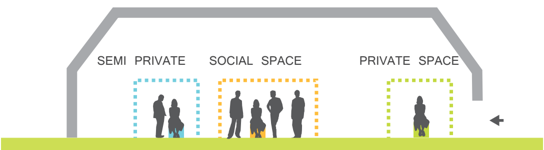
FLOW

A CLEAR VISIBLE ENTRANCE.

AN UNEXPOSED WARDROBE AREA BY THE ENTRANCE. .

OPEN FLOOR PLANS AND FLOWING SPACES.

PERSONAL AND SOCIAL SPACE



SEATING AREAS NEAR THE ENTRANCE CREATES A TRANSITIONAL ZONE. SEATING AREAS ON THE EDGE OF SOCIAL GATHERING POINTS PROVIDES DIFFERENT POSSIBILITIES OF SOCIAL PARTICIPATION.

UNEXPOSED WORKSTATIONS

ACOUSTICS

SOUND REDUCING WALLS AND DOORS SURROUNDING PRIVATE CONVERSATION ROOMS.

Ill. 64.1-13:
Evidence based design factors combined with case studies.

CASE STUDIES

The analysis of the different Cancer Health Care Centres illustrate different ways of creating a relaxing and soothing environment for cancer patients and their relatives focusing on the parameters that influence the experience and atmosphere of a room.

The architectural settings within the visited centres are not founded on evidence based design, but on experiences defined by the cancer organizations in Denmark and Scotland respectively. However, the architecture contains many of the same values as evidence based design, why the case studies provide valuable knowledge of positive and negative parameters in terms of the factors and architectural settings defined through evidence based design.

From the analysis the evidence based design parametres are elaborated in relation to the experiences gained from visiting the centres.

An important parameter in the case of the Cancer Health Care Centre is to consider the scale.

The centres in Scotland are of small scale, making them intimate and domestic. The centre of Hejmdal is bigger, but through the vertical division of the spaces an intimate atmosphere still characterizes the place. However, it is important to obtain a good overview and a clear plan vertically as well as horizontally in the building.

The program of rooms and functions, their requirements and the atmospheric character are presented and described in the following pages.

ROOM PROGRAM

ROOM PROGRAM

The following lists the rooms and functions of the Cancer Health Care Centre and their requirements. The values are based on evidence based design research, the Danish Working Environment Authority for school buildings and day care units, as well as an indoor climate analysis, that has been carried out to estimate values for the thermal and the atmospheric indoor climate. (See app. 2) [Erhvervs- og Byggestyrelsen 2003], [Arbejdstilsynet 2010]
A further description of the interplay between the rooms as well as their atmospheric quality will be described in the following pages.

	ROOM TYPE	REMARKS	NO.	NET M2	TOTAL M2	PERS./ ROOM
ENTRANCE, COMMON AREA	ENTRANCE, KITCHEN/DINING, LOUNGE	EASY ACCESS, OVERVIEW, LEVELS OF INVOLVEMENT	1	80	80	-
	LIBRARY/ COMPUTER AREA	FOR INFORMATION SEARCH - PART OF COMMON AREA	1	25	25	-
	CHILDREN'S PLAY AREA	PART OF COMMON AREA	1	10	10	-
	WORKSHOP	FEMALE: ARTS & CRAFTS,	1	20	20	-
	ACTIVITY ROOM	MALE: TELEVISION, GAMES, POOL ETC.	1	30	30	-
	YOUTH CLUB ROOM	MUSIC, NET CAFÉ ETC.	1	20	20	-
	WARDROBE	GUESTS	2	5	10	-
	TOILETS	STAFF, GUESTS, HC	11	4	44	-
PHYSICAL ACTIVITY	GYM	1 FOR MACHINES, 2 FLEXIBLE - TO BE PUT INTO 1 ROOM (LECTURES)	3	70	210	14-20
	CHANGING ROOMS, BATHS, TOILETS	BY GYMS	2	40	80	-
	STORAGE, CHAIRS	BY GYMS	1	15	15	-
	STOR. EQUIPMENT	BY GYMS	1	20	20	-
COUNSELING, TREATMENT	TREATMENT ROOM	PHYSIOTHERAPY	6	16	96	-
	CONVERSATION ROOM (KK)	FOR SMALL GROUP, BY COMMON AREA	2	10	20	-
	COMBI ROOM (KK)	CONV. ROOM AND MEETING ROOM	2	20	40	8-12
	CONVERSATION ROOM (KB)	COUNSELLOR'S ROOM, GROUP	5	15	75	-
	GROUP ROOM (KB)	POSSIBLE TO SIT IN A CIRCLE	2	25	50	10-12

LIGHT	REV. TIME	SOUND RED.	OPERATIVE TEMP. SUM/WIN	AIR CH.	MEAN AIR VEL. SUM/WIN	ACCESS NATURE	VIEW NATURE	VIEW INSIDE	PERS. SPACE	SOC. SPACE
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,4 S	≥ 48 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	✖	✖	(✖)	✖	✖
INDIRECT, BRIGHT 500 LUX	0,4 S	≥ 48 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	–	✖	–	✖	–
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,4 S	≥ 65 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	(✖)	(✖)	✖	–	✖
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,4 S	≥ 48 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	–	✖	✖	✖	✖
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,6 S	≥ 65 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	✖	✖	(✖)	–	✖
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,6 S	≥ 65 DB	25 ± 0,5 °C / 22 ± 1 °C	5 H^{-1}	0,18 / 0,15	(✖)	✖	✖	–	✖
200 LUX	–	≥ 48 DB	–	–	–	–	–	(✖)	–	–
200 LUX	–	≥ 48 DB	–	0,5H^{-1}	–	–	–	–	–	–
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	1,6 S	≥ 65 DB	23± 0,5 °C /21± 1 °C	7 H^{-1}	0,15 / 0,13	(✖)	(✖)	–	–	✖
INDIRECT 200 LUX	–	≥ 48 DB	28± 0,5°C/ 28± 0,5 °C	8 H^{-1}	0,2 / 0,2	–	(✖)	–	✖	–
–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–
BRIGHT, INDIRECT 500 LUX	0,4 S	≥ 48 DB	28± 0,5 °C / 27± 0,5 °C	3 H^{-1}	0,2 / 0,2	–	✖	–	✖	–
INDIRECT, WARM, DIM 500 LUX	0,4 S	≥ 48 DB	27± 0,5 °C / 25± 0,5 °C	1,5 H^{-1}	0,2 / 0,18	–	✖	–	✖	–
BRIGHT, INDIRECT 500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	8,5H^{-1}	0,18 / 0,15	(✖)	✖	–	–	✖
INDIRECT, WARM, DIM 500 LUX	0,4 S	≥ 48 DB	27± 0,5 °C / 25± 0,5 °C	1,5 H^{-1}	0,2 / 0,18	–	✖	–	✖	–
BRIGHT, INDIRECT 500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	8,5H^{-1}	0,18 / 0,15	(✖)	✖	–	–	✖

COURSE CENTRE	SCHOOL KITCHEN	TEACHING AND COOKING	1	50	50	
	STORAGE, KITCHEN	BY KITCHEN	1	10	10	
	MEETING ROOM		2	20	20	8-12
	LECTURE ROOM	COMBINED BY 2 FLEX. GYMS	-	-	-	80-90
SCIENCE CENTRE	LEADER OFFICE		1	15	15	1
	EMPLOYEES		1	15	15	2
	PART-TIME EMPLOYEES		1	15	15	3-4
	MEETING	CAN BE DIVIDED INTO TWO ROOMS	1	50	50	40-50
MANAGEMENT, OFFICES, STAFF	CENTRE MANAGER		1	15	15	1
	SECRETARY		3	12	36	2
	STUDENT'S OFFICE (KK)		1	20	20	-
	MANAGER OF KB		1	15	15	1
	SECRETARY, KB		1	15	15	2
	VOLUNTEERS KB	2 WORKSTATION	1	12	12	2
	KK EMPLOYEES	TEAM WORK, SHOULD CONTAIN QUIET ROOM	3	40	120	6-8
	COPY ROOM AND STORAGE		2	8	16	-
	STAFF/GUESTS LUNCHROOM	ALSO TO BE USED AS MEETING ROOM	1	30	30	30
	KITCHENETTE	BY COURSE ROOMS + STAFF ROOM	1	20	20	-
ADDITIONAL	STAIRCASES		2	18	36	-
	LIFT		1	9	9	-
	CLEANING ROOM		3	3	9	-
	TECHNICAL SHAFT		1	10	10	-
	TOTAL NET M2				1403	
	TOTAL GROSS M2				1800	
BASEMENT	STAFF WARDROBE	40 EMPLOYEES	4	15	60	-
	STAFF - SHOWER		2	4	8	-
	STAFF TOILETS	1 HC	3	4	12	-
	STORAGES	ALL	6	10	60	-
TECHNIQUE	HEAT CENTRE		1	20	20	-
	VENTILATION		1	60	60	-
	PANEL ROOM		1	20	20	-
	BIKE PARKING	+ 30 BIKE SPACES IN GROUND LEVEL	1	50	50	25
	BASEMENT, NET M2				330	
	BASEMENT, GROSS M2				429	

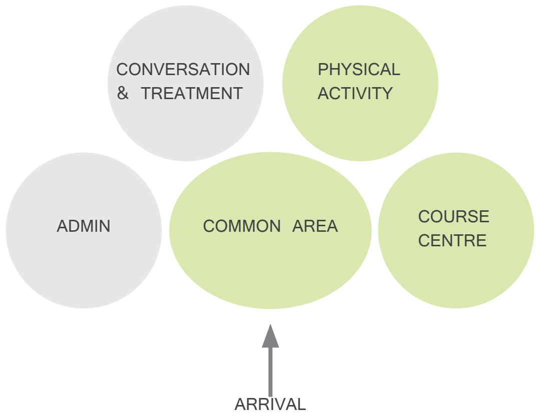
Ill. 68.1: Room programme.

BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,6 S	≥ 65 DB	25± 0,5 °C/ 22± 1 °C	8 H^{-1}	0,18 / 0,15	(✖)	✖	(✖)	–	✖
–	–	–	–	–	–	–	–	–	–	–
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	8,5H^{-1}	0,18 / 0,15	–	✖	(✖)	–	✖
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	9 H^{-1}	0,18 / 0,15	–	✖	(✖)	–	✖
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	✖	–
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	3 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
200 LUX	0,6 S	≥ 48 DB	23-26°C / 20 – 24°C	8,5H^{-1}	0,18 / 0,15	–	✖	(✖)	–	✖
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	✖	–
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
500 LUX	0,6 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	✖	–
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	–
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °CC	2 H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	8,5H^{-1}	0,18 / 0,15	–	(✖)	(✖)	(✖)	(✖)
200 LUX	–	≥ 65 DB	–	–	–	–	–	–	–	–
BRIGHT, INDIRECT SUNLIGHT, 2500 LUX MIN. 2 H, 500 LUX	0,4 S	≥ 48 DB	25± 0,5 °C/ 22± 1 °C	8,5H^{-1}	0,18 / 0,15	(✖)	(✖)	✖	–	(✖)
200 LUX	–	≥ 48 DB	–	2 H^{-1}	0,18 / 0,15	–	–	–	–	–
200 LUX	0,9 S	≥ 48 DB	–	0,5H-1	–	–	–	–	–	–
–	–	≥ 60 DB	–	0,5H-1	–	–	–	–	–	–
–	–	≥ 48 DB	–	–	–	–	–	–	–	–
–	–	≥ 60 DB	–	–	–	–	–	–	–	–

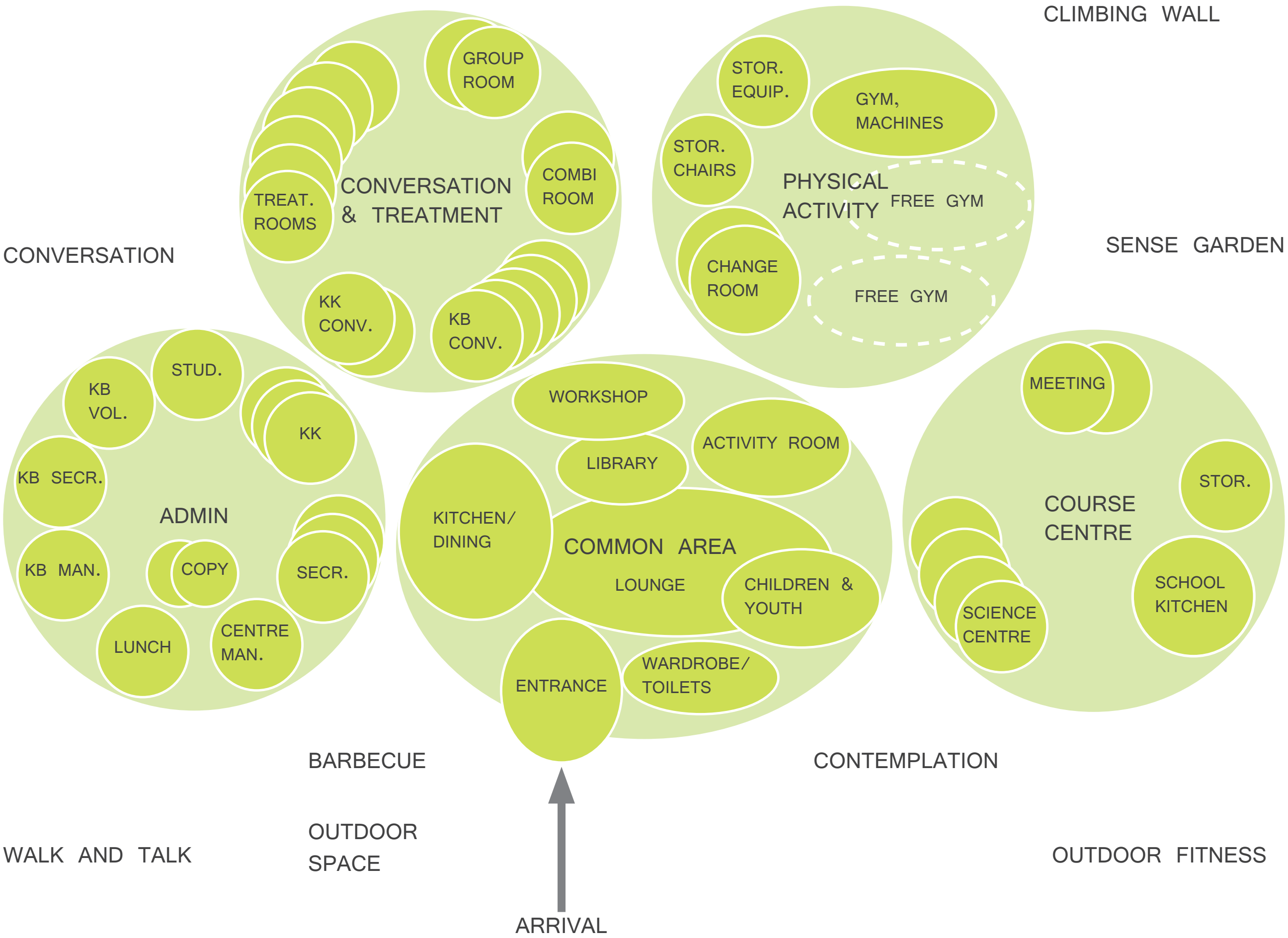
200 LUX	–	≥ 48 DB	–	0,5H-1	–	–	–	–	–	–
200 LUX	–	≥ 48 DB	–	0,5H-1	–	–	–	–	(✖)	–
200 LUX	–	≥ 48 DB	–	0,5H-1	–	–	–	–	–	–
–	–	≥ 48 DB	–	–	–	–	–	–	–	–
–	–	≥ 60 DB	–	–	–	–	–	–	–	–
–	–	≥ 60 DB	–	–	–	–	–	–	–	–
–	–	≥ 60 DB	–	–	–	–	–	–	–	–
–	–	≥ 60 DB	–	–	–	–	–	–	–	–

FUNCTION DIAGRAM

The diagram seeks to clarify the functions within the Cancer Health Care Centre and how they interact.
The building can roughly be divided into five areas, that is the common area, the administration area, the course centre, the physical activity area and the conversation and treatment area. These five areas and their atmospheric qualities will be further explained in the following pages.



Ill. 70.1: Function diagram showing which areas of the building should be accessible outside office hours.



Ill. 70.2: Function diagram showing the 5 main areas, their internal functions as well as their interrelation.

ATMOSPHERES

COMMON AREAS

Many users will spend most of their time used in the centre in the common areas as they function as a natural gathering point before or after physical activities, lessons, counseling therapy and other activities. Furthermore the activities implemented in the area encourage to informal stays, social interaction and conversations and should embody several smaller rooms or recesses providing the possibility for informal conversations in smaller groups or for individual reflection, contemplation and reading.

The surrounding environment should emphasize and support the provided activities, creating a familiar, secure and inviting atmosphere inducing confidence, trust and curiosity thus inspiring to more visits in the centre. The common areas should be brightly illuminated supporting the therapeutic and healing effect of light in relation to easing depression and sustaining the circadian rhythm. The light should be in soft and bright warm tones embodying an attractive and pleasant atmosphere accentuating informality and familiarity implying a high utilisation of natural daylight. Accordingly the materials should be familiar furthering an inviting atmosphere and in warm tones accentuating the light warm colors of the therapeutic light. The surrounding nature should moreover be visible and accessible from the common areas inspiring to use and further the restorative effects in relation to stress and pain experiences.

PHYSICAL ACTIVITY AREA

The expression of the physical activity area should be optimistic, energetic and stimulating hence encouraging for physical activities. Accordingly similar qualities as in the common areas should be implemented in relation to soft light, warm materials and view to the surrounding nature. However the area should be unseen from the outside creating a safe and protected environment considering the physical insecurity often following a cancer diagnosis.

THERAPY AND COUNSELLING AREA

The therapy and counselling area should frame confidential conversations in a private and undisturbed environment where the users can feel safe and relaxed.

Surveys suggest that dim lighting environment induce more self-disclosure, more pleasant and relaxed feelings thus indicating that dim lighting in counseling rooms could enhance communication. [Ulrich et al., 2008] Accordingly the atmosphere in the therapy and counselling areas should bring the feeling of a secluded and private environment sheltered from outside and implementing undisturbed views to the surrounding nature and consequently the lighting settings should be diffuse, soft and in deep and warm tones inducing an intimate and confidential atmosphere.

COURSE CENTRE AND MANAGEMENT

This area include the working environment of the employees and the area for courses, group meetings and lectures, why the lighting conditions in these areas are more "professional" stimulating concentration and providing the environment for a pleasant workplace. There should furthermore be views to the outside from these areas, although not necessarily nature. The areas additionally include a staff dining room and a teaching kitchen that should be designed with the same qualities in the common areas.


Shoal Bay Bach by Parsensons Architects.


Kvarterhus by Dorthe Mandrup Architects.

SOCIAL INTERACTION & CONVERSATION


72.1-6 Pavillon Seroussi, EZCT Architecture & Design Research


Cancer Centre Hejmdal, Frank Gehry


Las Palmas de leyda spa by Cristobal Valenzuela.

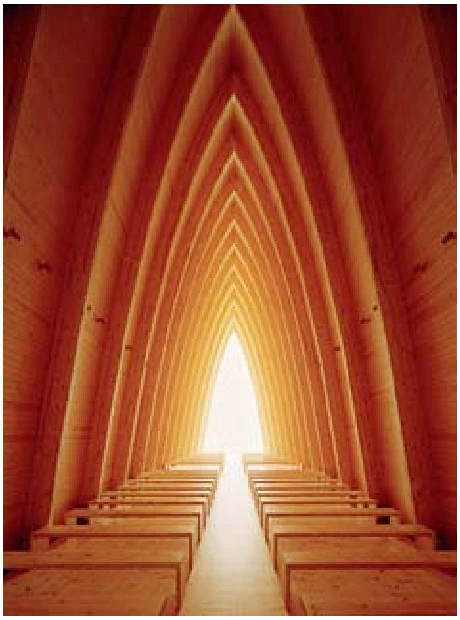

Listahaskolinn, Plus-Arkitektar

PHYSICAL ACTIVITY


Médiathèque BDIV de Fougères by Tétrarc


Sclera Pavillon, David Adjaye & Associates


Minnaert Building, Neutelings Riedijk Architecten


St. Henry's Ecuminical Chapel, Sanaksenaho Architects

73.1-6


House in Atagoyama, by a.un Architects


Great Bamboo Wall House, Kengo Kuma

PROGRAM CONCLUSION

The program contains analyses of the themes of the project: the concept of healing architecture and the method of evidence based design; the users, cancer and its side effects; the evidence based design factors; case studies; the context and the building requirements. The analyses have given an understanding of the themes revolving a Cancer Health Care Centre and design parameters and guidelines have been defined to be integrated in the further process.

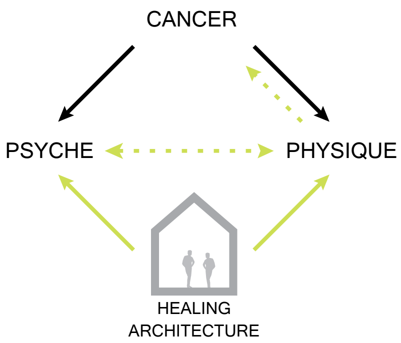
The concept of healing architecture is relatively new and is based on research carried out in different professional branches and varying in quality. The research paint a joint picture of how the build environment can positively affect health care outcomes, both physically and psychologically. These architectural elements and factors are the foundation of the method of evidence based design.

Cancer is a serious disease, which not only affects and exhausts the physiology but also the psychology of the patients. The disease itself as well as the harsh treatment brings along many side effects. The fear of the disease and its impact is known to cause stress, depression and woriness.
External elements can cause and worsen these conditions. Stress occurs or increases, when the senses perceive unfamiliar signals, such as noise, too little or too much light as well as unknown smells.
The project theme of designing a new Cancer Health Care Centre puts focus on healing architecture to create a soothing, relaxed and qualitative environment in order to reduce and relieve stress, anxiety and depression often experienced by cancer patients and their relatives.

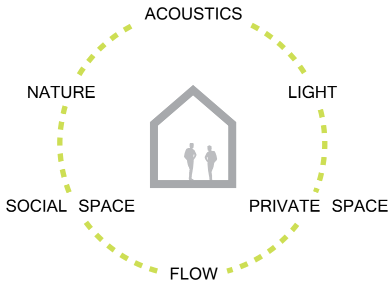
The evidence based design factors of light, acoustics, flow, relation to nature, private space as well as social space have positive effects in relation to reducing stress, depression, anxiety, fatigue and pain. The parameters listed from the analyses of the factors will be integrated in the design of the Cancer Health Care Centre as well as obtaining a qualitative indoor climate, which can increase the comfort and the experience of the building.

The Cancer Health Care Centre will be a retreat from the often harsh treatment courses and the anxiety filled consultations in Rigshospitalet, which is a typical hospital environment, where the cancer patients in Copenhagen receive medical treatments. In this regard, it is important that the centre does not resemble a hospital or an institution. The relation to Rigshospitalet is important, as most patients will come to the centre directly from there, why the physical and visual connection needs to be considered carefully.

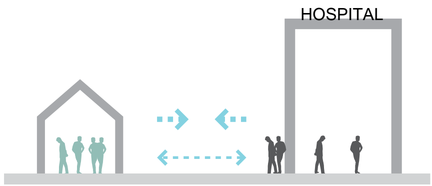
The building plot of the project has a special location bordering the quiet, green oasis of De Gamles By and the dense, busy urban area of Nørrebro. It is a site of limited size, as it is close to an existing building to the South and close to the large, preserved trees of the park to the North.
It will be a challenge to obtain adequate amounts of daylight, and special consideration should be given to the relation between existing buildings and the new centre as well as the relation to the park area.
The cancer centre should relate to the existing De Gamles By, but at the same time stand out, as it is a function of its own in the urban area of Nørrebro.
Also the centre should have a unique character and be visible and recognizable in the city of Copenhagen, as stated in the project brief.



Ill. 75.1: Cancer brings psychological as well as physical side effects. Healing architecture can affect these, which may affect the cancer disease positively.



Ill. 75.2: The evidence based design factors of light, acoustics, flow, relation to nature as well as personal and social space will be integrated in the design process of the Cancer Health Care Centre.



Ill. 75.3: The Cancer Health Care Centre should contrast the hospital and not resemble an institution. However, the connection to the hospital should be considered.

Ill. 75.4: The Cancer Health Care Centre should relate to the park area as well as the existing buildings of De Gamles By.

Ill. 75.5: The Cancer Health Care Centre should stand out from De Gamles By as well as Nørrebro and be a focal point in the area.

VISION

It is the vision to create an architectural concept for the Cancer Health Care Centre, that will stand out in Copenhagen as a unique, welcoming building, with inspiration in the concept of healing architecture and through the method of evidence based and integrated design. Contextual, functional, technical and aesthetic parameters will together create a healing environment, that will be a retreat for the cancer patients and their relatives from the harsh hospital environment they often find themselves in as well as from the difficult everyday life they may experience.
It will be a place for all cancer patients of Copenhagen, young and old, male and female, severely ill or recovered, and it will be a place for sorrow, melancholy and woriness as well as happiness and optimism.

THESIS

How can the concept of evidence based healing architecture and an integrated design process result in a unique architectural concept for the Cancer Health Care Centre of Copenhagen, which stands out as a focal point in Nørrebro and provides a welcoming, inspiring and healing environment, that will relieve the stress, anxiety and depression as well as accommodate the emotional spectre of the cancer patients and their relatives?

The programme of analyses, investigations and case studies form the base of the concep-tualization of a proposal for the Cancer Health Care Centre.

CONCEPT

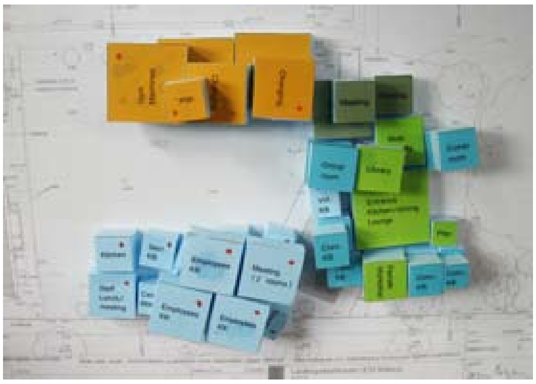
PHASE 1: MORPHOLOGY

The first stages of the conceptualization process evolve around studies of the building volume, the square meters and how they fit on the site. These different morphologies are studied with considerations for contextual as well as functional parameters, considered in terms of internal and external qualities.

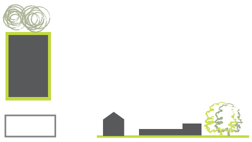
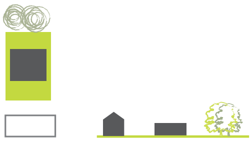
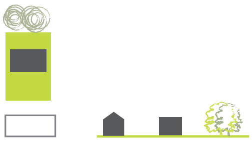
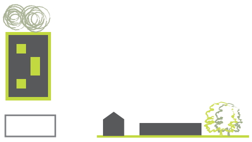
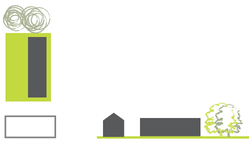
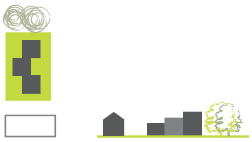
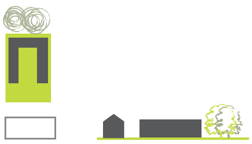
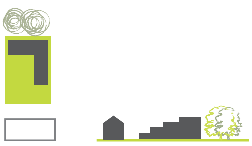
It is found important that the building defines and creates outdoor spaces on the building site.
This will give close connections between internal and external functions and create distances to the surrounding buildings, complying with the context.
The height of the building is important, as it on one side needs to relate to the lower buildings of De Gamles By and on the other the tall urban scale of Nørrebro with the Panum Institute and the Rigshospitalet.
In relation to the evidence based design guide, it is important to have a clear overview of the building. (See p. 64)
In the case of the Cancer Health Care Centre, there are many functions of different character, some which are for drop-in visits and some for appointment visits, and some are just for administration.
Thus it is found essential to create a clear overview of the various functions in terms of the functions relating to the users and visitors of the centre and the staff related functions.
The possibility of a overview is seen as an external as well as internal parameter, relating to the morphology or the layout of the building, as it draws the outlines of the possible internal organization.
It also becomes important in relation to creating easy access between the internal functions in terms of short distances.
The morphology further relates to the light income of the building in relation to its depths.

From the studies, it is concluded that a fragmented volume with a height of multiple storeys will fulfill many of the parameters listed. A fragmented volume can give a clear expression of the division of spaces or zones inside the building, it can create spaces around it and enable less deep volumes meaning better daylight conditions.
Spreading the volume too much will however result in larger internal distances, which can also interfere with the overview of the building. (See ill. 78.1-2)

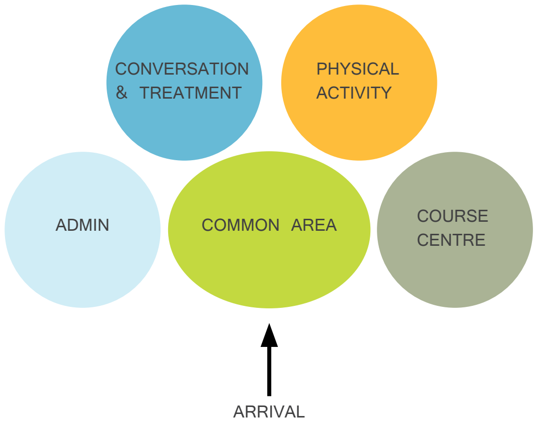
The competition program recommends a maximum height of 12 metres, meaning 3-4 storeys to respect the existing building neighboring the site.
To ensure a building volume, which gives space around it, has an appropriate depth and has a layout, where large distances within the building are avoided, it can be necessary to build several storeys, why the recommendation from the competition program will need to be reconsidered.



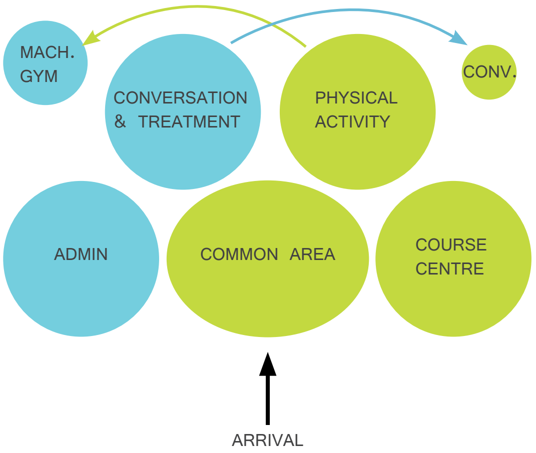
Ill. 78.1-2: The functional relations in a fragmented and a collected volume, respectively. A fragmented volumes makes it possible to give a clear division of the different functions, whereas a collected, low volume does not give any outlines for organizing the functions.

MORPHOLOGY	CREATING OUTDOOR SPACES	HEIGHT RELATING TO CONTEXT	EXTERNAL OVERVIEW OF BUILD-ING PLAN	INTERNAL OVERVIEW OF BUILD-ING PLAN	LIGHT INCOME	INTERNAL ACCESS TO FUNC-TIONS
 1 storey, 100% footprint.	–	–	–	–	–	–
 2 storeys, 50% footprint.	(+)	(+)	–	–	–	(+)
 3 storeys, 30% footprint.	(+)	+	(+)	–	(+)	(+)
 2 storeys, volume with court yards.	(+)	–	–	–	(+)	–
 3 storeys, long volume.	(+)	+	–	–	+	(+)
 2-4 storeys, fragmented volume.	+	+	+	+	+	(+)
 3 storeys, U-shaped volume.	+	+	(+)	(+)	+	–
 1-4 storeys, L-shaped volume.	+	+	(+)	(+)	+	(+)

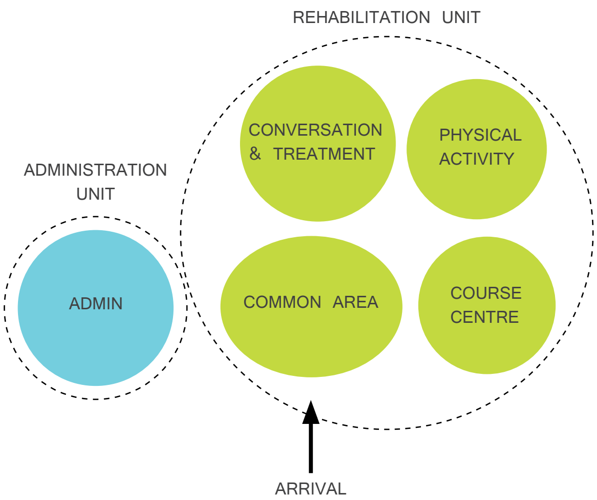
Ill. 79.1: Matrix of different morphologies on the site in relation to contextual as well as functional parameters.



Ill. 80.1: One zone per function, five zones in all.
The functions do not interconnect much, and there seems to be too much division.



Ill. 80.2: Zones open or closed outside offices hours, two zones in all, some functions overlapping creating confusion.



Ill. 80.3: Administration zone separated from the functions, the cancer patients would actually visit.

PHASE 1: FUNCTIONS

From the morphology studies it is concluded, that a fragmentation of the building volume will create better conditions for outdoor spaces, better light income as well as a clear overview of the functions in the building from the outside and the inside. In relation to the case studies of the Maggie's centres, it furthermore seems easier to create an intimate atmosphere in the centre, if the units are smaller.

In relation to this, the function programme is further developed to investigate which functions need to be expressed in the building volume, and how the building can be divided in an appropriate manner improving the overview of the functions for the cancer patients.

Having each function area stand out as a clear entity, seems to create clarity, but also gives an organization, where the different functions and facilities cannot interact much.
For instance it is important that the conversation rooms can be easily reached from several places in the building, why placing them in a separate unit seems inappropriate. (See ill. 80.1)

It furthermore seems relevant to divide the building according to the opening and closing hours of the various functions, some being closed outside office hours.
However, the division of open and closed facilities does not compliment the actual functions and their activities and seem to blur the overall overview. The machine gym area is for instance categorized as a facility that should be closed outside office hours, but it seems inappropriate to separate it from the other physical activity areas. (See ill. 80.2)

Lastly, it is concluded to have the building divided into two entities, one with the administration and one with the rehabilitation areas. In other words, a division of the employees' area and the cancer patients' area.
The Cancer Health Care Centre is programmed to consist of a large administration unit, and it seems relevant to separate this from the actual centre, in order to remove the institutional like atmosphere surrounding a large office environment and to be able to create a domestic and homey atmosphere within the areas used by the cancer patients.
Also this division underlines the need for the administration area to be closed off after office hours. (See ill. 80.3)

The wish for a fragmentation of the building into two units forms the base of the further conceptualization process.

PHASE 1: INITIAL SKETCHING

Early sketching processes lead to an initiating idea of the symbolism in the architectural expression. The Cancer Health Care Centre is to provide a safe, healing environment protecting the cancer diagnosed people from the outside world, giving them an oasis, where they can meet and relax and get a break from the tough reality they live in.
This should be expressed in the architecture of the building and the initiating ideas evolve around the concept of embracement, where the building embraces or wraps itself around its users, or where the two parts of the building embrace each other around their common purpose.
The building not only embrace internal functions but also create sheltered outdoor spaces, protected from the outside. These initial ideas form the base of the further conceptualization process.

Ill. 81.1: Sketches of the initiating idea of embracing building volumes.

Ill. 81.2: Model of the initiating idea of embracing building volumes.

Ill. 81.3: Inspiration picture. Helsinki Seafarers centre by ARK-House.

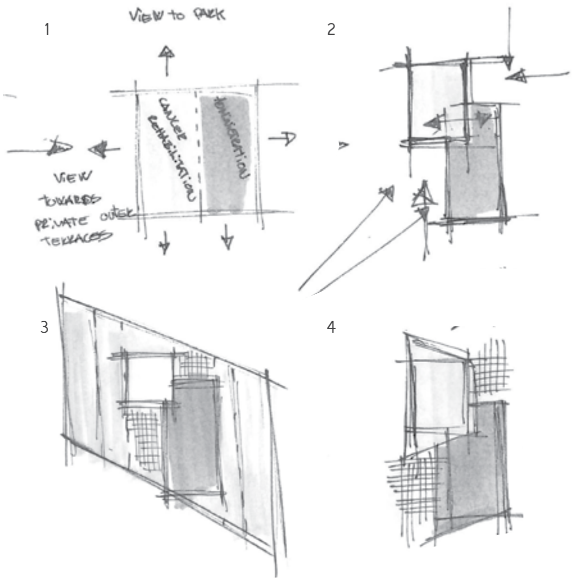
Ill. 81.4: Inspiration picture. The Israel pavilion for the Shanghai Expo 2010

PHASE 2: CONCEPTUALIZATION

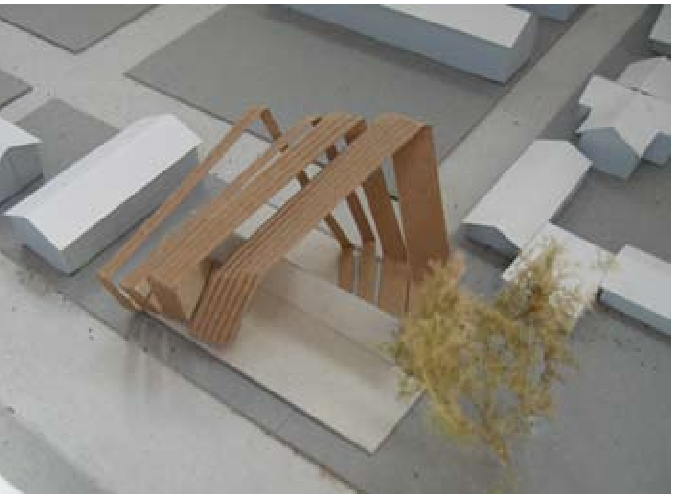
The initial sketching of an architecture with an embracing expression, develops further into ideas of a wrapping facade structure embracing and protecting an internal building core. As the building site is rectangular and situated in the stringent symmetric composition of De Gamles By, it is sought to give the volume a more straight expression conforming the symmetry in the area.
It is further tried to separate the administration and rehabilitation unit through pushing them farther apart creating an external area for entrance towards North East opening up an outdoor space on the sun side, towards South West.

The administration unit is prolonged along the street of Nørre Allé, where it seems to protect the rehabilitation unit and the outdoor area to the South West from the busy, urban area of Nørrebro. The rehabilitation unit is moved up towards North to avoid the shadow from the existing building to the South and to open up towards the light from West. (See ill. 82.1)

Initially, a concept of a light facade structure is investigated wrapping around and protecting both building volumes to symbolize a gathered building despite the separation into two building units. However, the administration building is as a work place for people who are well, why the atmosphere and the needs of this building are different from the functions of the rehabilitation building. For this reason, the functions of the administration unit seem to contrast the expression of the wrapping facade structure, why the structure only envelopes and protects the rehabilitation unit.
This further emphasizes the different functions of the two building volumes, and makes it clear to the visitor where to go. In the process of only having the structure wrap the rehabilitation unit, it is decided to physically separate the two building units completely. However, they are still thought to be connected through a common basement.



Ill. 82.1: Sketches of the initial concept. The building is divided into two units, where the rehabilitation unit is pushed forward for the sun and to create spaces around it. A structure is wrapped around to embrace and protect the environment of the cancer centre.



Ill. 82.2-4: Model pictures of different ideas of wrapping the two units of rehabilitation and administration.
Having a wrap which emphasizes the division of the two units seem more appropriate as it further complies with the symmetry of De Gamles By.

LIGHT INCOME

LIGHT INVESTIGATION OF HOW THE BUILDING SHOULD BE ORIENTED TO OBTAIN THE LARGEST AMOUNT OF DAYLIGHT.
THE INVESTIGATION SHOWS THAT THE LARGEST AMOUNT OF DAYLIGHT COMES FROM WEST, AS THE EXISTING BUILDING TO THE SOUTH FRONT OF THE SITE GIVES QUITE A LARGE SHADOW AND BLOCKS PARTS OF THE LIGHT FROM THIS SITE.

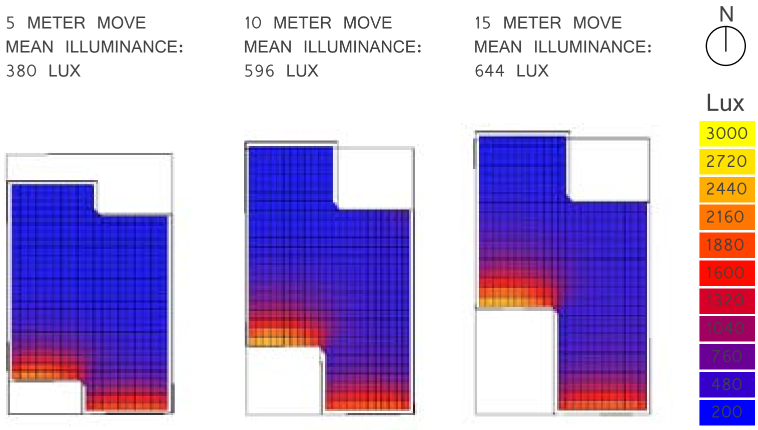
DISTANCE OF BLOCKS

LIGHT INVESTIGATION OF THE INFLU-ENCE OF THE DAYLIGHT INCOME IN THE BUILDING WHEN MOVING THE REHABILITATION BUILDING FARTHER TO THE NORTH AWAY FROM THE SHADING EXISTING BUILDING TO THE SOUTH.
THE INVESTIGATION SHOWS THAT THE FARTHER TOWARDS NORTH THE BUILDING IS MOVED, THE BETTER THE LIGHT INCOME.

5 METER MOVE
MEAN ILLUMINANCE:
380 LUX

10 METER MOVE
MEAN ILLUMINANCE:
596 LUX

15 METER MOVE
MEAN ILLUMINANCE:
644 LUX



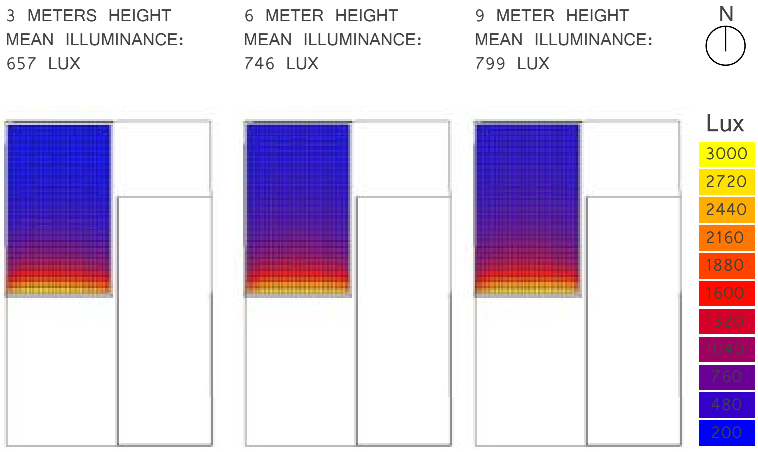
HEIGHT

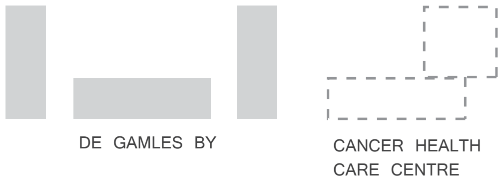
LIGHT INVESTIGATION OF THE IMPACT OF BUILDING HEIGHT IN THE LIGHT INCOME.
THE INVESTIGATION SHOWS THAT THE MEAN ILLUMINANCE GRADUALLY BECOMES LARGER WHEN MOWING THE PLANS UP IN HEIGHT.

3 METERS HEIGHT
MEAN ILLUMINANCE:
657 LUX

6 METER HEIGHT
MEAN ILLUMINANCE:
746 LUX

9 METER HEIGHT
MEAN ILLUMINANCE:
799 LUX





ill. 84.1-2: Principle section and plan. The rehabilitation unit is pushed away from the De Gamles By and relates to the larger urban scale of Nørrebro whereas the administration building links to the rhythm, scale and composition of De Gamles By.

Ill. 84.3-4: Model pictures of volume studies considering shape and direction of the volumes. Having a straight edge towards the park underlines the view towards this side, whereas angling it directs it towards the kinder garden. Angling towards South underlines the open space to this side and that this is the sun side.

PHASE 2: HEIGHT & SCALE

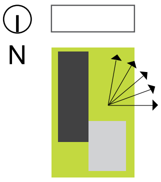
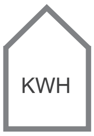
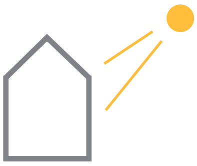
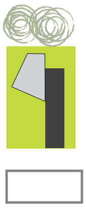
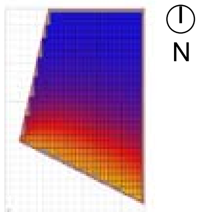
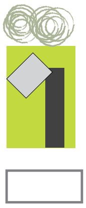
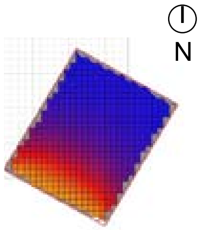
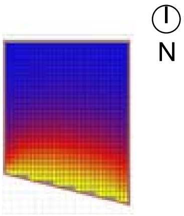
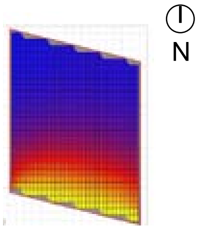
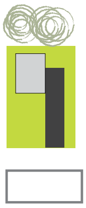
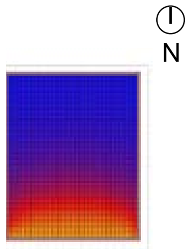
In the early morphology studies it is concluded, that having a fragmented volume will comply with many of the parameters listed, but can also necessitate a taller building volume than recommended in the competition program.
The initial concept contains of a split volume, of the two units, where the rehabilitation unit is pushed towards North to create outdoor spaces on the site and optimizing the light income. Furthermore it is desired to create a smaller, intimate scale and clear planning inside the rehabilitation unit, as this is found important through the case studies.

The recommendation from the competition program mainly takes the existing buildings of De Gamles By into consideration, as they are listed buildings. However, the competition program only states guidelines of the height of the new building, as there is no decisive local plan of the area.
As the Cancer Health Care Centre lies on the edge of De Gamles By, and thereby as well as through its functional relations to Rigshospitalet relates itself to the urban scale of Nørrebro, this also seems important to consider. The urban context of Nørrebro; the tall Panum Institute, the Rigshospitalet and large dwelling complexes in the area call for a taller building volume which can conform the larger urban scale.
It further seems significant, that the rehabilitation unit of the Cancer Health Care Centre marks itself in the area and is visible from the large traffic junction, from where most users will come walking or driving (see ill. 84.1-2).

The rehabilitation unit is raised and the administration unit is kept low and rectangular linking to the lower scale and symmetry of De Gamles By (see ill. 84.2). The relatively simple shape of the administration building enables emphasizing the rehabilitation unit as the main function of the new centre through contrasts in height, material and shape.

Designing the rehabilitation unit evolves around studies of light income, views, the shape considering context, the connection with the administration unit and finally the energy use. The studies are done simultaneously in plan and in simple models to consider all parameters. (See ill. 84.3-4, 85.1)
The volume should open up towards the light from South West and the view of the De Gamles By, and be directed towards the park to the North. This enables different atmospheres inside the building through the two different views of the quiet green park and the more lively view of De Gamles By with the beautiful old brick buildings.

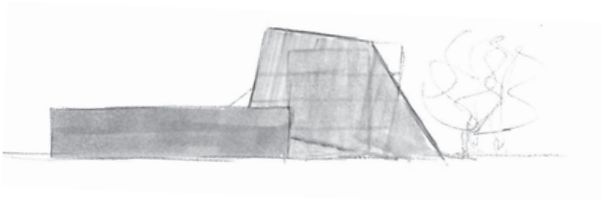
From the studies it is concluded to further optimize the volume shape angled towards South East, as it enables a large light income and emphasizes the views of the area.
The strait shape towards North emphasizes the view towards the green park area and furthermore it connects with the strict shape of the administration building.

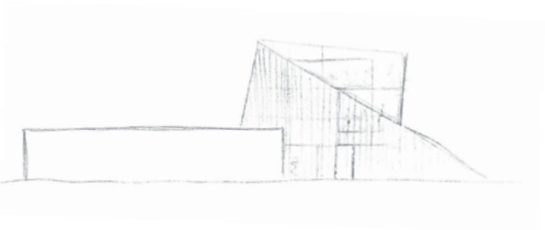
MORPHOLOGY	VIEW TOWARDS “DE GAMLES BY”	VIEW TOWARDS THE GREEN PARK	ENERGY USE	DAYLIGHT INCOME
				
	+	+	(–) 65 KWH/M²	+ 975 LUX 
	+	–	+ 63,2 KWH/M²	– 876 LUX 
	(+)	+	+ 63,8 KWH/M2	(+) 936 LUX 
	+	–	(–) 66,4 KWH/M2	– 894 LUX 
	–	+	(–) 64,5 KWH/M2	– 731 LUX 

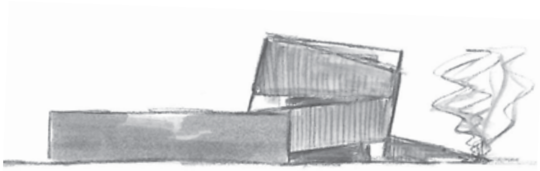
Ill. 85.1: Shape investigations

PHASE 2:
THE WRAPPING STRUCTURE

The wrapping facade structure is an essential part of the expression of the rehabilitation building. The structure should be light, embracing and protecting. It is important that the structure lets in the large amounts of light stated in the room program, to give a therapeutic atmosphere.
However, it is also very important to lower the direct light income, as some of the users may be sensitive to direct light caused by their illness, and for this reason it furthermore serves as solar shading also helping avoid glare and over-heating inside the building.
The light in the building should be warm, bright and soft emphasizing an intimate environment. To obtain this, the structure is thought to be of wood, as it will reflect the light and give it a glow of the wood creating a warm and intimate ambience. Additionally, a wooden structure can give the tall rehabilitation unit a light expression emphasizing its shape and contrasting the strict administration unit. (See ill. 86.6-7) In the initial designs the structure wraps around an internal building core that comes into sight in various places, and it extents further on out into the landscape creating outdoor spaces and a dynamic expression. However, this creates an expression of the wooden structure being stretched out around the internal shape of the building volume, creating a heavy and massive expression. (See ill. 86.1-5)



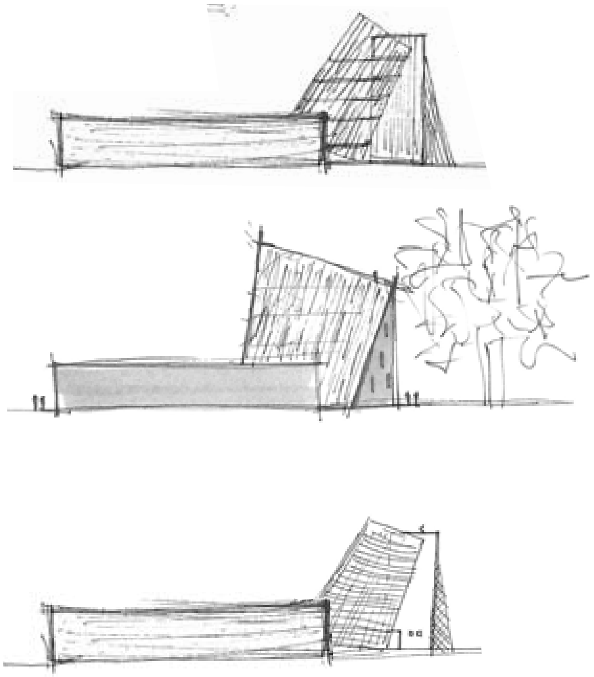




Ill. 86.1-3: Structures wrapping around an inner core.

Ill. 86.4-5: Model pictures of wraps extenting into the surround area.

Ill. 86.6-7: Inspirational pictures.



Ill. 87.1-3: Structures wrapping around the South part of the rehabilitation unit.

Furthermore, the places where the internal building core comes into sight it would need a facade structure of it's own, protecting from sunlight an views into the building, diminishing the actual function of the wooden structure.

The further development of the structure leads to a internal division of the Rehabilitation building into a stringent core to the North consisting of the private functions such as conversation rooms and group rooms, which links to the strict expression of the administration building.
The open social functions are placed towards South West embraced and shaped by the light wooden structure.
Yet, it seems that the division of the volume creates an uneven external expression and also the private functions seem to be left bare and unprotected. (See ill. 87.1-3)

The further process leads to a concept of the wrapping structure enveloping and shaping the whole rehabilitation unit opening up in a vertical line towards the entrance area to the East and continuing into the building forming the internal walls of the private zones of the building.
The structure is raised at the top in the South East facade making the building appear slim in the vertical direction contrasting the horizontal administration building and connecting to the larger urban scale at Nørrebro. (See ill. 87.4-6)

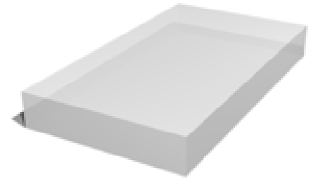
Ill. 87.4-5:
The wrap embracing the South part of the rehabilitation unit.

Ill. 87.6: The wrap embracing the entire rehabilitation unit, marking the enclosed rooms as well as the open space and marking the entrance area.

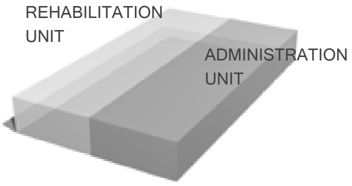
THE CONCEPT

The concept of the Cancer Health Care Centre derives from the wish to create a building design that complies with the surrounding context, has a welcoming, embracing expression with an optimal layout giving an easy overview as well as indoor conditions accommodated for the users with high illuminance levels and a pleasantly lit environment.

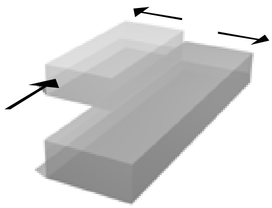
It is a desire to keep a clear differentiation between the two building units of the administration and the rehabilitation, emphasizing the rehabilitation building as a landmark in the surrounding area and the main function of the Cancer Health Care Centre, making it easy for the users to recognize where to go.
Furthermore the separation can help create a more homey atmosphere in the rehabilitation unit, as the busy, institutional working atmosphere around the many office functions is removed from this part of the building.
The two buildings are differentiated through materials, shape and scale as the administration building is low and stringent linking to the symmetric composition of De Gamles By and the rehabilitation building conforms with the tall urban context of Nørrebro, as it stands tall, and marks itself with its light wooden structure, which embraces and welcomes the cancer patients to come inside.



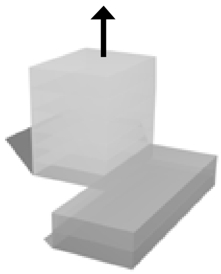
1 ALL 1800 M2 ARE LAID OUT IN TWO STORIES ON THE BUILDING SITE.



2 THE BUILDING IS DIVIDED IN TWO FUNCTIONS.
THE ADMINISTRATION UNIT FOR THE STAFF WORKING AT THE CENTRE AND THE REHABILITATION UNIT CONTAINING ALL FUNCTIONS FOR THE USERS OF THE CENTRE.

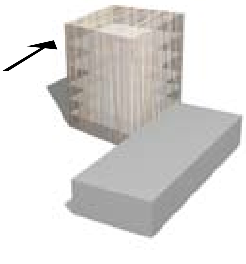


3 THE REHABILITATION UNIT IS PUSHED BACK TOWARDS NORTH TO AVOID THE SHADOW CAST FROM THE EXISTING-BUILDING TO THE SOUTH. THE UNITS ARE SEPARATED TO EMPHASIZE THEIR FUNCTIONS.



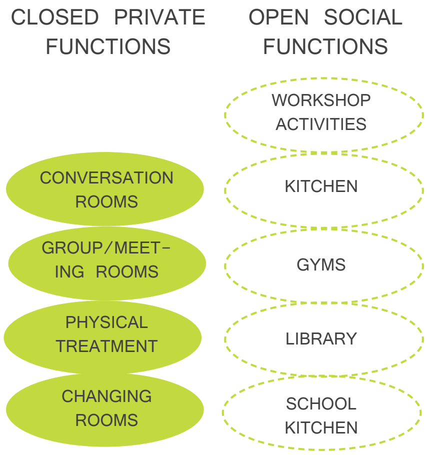
4 THE REHABILITATION UNIT IS RAISED TO MINIMIZE THE SCALE OF THE INTERNAL PLANS CREATING A MORE INTIMATE ATMOSPHERE AND TO CONFORM THE BUILDING SCALE TO THE SURROUNDING URBAN CONTEXT.
THE ADMINISTRATION UNIT IS LOW AND RECTANGULAR LINKING TO THE SYMMETRY OF DE GAMLES BY AND PROTECTING THE REHABILITATION UNIT AND THE OUTDOOR SPACE FROM TRAFFIC NOISE AND VIEWS INTO THE AREA.

5 A LIGHT WOODEN FACADE STRUCTURE IS WRAPPED AROUND THE PLANS EMBRACING AND PROTECTING FROM VIEWS INTO THE BUILDING AND DIRECT SUNLIGHT.
THE STRUCTURE OPEN UP TOWARDS THE ENTRANCE AREA WELCOMING PEOPLE INTO THE BUILDING.

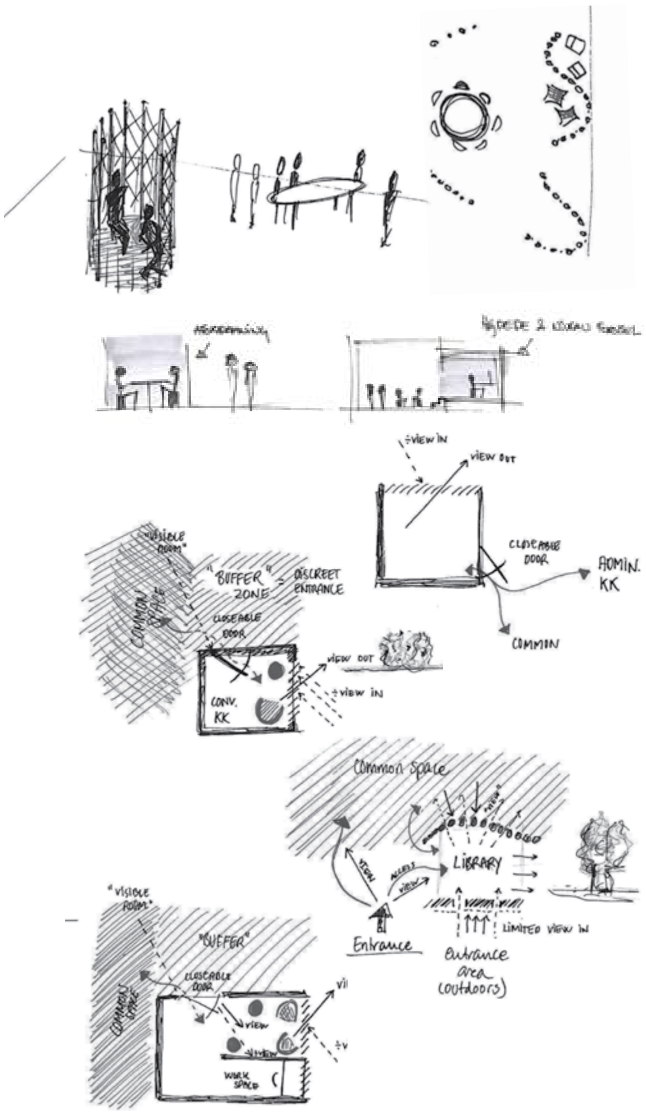


6 THE REHABILITATION UNIT IS ANGLED IN THE SOUTH FACADE OPTIMIZING FOR DAYLIGHT AND THE VIEW OF DE GAMLES BY. THE NORTH FACADE IS KEPT STRAIGHT OPTIMIZING IT FOR THE VIEW OF THE GREEN PARK AREA AND CONFORMING WITH THE RECTANGULAR SHAPE OF THE ADMINISTRATION UNIT.

7 THE FACADE STRUCTURE IS RAISED IN THE TOP SOUTH EAST CORNER EMPHASIZING THE VERTICAL EXPRESSION OF THE BUILDING CONTRASTING THE HORIZONTAL ADMINISTRATION UNIT.



Ill. 90.1: Diagram showing which functions are opened up, and which are kept with the possibility to close of from the rest of the building.



Ill 90.2: Different possibilities for creating private and social spaces and how they relate to each other.

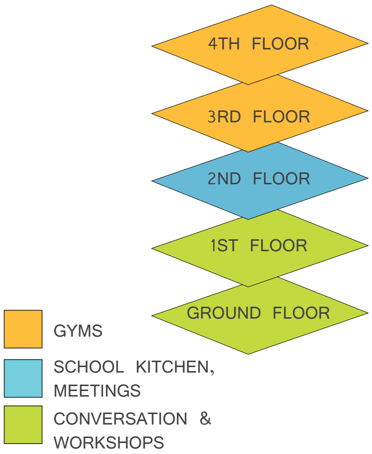
PHASE 3: PLANNING THE REHABILITATION UNIT

The following sections describe the planning of the rehabilitation unit and the administration unit, respectively.
The sketching phase of planning has much influence on the outer shape of the building and is an integrated part of the sketching phase as a whole on various levels.
However, in the following sections the process is simplified in order to clarify the main iterations undergone. The planning of the rehabilitation unit is described first follwed by the process of planning the administration unit.

The initial room program of the competition program describes almost all functions of the Cancer Health Care Centre, either social or private, as closed rooms. Yet, to ensure a clear plan and overview it is decided to open up the social functions and make them visible to inspire the users to participate in the various social activities of the centre.
The private zones such as conversation rooms and group rooms are kept with the possibility to close of from the rest of the building. (See. ill. 90.1)

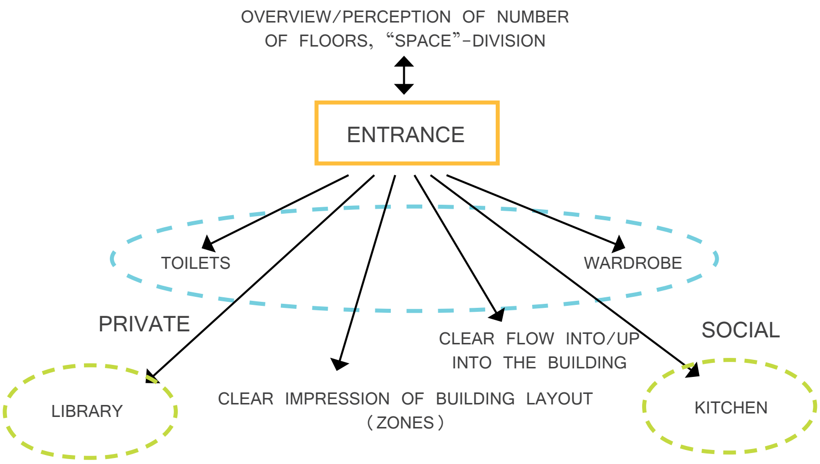
According to the analysis of the evidence based design factors as well as the case studies, the building should accommodate different kinds of private and social zones where the users can either participate in social gatherings, stay on the edge or be private.
The different zones should all be easily reachable as many of the users are emotionally fragile and may want to use all zones during a stay in the building.
The initial sketching of the building planning evolve around various studies in plan and section of how to create these different spaces and how they can relate to each other. (See ill. 90.2) The sketches form the basis of the further plan development.

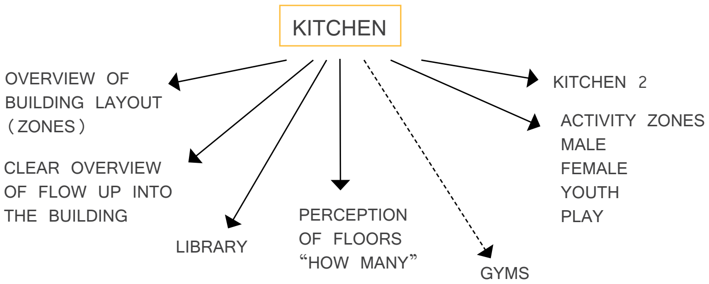
From the analyses it is found essential to create an intimate atmosphere and a clear overview of the building plan easing the navigation and making the users feel secure and safe.
In the case studies the relatively small scale of the Maggie's centres is found very functional because it helps create an intimate, domestic atmosphere and an easy and clear overview of the building. For this reason as well as the wish to comply with the surrounding urban scale, the rehabilitation unit is raised into five levels minimizing the area of each plan, creating the possibility for a more intimate atmosphere.
This further provides a good overview of the building layout and a possibility to zone the different functions in the vertical direction, where more private atmospheres can be obtained in the upper floors, as they are kept away from views into the building and become less disturbed. (See ill. 91.1.)
The reduced scale of the floor plans ensures smaller distances to walk in between the functions, as the plans will be connected with a lift beneficial for the week cancer patients.



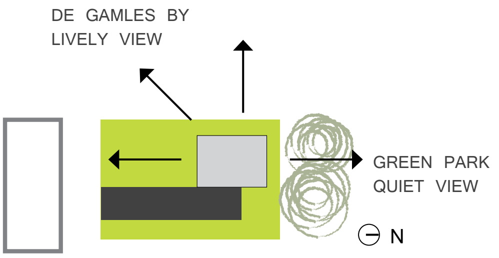
Ill. 91.1 Diagram showing the zoning of different functions in the five levels.

Each level is programmed with functions relating to each other. The functions that will be used by people visiting the centre for the first time such as kitchen, library and workshop activities are placed in the bottom floors to ease the access. Also conversation rooms and group rooms are kept in the lower floors to ease the access.
Gyms and school kitchen are placed in the top floors as the users most likely will have an appointment to come there or have visited the centre a few times before.
Ill. 91.2-3 show a selection of diagrams illustrating the visual connections desired between the different functions in the rehabilitation building. In order to create a clear overview of the building and the different functions it is important that the functions are visible from each other inspiring the users to participate in social gatherings and creating a clear overview of the building layout. Furthermore it is important the users have a clear overview of the different private and social zones in each plan as there moods might change several times during one stay creating need for an easy access between the different zones.



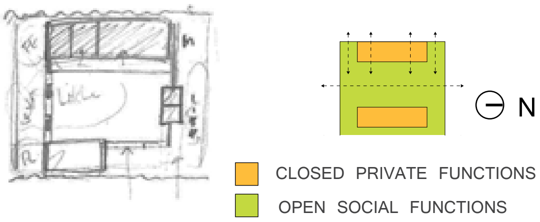


Ill. 91.2-3. Diagram showing internal visual connections between the various functions

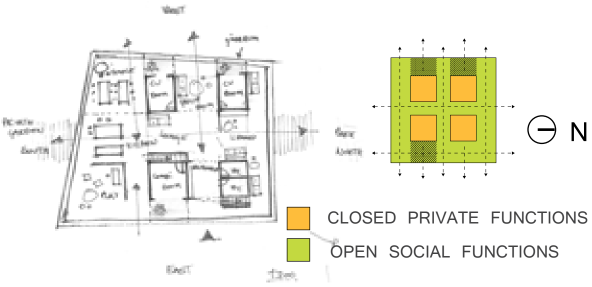


Ill. 92.1 Diagram showing the views defined as qualitative in relation to the functions of the rehabilitation building.

Ill. 92.2 Initial planning sketch. The closed private functions are used as space defining.



Ill. 92.3 Initial planning sketch. The closed private functions are placed in a core in the middle of the social spaces that flows outside near the wooden facade structure.

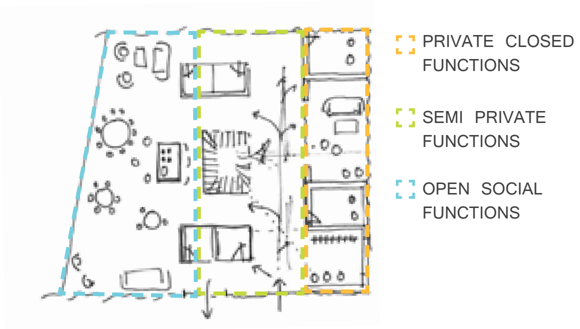


Ill. 92.4 Initial planning sketch. The closed private functions are placed in the middle of the room with small private courtyards outside functioning as space defining elements.

PHASE 4: ZONING

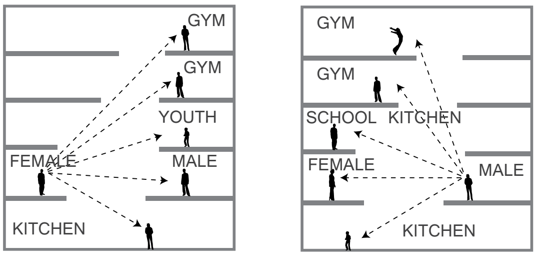
The initial planning sketches focus on using the closed private functions as space defining elements in the larger open social spaces, which are enveloped by the wooden facade structure defining a light and warm atmosphere. (See ill. 92.2-4)
In ill. 92.2 the closed rooms are scattered around in the room creating niches in between for social activities. However it seems that the closed private functions are rather exposed being placed in between the social functions making it difficult to create a secluded and intimate atmosphere connected with the private spaces.
In ill. 92.3 the closed rooms are placed in two cores. One in the middle of the room containing functions not dependant on daylight, and one by the West facade containing conversation-, group- and combi rooms. The open functions flow in between the two cores creating a view through the building towards the green park and the area of De Gamles By. Yet, the West side of the building is the side that receives the largest amount of daylight why the core to the West seem to close off the building to this side. Furthermore the space created in between the two cores is rather large and undefined, left as a flow area.
In ill. 92.4 the cores are split and pulled back from the facade creating room for social activities in between. But the mixing of social activities again makes it difficult to create a secluded atmosphere relating to the closed private functions.
In all sketches the private rooms are facing both South and West to obtain direct light. Yet, the view to the North of the peaceful green park relates to the desired contemplating atmosphere connected with the private functions. Thus, the closed private functions are placed with a view over the quiet park area and the social functions are located towards the more lively view of De Gamles By. (See. ill. 92.1.)

ill. 92.5-6: Model of the private closed rooms placed in two cores collected in one volume in the middle of the social space.



Ill. 93.1: Sketch of the ground floor illustrating the partitioning of private and social functions into zones graduating from private closed rooms to the North towards social open zones to the South West.

Ill. 93.2. Section through the plans with the closed private functions placed to the North and the social open zones floating out into the open space defined by the wooden facade structure of the South, West and East facade.



Ill. 93.3. Diagrams showing vertical visual connections after cutting the plans.

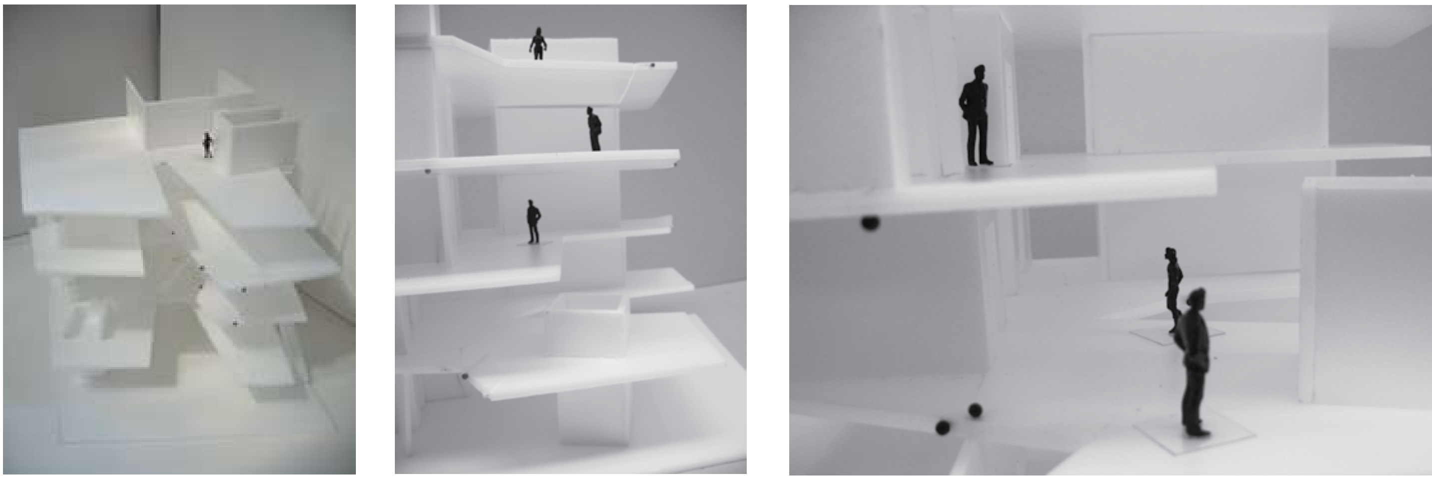
The functions are placed in bands of zones going from closed private zones towards North over a middle zone to the open social zones placed in the South West. (See ill. 93.1) The private zones contain conversation rooms, combi- and group rooms for group and family therapy and are placed with a view of the quiet green park relating to a contemplating atmosphere. The illumination demands for these rooms are furthermore lower than the social functions, why the location by the Northern facade complies with this.

The social zones contain social functions such as kitchen and school kitchen, workshops, lounge, youth lounge, activities and the gyms. They have a view of the more lively area of De Gamles By with a kindergarten, beautiful old brick buildings and people taking a walk through the area. The social functions have a very high illumination demand of 2500 lux 2 hours a day, to have a therapeutic effect on the cancer patients, requiring a placement towards South and West.

The middle band is defined as semi private and contains the entrance area, vertical flows between plans, horizontal flows between zones as well as sitting areas creating the possibility for the users to sit on the edge of social gatherings, talking in small groups as well as be a bit private without retreating entirely.

To obtain the desired visual connections between the social functions and to define space around the floating open zones the plans are cut towards South connecting the levels in the vertical direction.

It is investigated how, the cutting of the plans additionally improves the lighting conditions in the room. (See app. 3) From the investigations it can be seen that cutting the plans open and withdrawing them from the facade makes the daylight reach further into the depth of the building as the plans then all benefit from the tall South West facade.



Ill. 93.4-6: Models of the cut plans visualizing the vertical connections between the plans.

THE PLAN CONCEPT

The concept of the internal building layout derives from a wish to create an intimate and homey atmosphere within the building where the users have the possibility to participate in the different functions on various levels. It is important that the building layout meets all needs of the users, why different zones of private and social character should be easily reachable within the building as the users may want to utilize different zones of different social and private character during one stay or dependent on whether the user is visiting for the first time or has been visiting for a long period.

Thus a zoning of the various functions in both vertical and horizontal direction is the essential parameter of the concept.

Each plan has areas of both social and private character and a semi private middle zone, where the users can sit on the edge of the social functions. The functions are placed in a clear layout making it easy to use different functions and change zone according to mood.

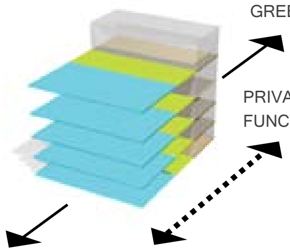
The building is zoned vertically and the gyms are placed in the top levels creating a more private atmosphere around these functions, where the views into the building are limited, and at the same time ensuring a pleasant view of the park and De Gamles By.

The vertical zoning furthermore evolve around a definition of functions used by first time visitors or people who use the centre on a regular basis. The functions that help create a homey atmosphere and ease the way into using the centre, such as the kitchen and the library, are placed in the low floors where they are easily accessible. The gyms and the school kitchen are placed in the top floors as the use often implies an appointment and will most likely be used by people who has visited the centre before and thus know the layout of the building and the various possibilities and functions.

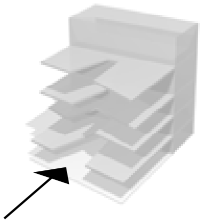
The plans are opened up vertically to ensure visual connections between the functions and to give the users an overview of what is happening above or below them. This also lets the light further into the building and creates well defined spaces in the open social space.

1 ALL 1000 M2 LAID OUT IN ONE PLAN.

2 THE SQUARE METRES ARE RAISED IN FIVE LEVELS MINIMIZING THE AREA OF EACH PLAN, CREATING INTIMACY, A CLEAR OVERVIEW AND MINIMIZING THE DISTANCES TO WALK AS VERTICAL MOVEMENTS WILL BE BY LIFT.
THE RAISED LEVELS ARE ZONED VERTICALLY WITH MORE PRIVATE ZONES UPSTAIRS AND EASILY ACCESSIBLE FUNCTIONS IN THE LOWER FLOORS ADRESSING THEMSELVES TO FIRST TIME USERS.



3 THE PLANS ARE PARTITIONED INTO ZONES IN THE HORIZONTAL DIRECTION WITH THE PRIVATE FUNCTIONS PLACED TO THE NORTH WITH A VIEW OF THE QUIET GREEN PARK AREA AND THE SOCIAL FUNCTIONS PLACED ON THE SUNNY SIDE TO THE SOUTH WITH A VIEW OF THE MORE LIVELY AREA OF DE GAMLES BY. THE MIDDLE ZONE IS A FLOW ZONE BETWEEN THE TWO ZONES ENABLING THE USERS TO SIT ON THE EDGE OF THE SOCIAL GATHERINGS.

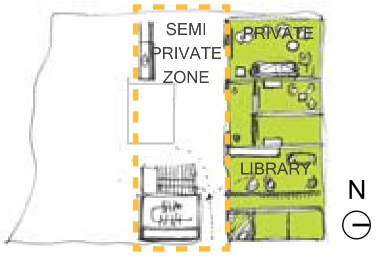


4 THE PLANS ARE MODIFIED AND OPENED UP IN THE MIDDLE CREATING SPACES IN THE OPEN SPACE, ENABLING VISUAL CONNECTION BETWEEN THE FUNCTIONS AS WELL AS ENABLING THE DAYLIGHT TO REACH FURTHER INTO THE BUILDING.

5 THE PLANS ARE EMBRACED BY THE LIGHT WOODEN FACADE STRUCTURE DEFINING A CONNECTED OPEN SPACE IN THE VERTICAL DIRECTION BETWEEN THE PLANS AND CREATING A WARM AND INTIMATE ATMOSPHERE AS IT FILTERS THE LIGHT AND GIVES IT THE WARM GLOW OF WOOD.

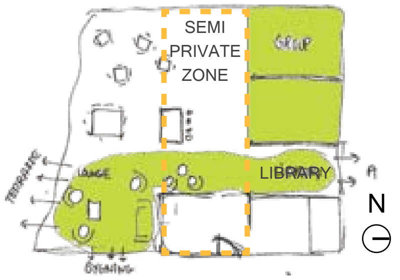
The external as well as the internal concept of the Cancer Health Care Centre are further developed. Initially, the plan is optimized in regards of light, flow and overview.

PLAN DETAILING



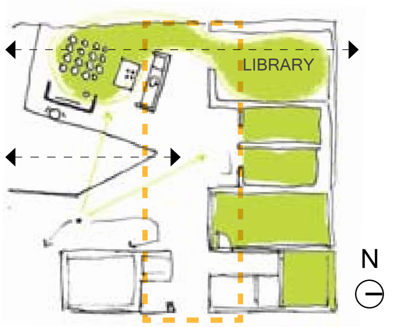
GROUND FLOOR

Ill. 98.1 Initiating sketch of the ground floor. The private zone is relatively closed creating a sharp transition from the semi private zone to the private zone



GROUND FLOOR

Ill. 98.2 Initiating sketch of the ground floor. The library is extended out into the semi-private zone softening the transition between the two zones.



GROUND FLOOR

Ill. 98.3 Initiating sketch of the ground floor. The library is moved to the North-West facade creating a more defined zone for the semi-private reading lounge near the kitchen.

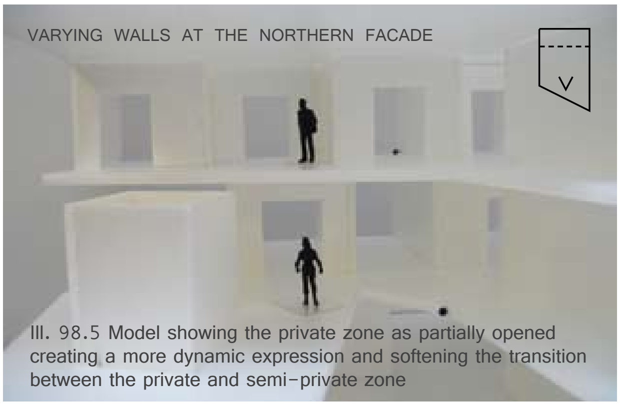
OPENING THE ZONES

The further development of the plan evolves around softening and partially opening the private zones to further divide into zones of more and less privacy, creating a flowing connection between the semiprivate and private zones and creating a more informal atmosphere around the private rooms. Furthermore the opening of the zones enables a view through the building, and enables the daylight to enter from various sides, creating a more even, pleasant light.

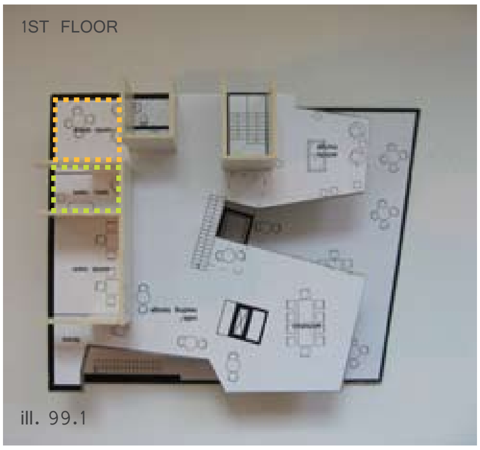
Initially, the library is placed to the right of the entrance area to create an easy access for first time visitors, who mainly wants to find information and maybe sit unexposed in the library, while getting a view over the centre, before they are encouraged to further step into the building. (See ill. 98.1) To soften the transition between the private and semi private zone, the library is extended into the semi private zone with a small reading lounge easing a further step into the building from the library. (See. ill. 98.2) However, the semi private sitting area seems to be undefined and exposed, as it is placed by the entrance area. For this reason, the library is moved to the North West corner creating a more defined room for the reading lounge in the semi private zone with a view of the kitchen and the social functions. The library still seems easy to access and clearly visible from the entrance area. (See ill 98.3)

The conversation rooms are pulled back defining a small seating niche in front and creating a more dynamic expression in the layout of the enclosed rooms. The kitchen is moved from the middle of the room, to the West facade to further define the kitchen space, creating a flow zone in the middle of the room between the different zones and to the outdoor space to the South of the building. (See ill 98.3)
Ill. 98.4-5 show a model of the private zone as closed or partially opened, respectively. The partially opened private zone in clearly illustrates a more dynamic and room defining layout where the transition between the private and semi private zone is more floating.

Ill. 98.4 Model showing the private zone as closed creating a sharp separation of the private and semi private zone.



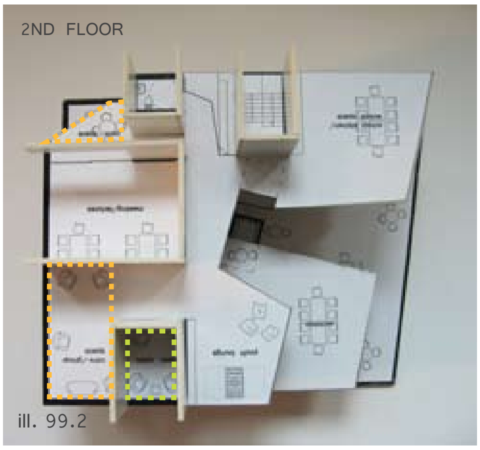
Ill. 98.5 Model showing the private zone as partially opened creating a more dynamic expression and softening the transition between the private and semi-private zone



ill. 99.1

OPEN CONVERSATION SPACE

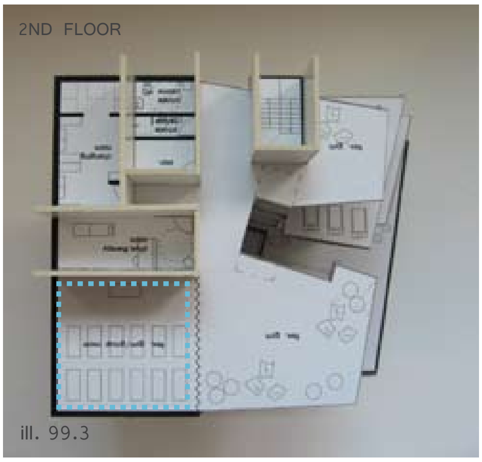
CLOSED CONVERSATION ROOM



ill. 99.2

OPEN CONVERSATION SPACE

CLOSED CONVERSATION ROOM



ill. 99.3

FLEX GYM & GROUP ROOM

DOUBLE PROGRAMMING

To further optimize the private zones, it is decided to double programme some of the closed rooms and in stead obtain more open private niches that can be used for various functions such small meetings, conversations or just quiet contemplation. An open niche can be easier to access and use than an actual enclosed room, and may ease taking a difficult and serious conversation.
The open niches further increase the flexibility in the building plan creating a more lively atmosphere. This is furthermore partly chosen with a reference in the case studies of the Maggie's Centres where open private sitting niches are placed in various places of the centres creating an informal atmosphere around the private zones and furthermore softening the transition between private and social zones.

One closed conversation room is placed on each of the three bottom floors supplemented by open private conversation spaces allowing the users to decide the level of privacy during conversations. (See ill. 99.1-2)
The combi- group- and meeting rooms almost all have the same room size and also serve many of the same activities, why the different rooms are flexible and can be shared between the three functions.
Each of the three bottom floors have one closed room functioning as either combi-, group- or meeting room. The rooms are additionally supplemented by the open conversation spaces that can be used for smaller meetings or family conversations.
The gym area on the 4th floor can be closed off to also function as a larger group- or meeting room. (See ill. 99.3)
The enclosed rooms are all thought to be with sliding doors, so they can be kept open making them more inviting and again giving an option of choosing the level of enclosure and privacy.

MODIFYING THE FLOOR PLANS

To emphasize the vertical connection between the plans and to define space around the open social functions the cutting of the plans is further detailed and extended to other places than the South facade.

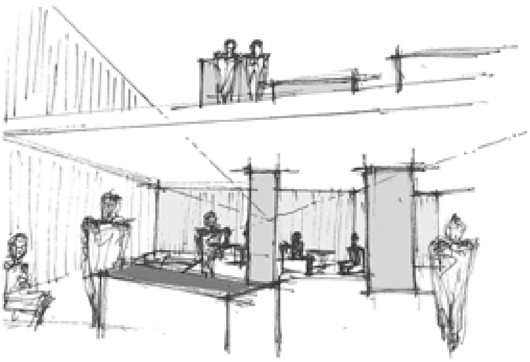
The library is partitioned into two levels continuing on the first floor as the functions on the first floor also comply with the library function. Hereby, the first floor is cut in the corner creating a vertical connection in the library. (See ill. 100.1) Modifying the plan like this creates a dynamic expression of the layout, making the ceiling of the ground floor appear light and floating. (See ill. 101.6-7)

The stairs between the floors is initially thought to be in one place, but as the plans are modified, it seems relevant to move the stairs to the different cuttings between the plans emphasizing the vertical connection and varying the flow and experience up through the building.
The lift will function as the main connection between the plans, as many of the users will be weak from their illness, making the lift the preferred connection path. The lift is placed in the middle of the room easily accessible and visible. (See ill. 100.1)

The plans are further cut open in the semi open conversation zones in the Northern facade varying the room experiences through the creation of double high spaces, making the light flow and dissolving the strict North facade of rectangular rooms.
The plans of the open social functions are modified to define spaces creating an expression of the social functions as islands cantilevering into the open bright space from the bearing structure of the enclosed rooms. (See ill. 101.4-5)
The vertical opening of the plans emphasizes the structural system of the bearing room cores, the bearing internal fire escape and the cantilevered plans highlighting the expres-sion of the plans beings strung out by the bearing room core structure. (See ill. 101.1-2)

The plans are additionally pulled back from the South facade emphasizing the vertical connection between the social functions through the creation of a shared tall vertical space optimizing the visual connections between the plans and further emphasizing the contrast of the embracing facade structure and the internal core structure. (See ill.101.3)

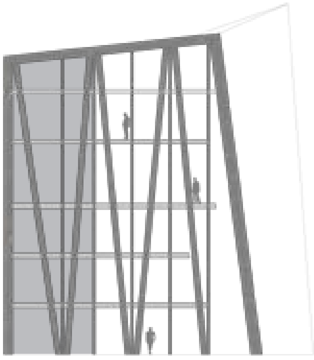
Ill. 100.1 Illustration of the 1.st floor with the vertical connecetion in the library



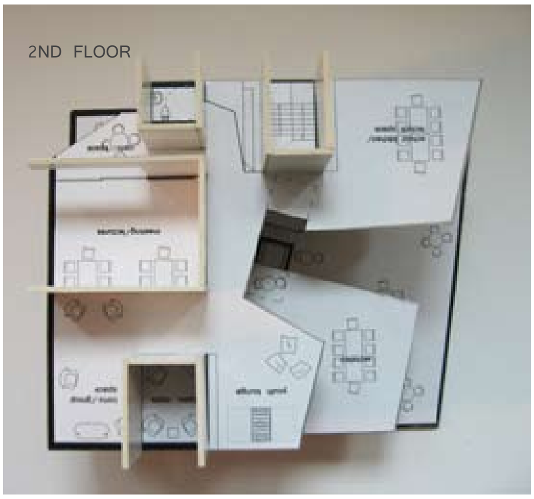
ill. 100.2 Perspective of the vertical connection between the 1st- & 2nd floor.

ill. 101.1: The plans and how they interact vertically, seen from West.

ill. 101.2: The plans and how they interact vertically, seen from North.



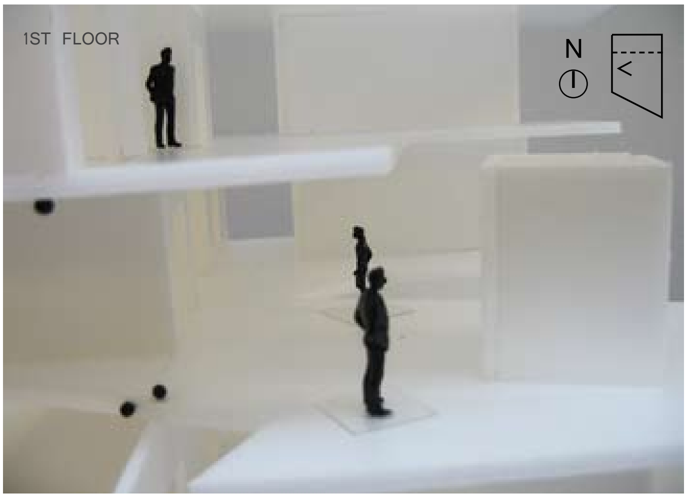
Ill. 101.3: Section showing how the plans are pulled in from the facade.



Ill. 101.4

Ill. 101.6-7:Model pictures illustrating the vertical connections between the plans. The ceiling seems to float, and the light flows into the middle space.

Ill. 101.5

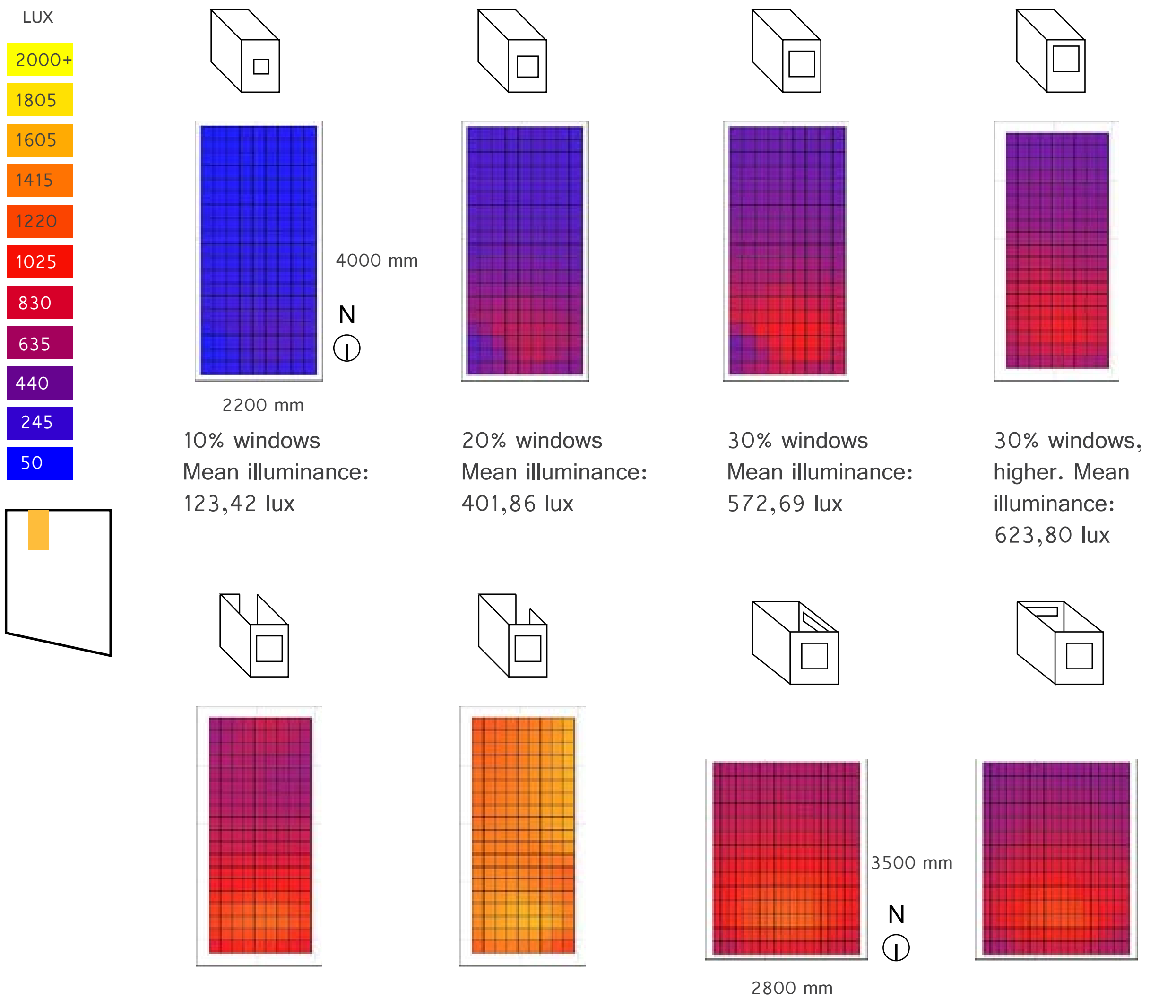


THE NORTH FACING ROOMS

The enclosed rooms of the Cancer Health Care Centre are placed towards the North with the recreative, quiet view of the park. The challenge is to provide these rooms with sufficient daylight, as the Northern facade receives a smaller amount of light than the other facades. Special consideration is made to obtain the required mean illuminance of 500 lux as well as gain an even light in the rooms to avoid glare.

Ill 102.1 shows initiating investigations of the illumination levels of the north facing conversation rooms, showing that it is possible to obtain a relatively high illumination level and a relatively even distribution of the light with a window area of 30%.

It is desirable to keep the window area towards North relatively small, to lower the heat loss in the building and reduce the energy consumption, and as 30% windows seem sufficient this forms the base of the further process.



10% windows
Mean illuminance:
123,42 lux

20% windows
Mean illuminance:
401,86 lux

30% windows
Mean illuminance:
572,69 lux

30% windows, higher. Mean illuminance:
623,80 lux

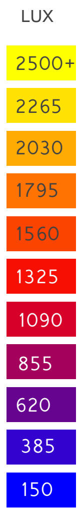
30% windows, wall open towards South.
Mean illuminance:
832,52 lux

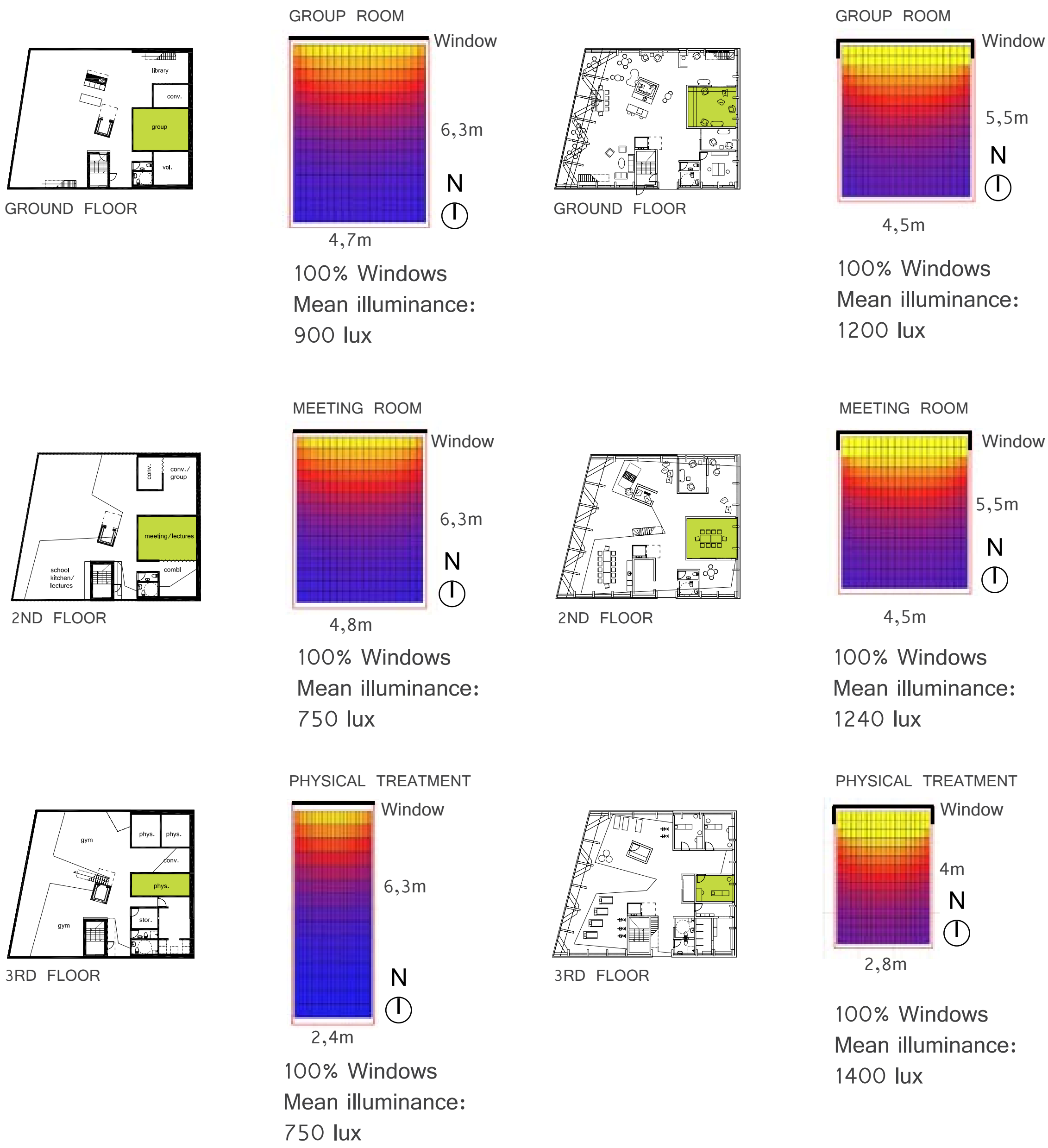
30% windows, wall open towards South.
Mean illuminance:
1397,80 lux

30% windows, window 2000x500 towards West.
Mean illuminance:
869,81 lux

30% windows, window 2000x500 towards South.
Mean illuminance:
755,08 lux

Ill. 102.1 Lighting investigations of the North facing conversation rooms.





Ill. 103.1 Lighting investigations of the North facing group-, meeting- and combi rooms.

The investigations show that the illumination levels are higher if the rooms are opened in the side letting in light from the surrounding room why this possibility is created in all conversation-, meeting- and combi rooms. As mentioned earlier, this also creates a possibility to choose the level of privacy when using the rooms, making it less formal. When the rooms are closed, however, the light is a bit uneven, and to avoid this the shape of the room is reconcidered.

The further detailing evolves around the remaining private rooms towards North.

The first part of the investigation show that the incoming light is not distributed evenly in the large group- and meeting rooms in the ground floor and on the 2nd floor because of the relatively large depth of the rooms. (See ill. 103.1) Furthermore the physical therapy rooms on the 3rd & 4th floor are unevenly illuminated because of the depth.

Thus the shape of the rooms are changed to diminish the depth, creating a more even illumination of the rooms.

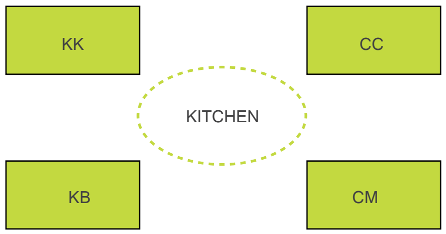
Small windows are additionally placed in each side of the walls of the North facing rooms near the facade pulling in lights from the surrounding rooms and furthermore emphasiz-ing the facade structure from the internal system of the room cores and the cantilevered plans.

PLANNING THE ADMINISTRATION UNIT

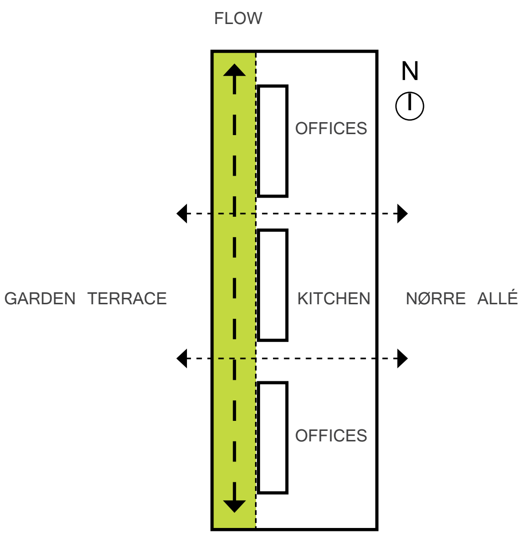
The concept comprises a division of the Cancer Health Care Centre into two units, rehabilitation and administration, in order to create a clear building layout and all offices and functions connected to these has been gathered in the administration unit.
It is clearly stated in the competition programme, that it is of high importance that the people working in the centre have a space of there own where they can retreat and talk to each other without disturbing or being disturbed from the users of the Cancer Health Care Centre.
Regarding the relatively large scale of the centre it is furthermore assumed that the employees have arranged time schedules between administrative work and working with the cancer patients why dividing the two functions will not cause any inconvenience for the employees.

It is sought to create a strict and clear layout of the administration unit reflecting and emphasizing the outer rectangular shape of the building volume, which contrasts the vertical and angled volume of the rehabilitation unit and links to the composition of the buildings in De Gamles By. (See ill. 105.4)

Ill. 104.2 View from the corridor in the administration unit.



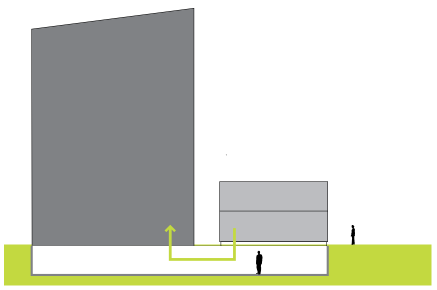
Ill. 105.1 Diagram of the function division in the Administration building



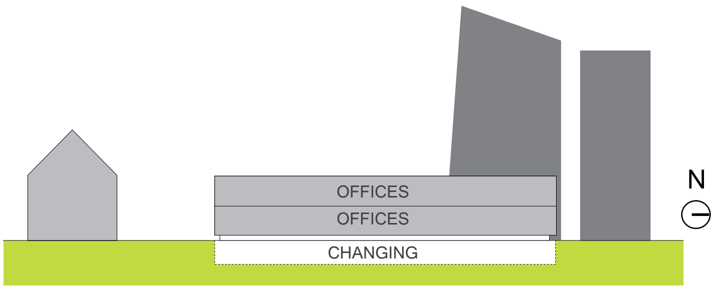
Ill. 105.2 Diagram illustrating the layout principle of the Administration building.

The offices are divided into four sections comprising the Centre Manager (CM), The Danish Cancer Society (KB), Copenhagen Municipality (KK) and the Course Centre (CC), respectively. (See ill. 105.1)
The office sections are all placed towards the East facade with a view of Nørre Allé connected by a straight corridor along the West facade creating a distance between the administration offices and the outdoor Southern space of the rehabilitation unit. (See ill. 105.2)
The offices are divided into two floors with the Danish Cancer Society and the Centre Manager placed in the ground floor and the Copenhagen Municipality and the Course Centre in the second floor.
The office zones are divided by a kitchen area on each floor and a double high dining area pulling in light in the middle of the building, defining the different office zones and creating a vertical connection in the building.
The offices are created as open spaces separated from the corridor by small printing or sitting niches creating an open and light interior of the building and breaking up the corridor. (See ill. 105.1-2)

The rehabilitation unit and the administration unit are connected through the basement allowing the volumes to be separated above ground emphasizing the different functions of the two units, as well as enabling an easy access to the unit for the employees.
To create a light and pleasant passage to and from the rehabilitation unit, the basement is raised 0,8 meter above ground with a window band pulling in light to the basement rooms. The window band furthermore emphasizes the horizontal lines of the administration building and makes it seem less heavy. (See. ill 105.3-4)
The basement contains all technical rooms and the staff changing rooms. The changing rooms are placed to the North near the main entrance of the administration unit and near the passage to the rehabilitation unit easing the accessibility.



Ill. 105.3 Principle diagram showing the basement connections between the two buildings.



Ill. 105.4Principle diagram showing the levels of the Administration building and the link to the lower scale of “De Gamles By”

PLANS

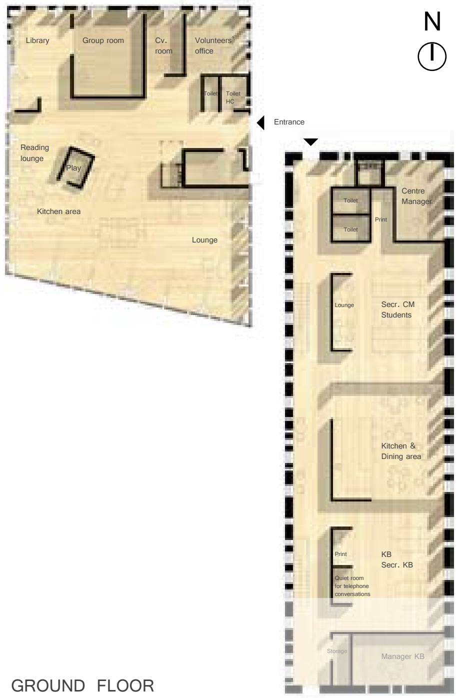
The two functions; rehabilitation and administration are divided into two units, emphasizing the rehabilitation unit as a landmark in the surrounding area and as the main function of the Cancer Health Care Centre, making it easy for the users to recognize where to go.
The rehabilitation building and the administration building are connected through the basement allowing the volumes to be separated above ground emphasizing the different functions of the volumes.

In relation to the indoor concept the plans of the rehabilitation unit are divided into zones of different social or private characters complying with the needs of the users in relation to the defined parameters in the evidence based design guide. (See p. 64)
The private zone is towards North with a view over the park, and the social zone is to the South which is the sun side, and where there is a view of De Gamles By.
To ease the transition between the different zones and to create a more informal atmosphere around the private zone, small open niches are created next to the closed rooms allowing the users to chose their level of privacy.
The ground floor of the rehabilitation unit contains the main entrance of the building.
The entrance area is placed behind the fire escape in the semi private zone creating a secluded area where the visitors can collect themselves in privacy and get an overview of the building before entering completely.
To further define a clear building layout and to gain better daylight conditions the plans are cut in the open zones and moved back from the facade optimizing the vertical visual connections between the floors.

The administration building contains offices for the staff working at the centre.
The offices are divided into four sections of the different departments working in the centre. The office sections are all placed near the East facade with a view of Nørre Allé connected by a straight flow line along the West facade, which creates a distance between the administration offices and the Southern outdoor space of the rehabilitation unit.

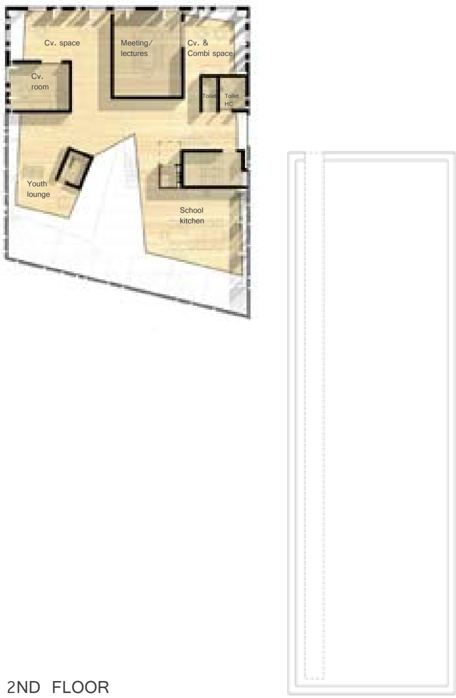
Ill. 107.1-7: Plans, 1:500

BASEMENT



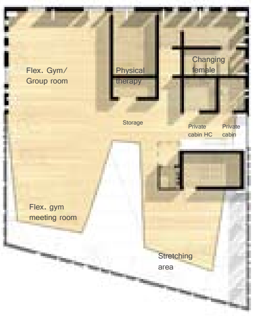
GROUND FLOOR

1ST FLOOR



2ND FLOOR

3RD FLOOR



4TH FLOOR

5TH FLOOR

THE OUTDOOR AREA

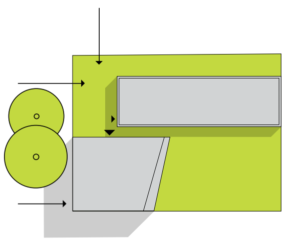
The site of the Cancer Health Care Centre is kept in a green layout linking to the expression of the surrounding area with the park North of the site and De Gamles By speckled with small green grass areas and large trees creating a contemplative and peaceful atmosphere surrounding the area.

The entrance to the centre should be clear and inviting, in relation to the described evidence based design guide, easing the overcoming of stepping into the centre (see p. 64).
The main entrance of the Cancer Health Care Centre is placed facing East towards the beginning of Nørre Allé, as most users will arrive from this direction either by car, public transportation or by foot from the hospital.
Additionally, parking lots are placed along Nørre Allé creating the possibility for physically impaired users to be set off very close to the building.

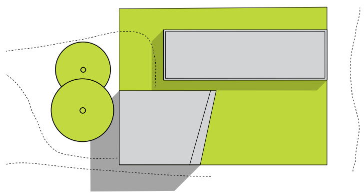
A secondary entrance is placed in the library in the ground floor facing the park and linking to an existing path, creating the possibility for a peaceful walk between the tall old trees of the park. An additional path leads from the traffic junction North of the building site to the centre creating the possibility to collect one self in the quiet and calm surroundings of the park before going to or from treatments in the hospital.
The paths emphasize the link between the park and the building and draws in the green to become part of the building experience and extending the possibilities for outdoor stays around the building.

A private wooden garden terrace extends from the building towards the South, enabling the kitchen/café area to be taken out by opening up sliding doors in the South facade. The terrace is sheltered from the busy area of Nørre Allé by the administration unit of the centre and by small trees to the West of the site creating a private and tranquil atmosphere.

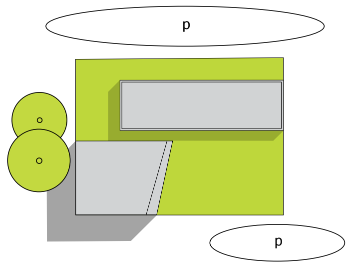
Additionally, a private roof terrace is placed in the fifth floor, connected to the gym spaces inside the building, defining a quiet and secluded outdoor space with no views from passers-by and providing a great view of the surrounding context.



THE ENTRANCES TO THE CENTRE.



PATHS AROUND THE CENTRE.



PARKING AREAS AROUND THE CENTRE.

Ill. 109.1: Site plan, 1:1000


Herb garden
Flower bed
Arrival through the park
Flower bed
Contemplation path
Flower bed
Herb garden
Pavilion
Library path
Bike parking
Entrance
Roof Terrace
Kinder garten
Garden Terrace
Nørre Allé
Bike parking
Henrik Pontoppidans Vej
Entrance
"De Gamles By"

The structure which embraces the interior of the Cancer Health Care Centre will shelter from the sun and provide views to the outside, but also create a protected space for the cancer patients.

FACADE DETAILING

FACADES

The following section describes the process of detailing the facades for the Cancer Health Care Centre. The first section comprise the design of the facades for the rehabilitation unit and the following section describes the design of the facades of the administration unit.

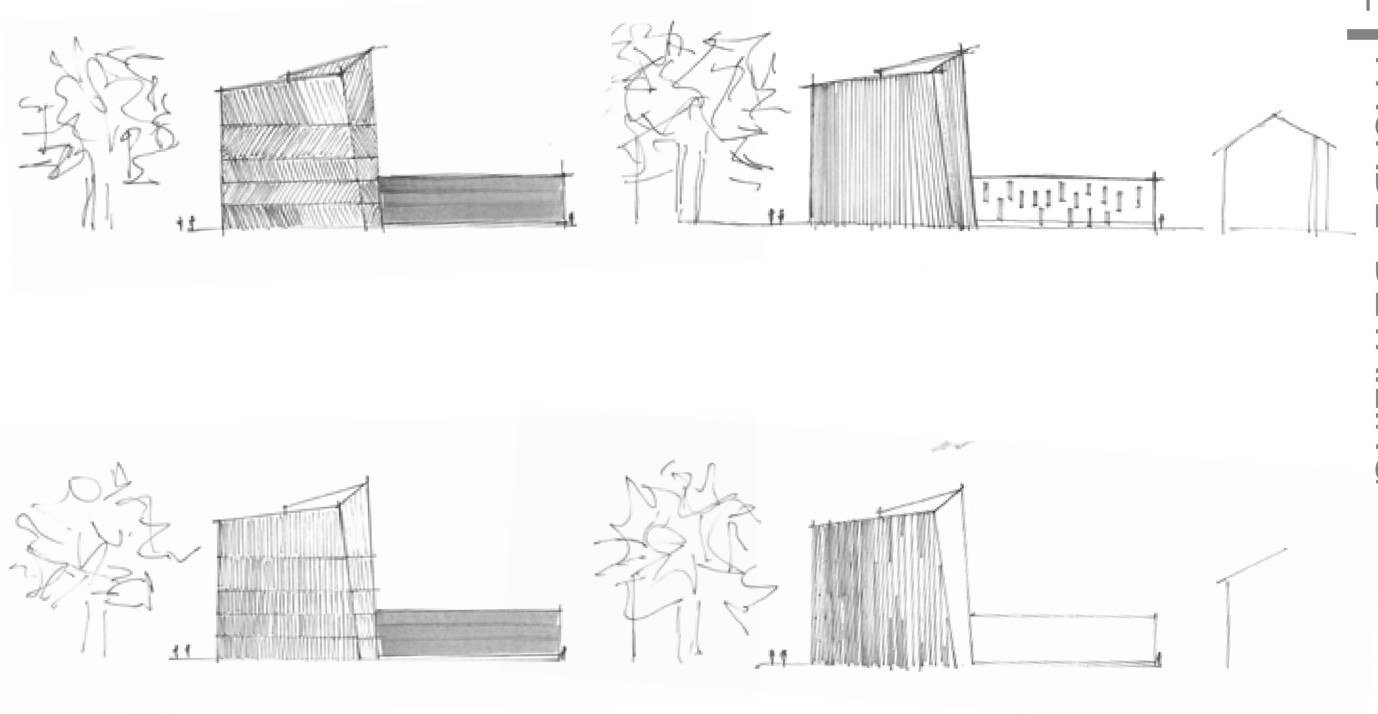
As previously described, it is decided to create the facades of the rehabilitation unit as a light wooden structure wrapping and embracing the interior spaces. The structure is thought to be of wooden slats, that will filter the light into the building and appear light and semi transparent from the outside.
The wooden material will color the reflected light in warm and golden tones creating a warm and pleasant atmosphere inside in the building. (See ill. 112.1-3)

Ill. 113.1-4 illustrates initiating sketches of various facade structures.
In illustration 113.1-2 the wooden slats are divided in the height of the floor plans to visualize the internal structure in the outer facade and to give the large facade a more human scale. However, the division of the slats gives the building a horizontal character, making it appear plump not contrasting the horizontallity of the administrations unit.
It is therefore tried to have the wooden slats reach from top to bottom emphasizing the verticality of the building and making it appear slim and tall contrasting the administration building and conforming with the tall urban context of Nør-rebro. (See ill. 113.3-4)
To give the facade a more dynamic expression, some of the slats are cut in various places, diverting the light and shadow cast internally in the building and varying the views from the inside to the outside. (See ill 113.4)
The further detailing evolves around light investigations determining the dimensions of the wooden slats and the distance between them. It is important that the structure does not block to much of the daylight as the illumination demands inside the building are very high in the social functions, as they require 2500 lux to have a therapeutic effect, which can help reduce depression and fatigue of the cancer patients.
Furthermore, some of the cancer patients may be sensitive to exposure to direct light, why the facade structure should reflect a large part of light minimizing the direct light and additionally creating a warm and pleasant lighting atmosphere inside the building. (See p. 114-115)

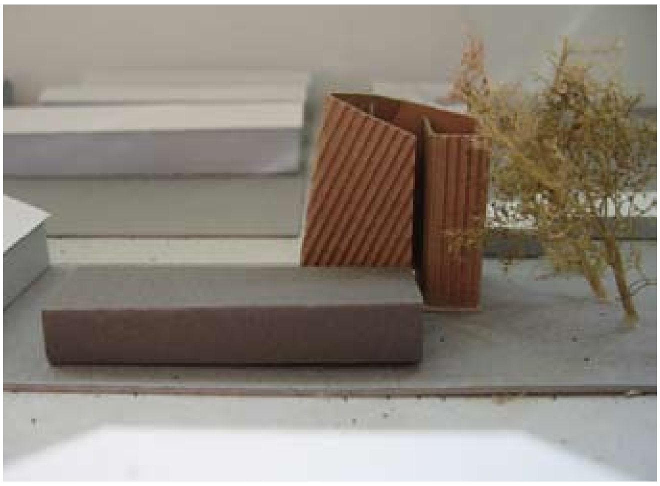
Ill. 112.1: Barcelona Biomedical Research park by Manel Brullet & Albert de Pineda, Spain.

Ill. 112.2: Roosendaal Market Square Pavillon by René Van Zuuk Architecten, Netherlands.

Ill. 112.3: Pavillon of Versailles by Exploration Architecture, France.



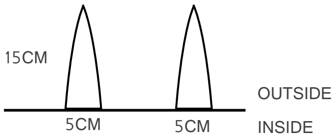
Ill. 113.1 - 4 initiating sketches of the wooden facade structure as either tall vertical slats or slats divided by the internal plans.

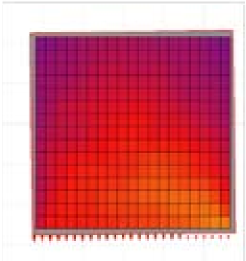
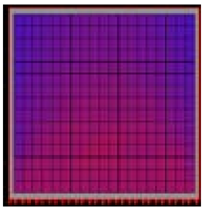
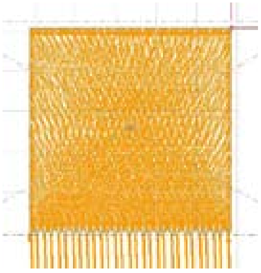
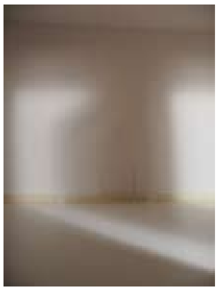
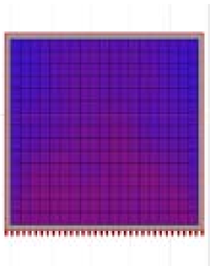
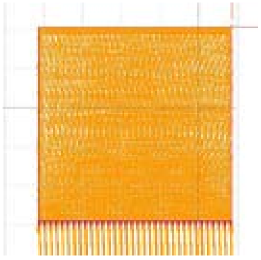
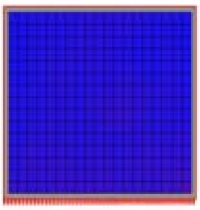
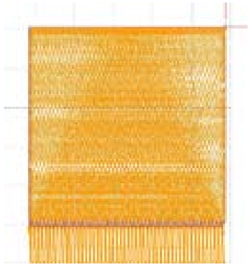


Ill. 113.5-6: Model pictures of the wrap embracing the rehabilitation unit.

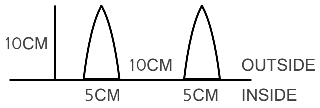
LIGHT INVESTIGATIONS

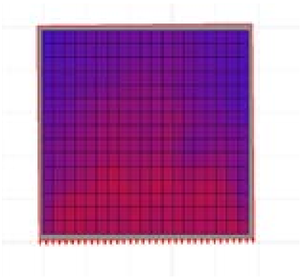
To determine the dimensions of the wooden slats and the distance between them, investigations are done in illuminance levels diagrams and ray diagrams in Ecotect for the 21st of March as well as in a mock up model. The investigations are done fore slats with a width of 5 cm, as early trials in the mock up model has shown that not much light enters with wider slats. An investigation has been made of the entire floor plan with 100% glass

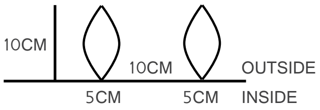


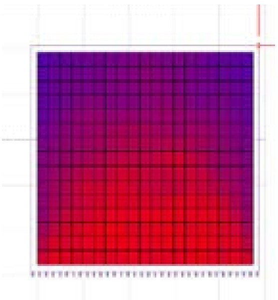
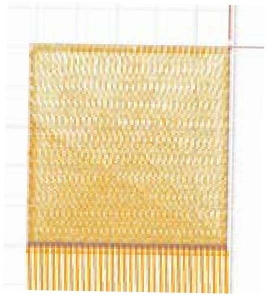
SLATS 5 X 15 CM	LIGHT DISTRIBUTION	REFLECTED LIGHT	MODEL INVESTIGATIONS
15 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 1154,23 LUX BLOCKED SUNLIGHT: 23% THE REFLECTED LIGHT IS RELATIVELY SCATTERED, BUT THE ILLUMINANCE IS HIGH BLOCKING ONLY 23% OF THE INCOMING DAYLIGHT. THIS HOWEVER GIVES AS SUSPICION THAT THE SLATS DO NOT SHADE ENOUGH.			
15 & 10 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 701 LUX BLOCKED SUNLIGHT: 56% THE REFLECTED LIGHT IS NOW MORE EVENLY DISTRIBUTED, BUT THE SLATS ARE BLOCKING 56% OF THE SUNLIGHT CREATING A SMALL MEAN ILLUMINANCE LEVEL.			
10 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 565 LUX BLOCKED SUNLIGHT: 65% THE AMOUNT OF REFLECTED LIGHT IS HIGH, CREATING A SOFT LIGHTING ATMOSPHERE IN THE ROOM. THE ILLUMINANCE HOWEVER IS SMALL AS THE SLATS BLOCKS 65 % PERCENT OF THE INCOMING DAYLIGHT.			
5 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 275 LUX BLOCKED SUNLIGHT: 83% THE REFLECTED LIGHT IS SMALLER AND NOT DISTRIBUTED MUCH, AS THE RELATIVELY SMALL SPACING BLOCKS 83 PERCENT OF THE INCOMING LIGHT.			

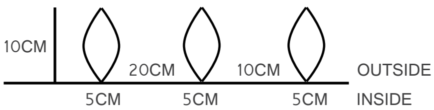
for comparison. (See app. 4) 100% glass gives a mean illuminance of approximately 2100 lux, and to gain 2500 lux it is estimated that the mean illuminance should be 1500 lux. In relation to this, having 60% of the light entering should be sufficient, thus 40% can be blocked without compromising the desired lighting levels.
The investigations here are done for a simplified room, where one has been tested without the slats to compare how much the slats reduce the lighting levels.

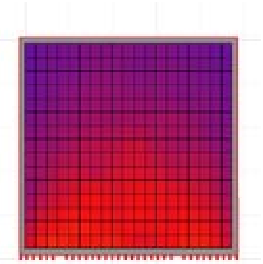
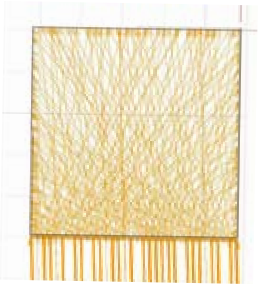


SLATS 5 X 10 CM	LIGHT DISTRIBUTION	REFLECTED LIGHT	MODEL INVESTIGATIONS
10 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 729 LUX BLOCKED SUNLIGHT: 54% THERE IS SLIGHTLY LESS REFLECTED LIGHT THAN WITH THE 15 CM DEPTH. HOWEVER THE MEAN ILLUMINATIONS LEVEL IS HIGHER.			



10 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 882 LUX BLOCKED SUNLIGHT: 45% THE REFLECTED LIGHT IS EVENLY DISTRIBUTED AROUND THE ROOM AND THE ILLUMINA-TION LEVEL IS HIGHER THAN WITH THE RECTANGULAR SLATS.			

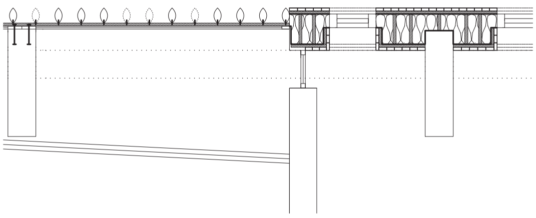


10 AND 20 CM SPACE BETWEEN SLATS MEAN ILLUMINANCE: 933 LUX BLOCKED SUNLIGHT: 42% THE REFLECTED LIGHT IS STILL EVENLY REFLECTED BUT MORE SCATTERED, HOWEVER THE ILLUMINATION LEVEL IS HIGH, AND LESS LIGHT IS BLOCKED, WHY THIS FACADE STRUCTURE IS CHOSEN FOR FURTHER DETAILING.			

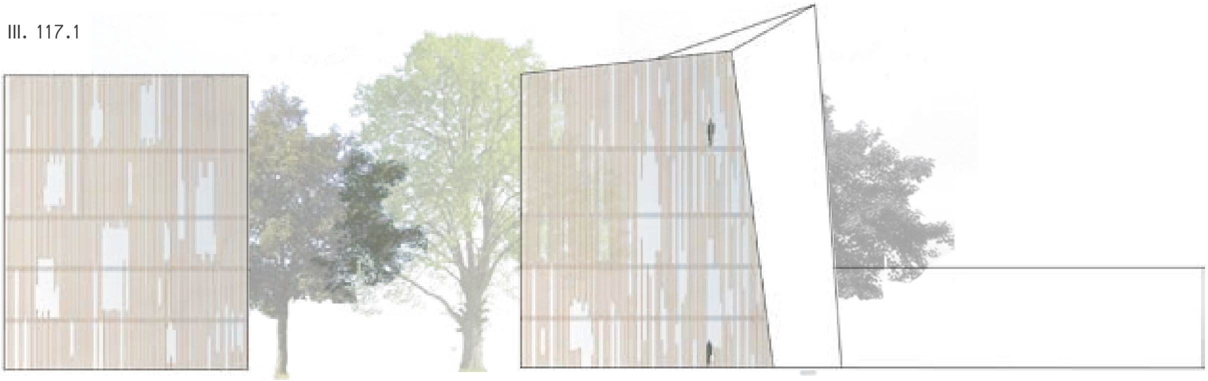
FACADES

From the light investigations it is concluded to have slats, which are rounded of in the edge, and with 5 cm width and 10 cm depth in a distance of 10 cm and 20cm. Having the slats sit too close blocks too much light, whereas having them to far apart gives less reflected light. The rounded edge increased the lighting level as they let more reflected light into the building. These seems to give the best reflected light in the mock up model and further only blocks 42% of the light, why it can be assumed that the required lighting level of 2500 lux and 1500 lux as a mean illuminance is obtained, based on the investigations done of the entire plan with 100% glass. (See app. 4) It is further an idea from the facade expression, that the slats are cut in various places, why they will have larger distances some places, increasing the incoming light.

The further detailing of the facade takes its point of departure in the sketch of vertical slats being cut in several places to vary the expression, the light income in the building and the views from inside. (See ill. 113.4)
In the ongoing process, the North facade and the West facade are sketched on simultaneously.
The North facade has to be insulated to lower the energy use and the temperature variation whereas the Southern and half of the West and East facades are in glass. To emphasize the embracing expression of the facade structure, the same structure is desired to be recognizable in all facades thus special consideration is given to the transition between the insulated walls to the North and the glass facades to the South. (See Ill. 116.1)
In ill. 117.1 upward striding irregular openings are placed various places in the West facade continuing to the North facade. The glass facade is more transparent as some of the slats are removed graduating the facade from more closed by the private closed rooms to the North and more open by the social functions in the Southern facade.
The openings in the Northern facade are made more stringent but they do not seem to underline the vertical lines in the structure making the building appear plump.
For this reason it is tried to have the irregular openings continue in the North facade with some smaller vertical windows underlining the vertical lines of the structure. In the glass facade more slats are furthermore removed accentuating the vertical lines. (See ill. 117.2)
In ill. 117.3 the openings are made slimmer and more vertical continuing in the North facade. However the irregular openings seem to create a ragged and unconnected expression of the facade, why they are made more rectangular creating a complete expression of the facade structure. (See ill. 117.4)
The following detailing of the facades evolves around optimizing the facade structure, to gain the right illuminance levels and views in the Northern facing rooms.

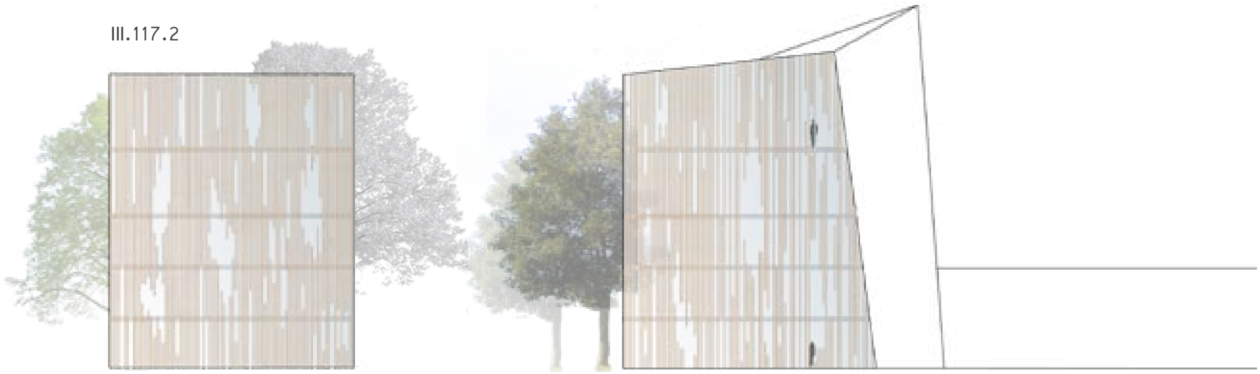

116.1 Horizontal section detail of the facade 1:50

Ill. 117.1



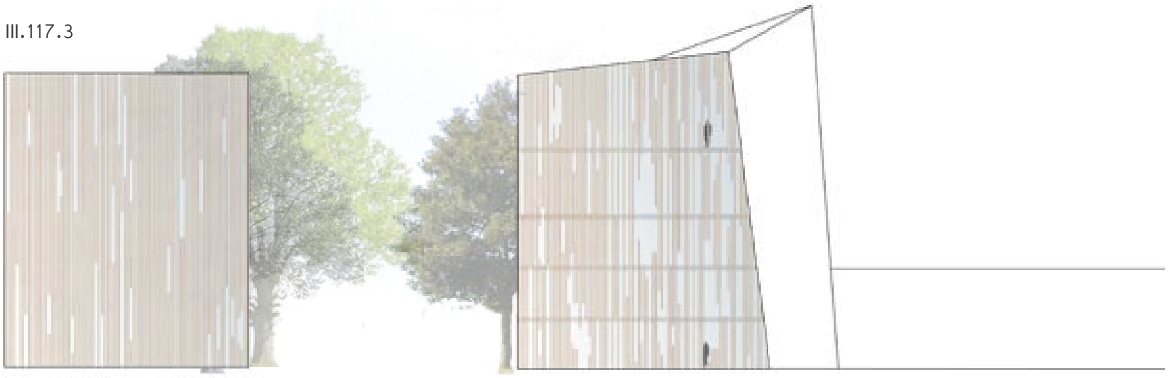
NORTH FACADE 1:500 WEST FACADE 1:500

Ill.117.2



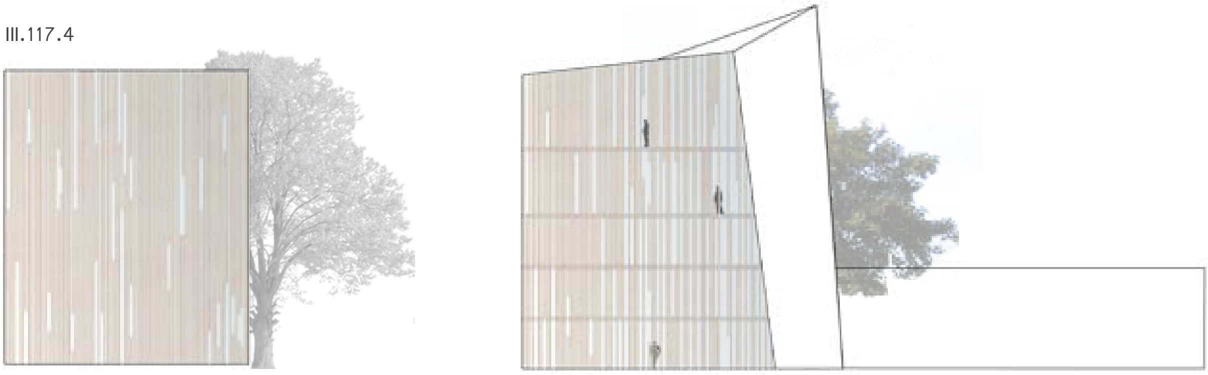
NORTH FACADE 1:500 WEST FACADE

Ill.117.3



NORTH FACADE WEST FACADE

Ill.117.4

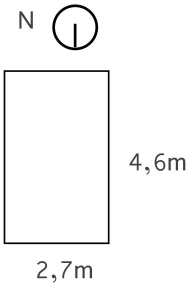


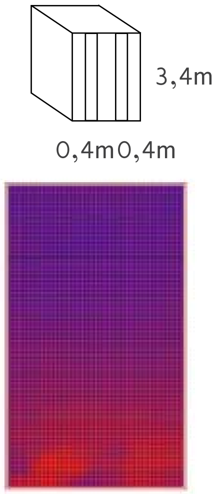
NORTH FACADE WEST FACADE

THE NORTH FACADE

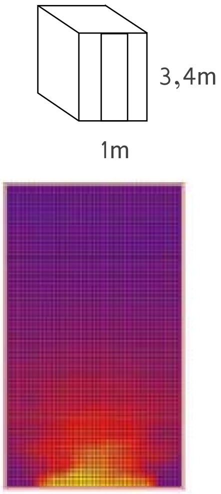
To detail the facade structure, it is relevant to investigate the closed rooms to see, how the light is distributed through the windows as well as how the views are from the rooms to the outside. The investigations evolve around the North facing conversation rooms as they have the smallest facade and less window area to illuminate the room.

The lighting demand for the conversation rooms is 500 lux and it should be evenly distributed to create a pleasant light in the rooms and to avoid glare. Furthermore there should be a good view of the park from the rooms, as this creates a recreative atmo-sphere in the room. The window sizes and areas should also comply with the low energy demand, why there is a limited window area permitted.

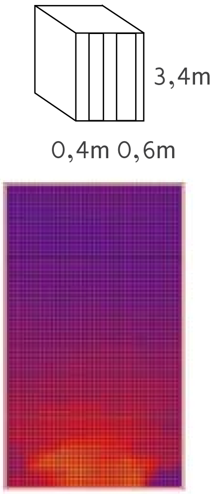




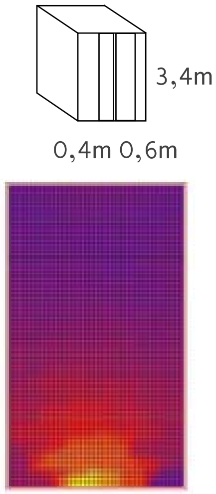
30% windows
Mean illuminance:
744 lux



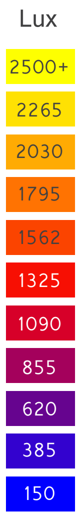
37% windows
Mean illuminance:
851 lux

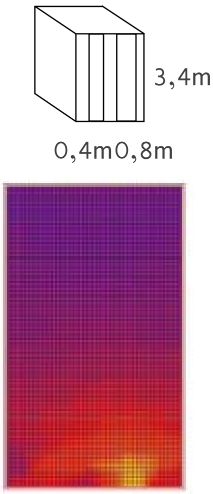


37% windows
Mean illuminance:
825 lux

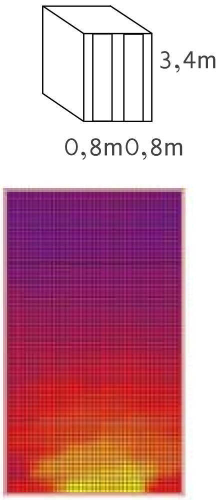


37% windows
Mean illuminance:
850 lux

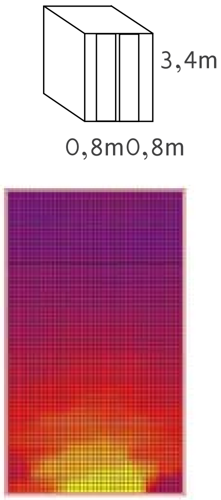




44% windows
Mean illuminance:
900 lux



60% windows
Mean illuminance:
1070 lux



60% windows
Mean illuminance:
1078 lux

30% windows
Mean illuminance:
808 lux

Ill. 119.1 View from the conversation room with two times 0,4m windows. The slim windows sizes are blocking the view.

Ill. 119.2 View from the conversation room with 0,4m & 0,6m windows. The large space between the windows seem to block the view.

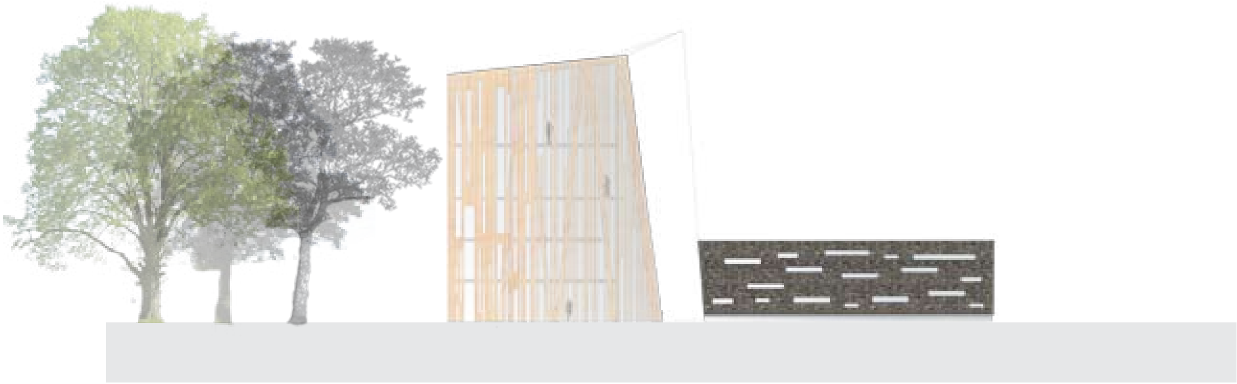
Ill. 119.3 View from the conversation room with 0,4m & 0,6m windows. The close placement of the windows make them seem like one creating a better view from the room.

Ill. 119.4 View from the conversation room with 0,4m & 0,8m windows. The illumination level is 900 lux with the 0,8m window making the room appear light and welcoming.

The initiating investigation takes its point of departure in the chosen North facade with slim vertical windows of 0,4m.
The investigation shows that the mean illuminance is 744 lux, which complies with the demand, but the slim windows seem to block the view from the room creating a closed atmosphere (See ill. 119.1). The following investigations are made with wider windows combined with the slim windows to keep the upward striding vertical lines in the facade, but to ensure a better view from the room.
It is chosen to incorporate the windows sizes of 0,4 m and 0,8 m placed close together so they from the inside seem as one window and create a nice, framed view from the room. (See ill. 119.4) Furthermore, the light is more evenly distributed in the room, with a higher illuminance level in the back part of the room, and a mean illuminance level at 900 lux.
It is desirable to keep the window area towards North relatively small, to lower the heat loss in the building and reduce the energy consumption. In terms of obtaining the desired amount of daylight it is seen, that minimum 30% of the facade needs to be window, which is also appropriate in terms of the energy use.
The investigations of two times 0,8 m windows exceed the amount of window area desirable in the North facade in terms of the building energy use, and it is also concluded that the high illuminace levels from these large windows are higher than actually needed.
Furthermore the slimmer windows of 0,4m are important in the facade expression, as they emphasize the vertical lines of the building conforming with the tall urban context of Nørrebro.

THE ADMINISTRATION UNIT

The initial design of the facade expression of the administration unit focuses on the West facade.
The expression of the administration unit should be in the background of the rehabilitation unit emphasizing this as a landmark containing the essential functions of the centre.
The expression of the administration unit should be strict and heavy contrasting the light and upward striving expression of the rehabilitation building. Also, it links to the symmetry of De Gamles By, which should be expressed in the facades.
The initial work evolves around different facade expressions and materials.
The facade is initially in dark bricks conforming with the brick buildings of the surrounding area. The windows bands are horizontal following the shape of the building and contrasting the vertical expression of the rehabilitation unit. However, the horizontal bands make the building appear chubby and does not compliment the rehabilitation unit. (See ill. 121.1)
The dark bricks furthermore seem dim compared to the functions of the centre.
In ill 121.2 the windows are placed in vertical slim bands complying with the upward striving lines of the rehabilitation unit and emphasizing the building volume. The material is changed to a lighter grey concrete to make the building stand more in the background. Yet, the concrete does not seem to comply with the surrounding context of De Gamles By as it has a flat texture and again gives a cold, dim expression.
It is tried to have the facade in lighter grey bricks, that seem to comply with the light wooden facade of the rehabilitation unit. Furthermore, the window sizes are changed to imply some wider windows of 0,8 m complying with the windows sizes of the rehabilitation unit and ensuring a good light income and view from the building. (See ill. 121.3)
Lastly, it is concluded, that the grey tones tried out in the administration unit all together give it a dim and cold look, and also it does not seem to compliment the existing buildings of De Gamles By. It seems to also contrast the fact that the administration unit links to De Gamles By through its shape and composition, and it seems more desireable to actually underline this link through materiality as well.
For this reason it is tried to have the facade material as red bricks complying with the red brick buildings of De Gamles By. Also the shape of the administration unit is modified in the height to compliment the existing buildings in the area. The red bricks complies with the warm tone of the wooden slats complimenting the rehabilitation unit, and give the administration unit a warmer expression. (See ill. 120.4)



Ill. 121.1 West facade with horizontal window bands and dark grey bricks.

Ill. 121.2 West facade with slim vertical window bands and light grey concrete.

Ill. 121.3 West facade with wider vertical windows bands and light grey bricks.

Ill. 121.4 West facade with vertical windows bands and red bricks.

FACADES

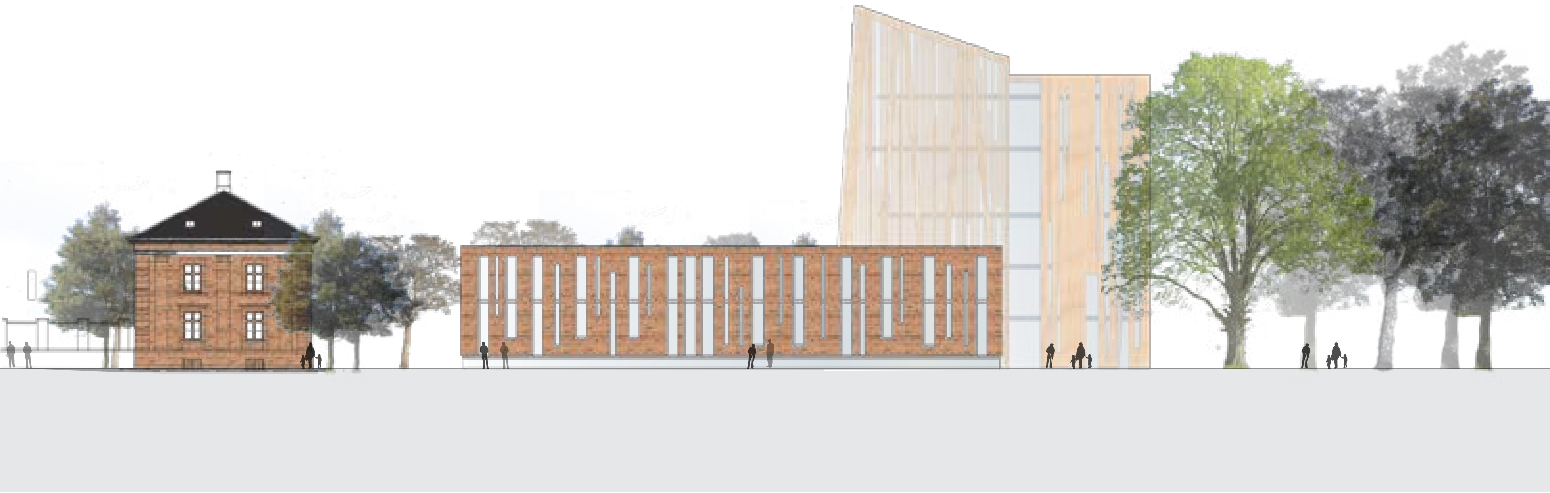
In relation to the outdoor concept the facade is designed as a light wooden slat structure wrapping around and embracing the rehabilitation unit protecting from incoming views and direct sunlight. The wooden material will color the reflected light in warm and golden tones creating a pleasant and tranquil atmosphere internally in the building.

To emphasize and express the inner partitioning of the private and social zones in the outer shape of the building volume the facade graduates from a strict and more regular expression in the North facade by the private zones to a more transparent and organic ambience in the South facade by the open social zones creating a dynamic expression of the structure embracing the building.

To highlight the expression of a tall slim building volume the vertical slats in the South facade are placed in bands differentiating in height creating a dynamic and organic appearance. The vertical bands are continued in more regular window bands in the Northern facade continuing the wrapping structure.

The shape of the administration unit is low and horizontal with a heavy expression in red bricks linking to the composition of De Gamles By, whereas the rehabilitation unit is tall and vertical in light wood conforming with the tall urban context of Nørrebro. A slim horizontal window band is placed along the ground of the administration unit stressing the horizontal lines of the building and furthermore creating a light and pleasant environment in the basement of the administration where the staff wardrobes are placed and the connection between the two building volumes.

WEST FACADE 1:500



EAST FACADE 1:500

SOUTH FACADE 1:500

NORTH FACADE 1:500

The indoor climate, the constructional considerations as well as the energy demand have been integrated iteratively in the process throughout the project. In the following it will be presented in a linear manner and through the final results.

TECHNICAL DETAILING

INDOOR CLIMATE SIMULATION

In a healing environment, the quality of the indoor climate in terms of temperatures and air quality is of high importance why the indoor climate is taken much into consideration in the development of the Cancer Health Care Centre.
The open common space towards South is a critical space, because of the large window areas, which are needed to obtain the desired lighting levels. The area is analyzed firstly in terms of the 24 hour average conditions and secondly it is simulated more precisely in B-SIM, to gain an understanding of the problems of over temperatures and temperature variations compared to the demands listed from the indoor climate analysis in the room programme (see p. 66). Finally these investigations are compared with the energy demands of a low energy building to see how the parameters comply.

24 HOUR AVERAGE

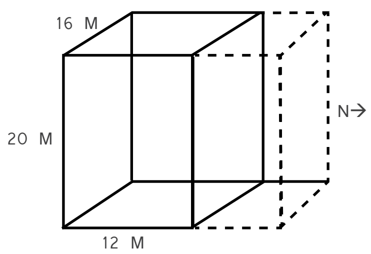
Early in the project analyses are carried out in a 24 Hour Average spread sheet in August, which is the warmest month in Denmark. The building is approximated as seen in the diagram below with a window area towards South of 80 percent and 50 percent towards West and East. (See ill. 126.2)

The spread sheet has limitations in the detailing of the parametres, as it is based on average values and does not enable regulations from hour to hour. Where the mean temperature can easily be fulfilled in the programme, it seems more difficult to fulfill the indoor climate demand of a temperature variation of only one degree. The spread sheet implies that only mechanical ventilation is used, which can be a result of the limitations of the program, where it is not possible to regulate the ventilation rates during the day from neither the mechanical nor the natural ventilation, why especially adding natural ventilation makes the temperatures unstable.

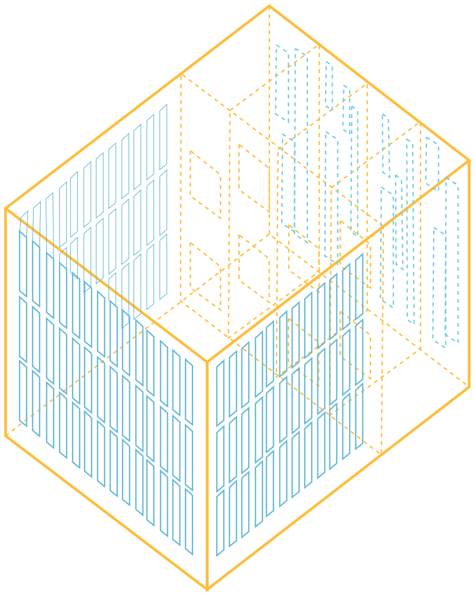
The energy demand rises significantly, when only mechanical ventilation is used, and it is not qualitative, as the feeling of opening up windows in the summer seems important in terms of creating a domestic atmosphere in the centre as well as connecting outdoor and indoor spaces. Furthermore, it is assumed that the demands of the indoor climate can be fulfilled with hybrid ventilation of both mechanical and natural, and that a more precise simulation of the indoor climate is needed to prove this.

24 HOUR AVERAGE				
	MECHANICAL VENTILATION RATE	NATURAL VENTILATION RATE	TEMPERATURE RESULTS	ENERGY USE, BE06
1ST TRIAL	0 H^{-1}	8 H^{-1}	MEAN: 21,9°C MAX. 24,1 °C TEMP. VARIATION: 4,5 °C	95,2 KWH/M2 P.A. (OVERTEMP. 0 KWH /M² P.A.)
2ND TRIAL	2,5 H^{-1}	0 H^{-1}	MEAN: 24,5°C MAX. 25,1 °C TEMP. VARIATION: 1,2 °C	122,2 KWH /M² P.A. (OVERTEMP. 20,4 KWH /M² P.A.)

Ill. 126.1: The results from the 24 Hour Average spread sheet, when inlet air has same degree as the outdoor mean temperature. Low temperature variations implies only mechanical ventilation and does not comply well with the low energy demand.



Ill. 126.2: Diagram showing the approximation made for the open commons space for the 24 hour spread sheet.



Ill. 127.1: The building as it is approximated in B-SIM. The open space towards South is the thermal zone chosen to simulate. Openings are made towards the spaces to the North resembling that the common spaces reaches out towards North in the library e.g.

DEMANDS		TEMP. CLASS A,	VARIATIONS CLASS B	TEMP. CLASS B,
SUMMER	MIN.	23,8°C	22,3°C	20°C
	MEAN.	24,3°C	24,3°C	22°C
	MAX.	24,8°C	26,3°C	24°C
WINTER	MIN.	21,1°C	19,6°C	18°C
	MEAN.	21,6°C	21,6°C	20°C
	MAX	22,1°C	23,6°C	22°C

Ill. 127.2: Design demands and their range within the PPD.

VENTING/VENTILATION			
	VENTILATION RATE	VENTING RATE	MAX. CO2-LEVELS
1ST TRIAL	0 H^{-1}	8 M^3/S	2286 PPM
2ND TRIAL	1 M^3/S	8 M^3/S	879,9 PPM
3RD TRIAL	1,2 M^3/S	8 M^3/S	805,8 PPM

Ill. 127.3: Diagram showing the need for mechanical ventilation also during summer. The simulations are made for three months, June, July and August, to get a broader spectrum for the CO_2-levels.

BUILDING SIMULATION

The open, common space towards South is simulated in the building simulation software, B-SIM, to obtain a more precise picture of the indoor climate. The process has been iterative, and to give an overview, the different parameters and their importance are presented, showing small iterations. The B-SIM model can be found on the attached cd-rom and further information is in the appendix 5.

METHOD

The model is approximated like in the 24 Hour Average spread sheet. The options for defining shading systems did not seem sufficient, so to create the wooden slat structure of the facade the model is approximated as best as possible. Thus the windows are divided into narrow windows, which each have side fins with the dimensions of the slats in the facade. (See ill. 127.1) An estimation of Winter and summer are simulated, represented by January and August, respectively.

The simulations show that it is difficult to fulfill the demand of the temperature variations of only one degree in this project as there are also demands for high lighting levels and a low energy consumption. By only using mechanical ventilation and including a separate cooling system the demand may have been possible to fulfill, but this increases the energy demand. A smaller amount of windows may also have been helpful, but this is not desirable in terms of creating a healing environment with qualitative use of daylight and therapeutic lighting levels. For this reason the simulations are done from a lower demand on temperature variations to indoor climate category B, as this is also a qualitative category, which seems appropriate. (See ill. 127.2)

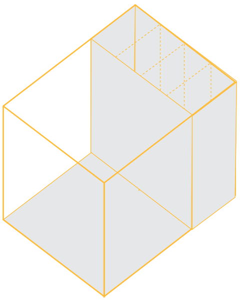
AIR QUALITY

In B-SIM ventilation comprises the mechanical ventilation, whereas the venting represents the natural ventilation, which is desired during summer to lower the energy demand.

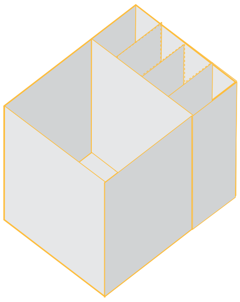
Two parametres are important: the air quality in terms of the CO_2-pollution, which is desired to be max. 800 ppm, as well as the need for cooling.

The diagram (ill. 127.3) shows that it is not sufficient to only have natural ventilation during summer in regards of the CO_2-levels, as it is set to be controlled by temperatures to avoid venting in cold hours. To have the CO_2-levels fulfilling the demand it is necessary to have a constant air change, regardless of indoor temperatures. For this reason mechanical ventilation with VAV-control (Variable Air Volume) is put on also during summer, regulating after CO_2-pollution, but with as low air change rate as possible. An air change rate of 1,2 m^2/s, is appropriate, as the CO_2-level is maximum 805,8 ppm. As the air change rates needed are lower than firstly expected, the energy consumption does not increase much.

Ill. 128.1: The ability to accumulate heat depends on a materials surface defined by its thermal resistance, the R-value. A concrete element covered by for instance plaster or wood has an increased R-value, reducing its accumulating ability. (R-values from B-SIM) [Miljøstyrelsen, 2007]



1st trial, thermal mass on floors, and North room walls, 1336 m^2.



2nd trial, approximation with thermal mass on all interior surfaces., 3000 m^2.

THERMAL MASS AREAS, B-SIM						
	AREA	HOURS				TEMP. MIN./ MEAN/ MAX.
		<22,3°C	>22,3°C	>26,3°C	>27,3°C	
1ST TRIAL	1336 M^2	0	740	41	25	22,00°C /23,05°C /32,13°C
2ND TRIAL	3018 M^2	0	744	25	14	22,45°C /24,72°C /31,20°C

128.2-4: Simulations with different amounts of thermal mass. By a large amount, the hours of overheating are reduced relatively much and temperatures are less varying.

THERMAL MASS AREAS		
1ST TRIAL	ALL IN CONCRETE	4669 M^2
2ND TRIAL	FLOOR PLANS WITH ACOUSTIC CEILING AND WOODEN FLOOR, WALLS IN SMALL ROOMS WITH PLASTER, EVERYTHING ELSE IN CONCRETE.	3316,6 M^2
3RD TRIAL	FLOOR PLANS WITH ACOUSTIC CEILING AND WOODEN FLOOR, ALL WALLS IN CONCRETE.	3593,6 M^2

128.5: Amounts of thermal mass possible in the building. In regards of the acoustic qualities, the middle one is appropriate.

SUMMER

Next to the CO_2-pollution, the temperatures and their variation are analyzed. Two parameters play a part in terms of gaining the desired temperatures and avoiding too high temperature variations during summer, and that is mainly venting and the thermal mass amount, apart from the shading mentioned earlier.

THERMAL MASS

Thermal mass comprises heavy material with a high heat accumulation ability, storing the excess heat during warm hours and releasing it in colder hours thus helping create more steady temperature variations. This makes it an important parameter and especially in buildings with large amounts of windows, such as the Cancer Health Care Centre. Thus it becomes important to obtain as much area of thermal mass as possible in terms of acoustical and aesthetic demands and qualities. The heat storing ability of thermal mass is reduced, when covered with other materials, such as plaster boards or wooden panels. The diagrams show the relations of thermal mass, covered or uncovered, areas tried out in B-SIM and the possible areas in the building. (See ill. 128.1) It is possible with considerations for acoustic quality and aesthetics to have an effective area of thermal mass of approximately 3300 m^2, which can be assumed to have a considerable effect on the indoor temperatures (see ill. 128.2-5).

VENTING

Two systems are defined for venting, as some days cause more problems with overheating, because they are hotter than average. One system is for "regular summer" and one is for "extreme summerdays" scheduled in the hotter weeks on the most critical hours of the day, from noon till late afternoon. This system is set to multiply the original venting system by a factor, resembling that on very hot days most windows assumably will be opened giving much higher air change rates to cool the building. It is further concluded that the set point temperatures need to be lower than the operative mean temperatures, likely because there is a certain delay in the cooling. However, they should not be lower than the minimum operative temperature of 22,3°C during summer months, as it naturally causes the temperature to drop below the minimum temperature at some hours. The diagram shows venting rates and set point temperatures (see ill. 129.3). The third and fourth trial are both appropriate considering hours of over temperatures. However, when they are simulated for the three summer months, it can be seen, that the fourth option with higher venting rates is better implying less ours of overheating. Of course it is doubtful, whether the high rates are comfortable and it is important to avoid draft. For hot days when the air is warm, the venting rate will naturally be high, as the windows will be opened more to get fresh air. To avoid the large venting rates, other parameters can be altered to prevent from overheating.

MEAN TEMPERATURES				
	SET POINT TEMP.	HOURS >26,3°C	HOURS >27,3°C	TEMP. MIN./ MEAN/ MAX.
1ST TRIAL	24,3°C	25	14	22,45°C /24,72°C /31,20°C
2ND TRIAL	22°C	17	11	20,45°C /21,27°C /30,67C

Ill. 129.1: Trial with lower mean temperature. For a mean temperature of class B, the tolerance limit temperatures should have been 26 and 27 degrees. To make it comparable, they have been set to 26,3 and 27,3 degrees.

COOLING COIL			
	HOURS >26,3°C	HOURS >27,3°C	TEMP. MIN./ MEAN/ MAX.
NO COOLING COIL	25	14	22,45°C /24,72°C /31,20°C
COOLING COIL, MAX. INLET TEMP. 21°C	23	9	22,45°C /22,85°C /29,65C

Ill. 129.2: Trials with and without a cooling coil.
A cooling coil can help ensure the inlet air is not as hot as the outside temperature, reducing the hours of overheating.

OVERHEATING

It is recommended as a tolerance limit that the operative temperature does not exceed 26°C for more than 100 hours a year, and 27°C for 25 hours a year. In the case of this project these temperatures are set to 26,3°C and 27,3°C relating to the relatively high desired operative mean temperature. [DS474, 1993]
There are too many hours of overheating, and a reason can be the need for a relatively high mean temperature.
Ill. 129.1 shows the role of the mean temperature in the overheating. However, a high mean temperature is relevant when dealing with ill people, who may suffer from various physical conditions and be more sensitive to cold.
If dispensation is given, another parameter is that it could be relevant to have a cooling coil in the ventilation system, which can cool the air in the summer and prevent the inlet air from being higher than 21 °C. This requires special permission in Denmark, but as the building facilitates ill people with high demands for the comfort, it can be imagined that an exemption will be allowed. In relation to energy, having a cooling coil cannot be applied in the energy verification programme Be06, why an assumption is made to get a picture of the increased energy demand. A cooling coil which controls the inlet temperature during summer, does not result in a much increased energy consumption (see p. 132-133).
It is further discovered that when adding a cooling system, the venting rates can be reduced radically, and thus it seems to be a reasonable solution. To get a higher mean temperature the set point temperature for regular summer heating needs to be higher. The final results can be found in appendix 5.

VENTING/VENTILATION													
	BASIC VENTING RATE	MAX. VENTING RATE	REG. SUMMER VENTING, FACTOR	SET POINT TEMP.	EXT. SUMMER VENTING, FACTOR	SET POINT TEMP.	REAL AIR CHANGE RATE, MEAN/ MAX.	HOURS <22,3°C	HOURS >22,3°C	HOURS >26,3°C	HOURS >27,3°C	TEMP. MIN./ MEAN/ MAX.	
1ST	8	10	1	22,5°C	2	22°C	10,21H^{-1}/ 22,37H^{-1}	5	739	31	15	22,47°C /24,83°C /31,40°C	
2ND	8	10	2	22,5°C	3	22°C	15,06H^{-1}/ 32,37H^{-1}	5	739	25	14	22,45°C /24,72C /31,20°C	
3RD	8	10	2	22,5°C	3	22,5°C	15,06H^{-1}/ 32,37H^{-1}	0	744	25	14	22,45°C /24,72°C /31,20°C	THREE MONTHS: 85 HOURS >26,3 46 HOURS >27,3
4TH	8	10	1	22,5°C	3	22,5°C	11,52H^{-1}/ 32,37H^{-1}	0	744	28	14	22,46°C /24,77°C /31,22°C	THREE MONTHS: 93 HOURS >26,3 50 HOURS >27,3
COOLING COIL													
5TH	8	10	1	23,5	1	22,5	4,09H^{-1}/ 12,37H^{-1}	0	744	17	9	22,45°C /23,74°C /29,34°C	THREE MONTHS: 68 HOURS >26,3 31 HOURS >27,3

Ill. 129.3: Trials of August with different venting rates and venting set point temperatures, and lastly with a cooling coil.

WINTER

The building is simulated in regards of the indoor climate conditions during winter. Different setting apply for this season, where the operative mean temperatures are different, comprising different settings for the heating system, and it is assumed, that the building will only be ventilated by mechanical ventilation.

Fulfilling the demands of the temperature variations and the operative mean temperatures is easier during winter than during summer, which compared to the 24 Hour Average result, is assumed to be because there is no natural ventilation, thus making the temperature variations more stable.

The important parameters in the winter season is the temperature of the inlet air from the ventilation system and the temperature settings of the heating system, in terms of the set point temperature and the minimum outdoor temperature. (See ill. 130.2)

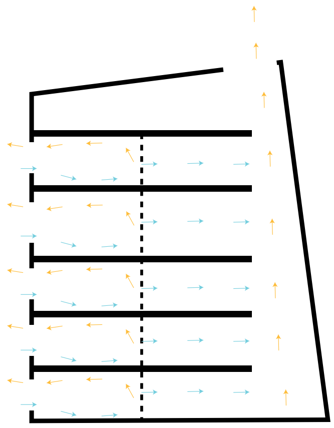
There is a reduced need for mechanical ventilation during winter, compared to summer rates. (See ill.130.1)
This is assumable because the CO_2-pollution is bigger in the warm weather, and can also be seen as a result of the ventilation in the winter being a constant factor, whereas during summer the temperatures are regulated with natural ventilation.

VENTING/VENTILATION		
	VENTILATION RATE	MAX. CO2-LEVELS
1ST	2 M^3/S	685 PPM
2ND	1,6 M^3/S	724,4 PPM
3RD	1,2 M^3/S	753,2 PPM
4TH	0,8 M^3/S	791,5 PPM

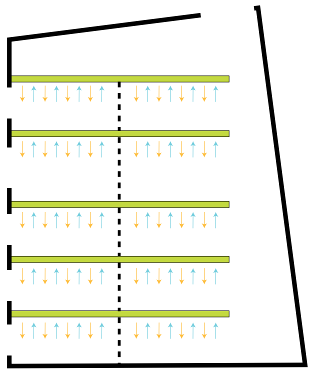
Ill. 130.1: Diagram showing the needed ventilation rate for mechanical ventilation during winter. The simulations are made for three winter months, to get a broader spectrum for the CO_2-levels. The resulting air change rate of 0,8 m^3/s corresponds to 0,7 h^{-1}.

HEATING							
	SET POINT TEMP.	TEMIN	HOURS				TEMP. MIN./ MEAN/ MAX.
			<19,1°C	>19,1°C	>23,6°C	>24,6°C	
1ST TRIAL	20°C	15°C	0	744	0	0	19,83°C /20,17°C /21,89°C
2ND TRIAL	22°C	20°C	0	744	0	0	21,59°C /21,89°C /22,86°C

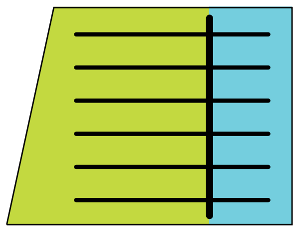
Ill. 130.2: Diagram of the heating settings.



Ill. 131.1 Diagram showing the natural ventilation principles of the building.



Ill. 131.2 Diagram showing the mechanical ventilation principles of the building.



Ill. 131.3 Diagram showing the mechanical ventilation principle if the building

VENTILATION PRINCIPLES

The following seeks to describe considerations of ventilation principles implemented in the building in terms of both natural and mechanical ventilation.
In regards of lowering the energy demand of the building, natural ventilation is implemented as a part of the ventilation system during the warmer months of the year.

NATURAL VENTILATION PRINCIPLE

The closed rooms have single sided ventilation when the doors are closed, meaning the rooms are ventilated through the windows pulling in air that will be heated by the building warmth and thus flow to the ceiling and out of the window again.
The building is furthermore optimized for creating a combination of buoyancy and cross ventilation because of the open spaces and height of the building. Fresh air is pulled in by the windows in the facades in each floor, and heated by the building warmth causing the air to be lighter. The warm air is let out in the tall vertical atrium space by the South facade creating a buoyancy effect and finally the polluted air is let out by the roof. (See ill. 131.1)

MECHANICAL VENTILATION

It is chosen to ventilate the building mechanically through a mixed ventilation principle where the inlets and outlets of the ventilation system both are placed in the ceiling.
The cantilevered floor plans are oversized on purpose to 0,4m making room for hiding the ventilation system in the ceiling.
The mixed ventilation principle decreases the possibility for draught in contrast to a repression principle where the inlets of the ventilation system should be carefully placed avoiding this. The mixed ventilation principle furthermore creates the possibility for a more flexible layout of the building as in- and outlets are placed in the ceiling.
The piping system should be simple and symmetrical to optimize it and decrease the energy consumption of the ventilator. Thus the main vertical pipe is placed in the wall of the closed rooms in the northern facade and horizontally along the floor plans. (See ill.131.2-3)

ENERGY DEMAND

It has been a goal for the project, that the Cancer Health Care Centre can fulfill the energy demands of the Low Energy Class 2, as a minimum.
The considerations for the energy demand has been a part of the design process from the beginning.
Initially analyses are carried out in a Month Average spread sheet, but this gives limited options for especially the ventilation, which is an important part of this project.
Thus, the investigations are further carried out in the energy verification programme Be06, which gives more elaborate options for regulating different parametres, such as the ventilation systems.

Initially, the shape of the building has been tried out according the energy demand, and furthermore the window amount to the North is taken into consideration as well as the need for high ventilation rates.
To gain the desired amount of daylight in the North rooms, a minimum of 30% windows is required.
Consequently, this has been possible to increase to 40%.
The room program lists different requirements for the ventilation rates, and to fulfill the high demand for a qualitative indoor climate they are quite high. The planning of the building evolves around opening up the rooms and double programming some of them. This enables having lower ventilation rates, which further suits the energy demand.
Thus the important parameters have been the ventilation in terms of natural or mechanical, air change rates, heat recovery and whether the ventilation system is temperature regulated, window areas and the construction in terms of U-values and thermal ability.

From the indoor climate simulations, it has been seen that it is a challenge to fulfill the high demands for a qualitative indoor climate, the demands for a qualitative daylight of high illuminance levels and at the same time comply with the low energy consumption.
The large glass area needed to create the qualitative lighting within the building comprises a bigger heat loss and also makes temperatures more unstable during a day.
However, the need for qualitative daylight is set in high priority.
The high demands for the indoor climate can imply use of only mechanical ventilation to make it easier to control the temperature swings and air quality. This however would increase the energy demand radically and further create a building, where the users would not have much freedom to feel at home as they would not be allowed to open windows and doors to the outside on warmer days.

The final results from B-SIM do not fully fulfil the desired demands, and small corrections can be an option to improve this, such as optimizing the amount of thermal mass as well

as lowering the operative temperatures demands a little. Also having a cooling coil in the ventilation system can be helpful and reduce the hours of overheating, if this is given dispensation. The model with the fourth trial in the diagram on the previous page is taken into BE06 to analyze and verify the energy consumption. (See ill. 133.1)
It is relevant to know, how much effect it has on the energy consumption, if the ventilation system has a cooling coil. However, this parameter is not registered in BE06 and adding cooling does not change the consumption, which can be seen as a result of BE06 not finding a need for cooling.
For this reason results for the energy demand for the ventilation is taken from B-SIM for comparison, and added as an extra value on the SEL-value, that is the specific energy demand for air transport in the ventilation system (see app. 6).

Some subsidies are allowed for the project, as it has a relatively high demand for ventilation and longer opening hours. (See app. 6) Currently, the subsidies are not applicable for low energy buildings, however it is assumed in this project, that as the low energy classes will be the regulatory demand in the near future, the subsidies will become applicable for them as well. From this consideration, it can be seen that the Cancer Health Care Centre fulfills the demand of Low Energy Class 2 with the subsidies, and is only a little too big to fulfill the demand of Low Energy Class 1 with subsidies.

BE06, KEY VALUES	
	KWH/M²
TOTAL ENERGY DEMAND	86,8
ENERGY FOR HEATING	46,4
ENERGY FOR VENTILATION, LIGHTING E.G.	40,5

Ill. 133.1: The energy demand of the building.

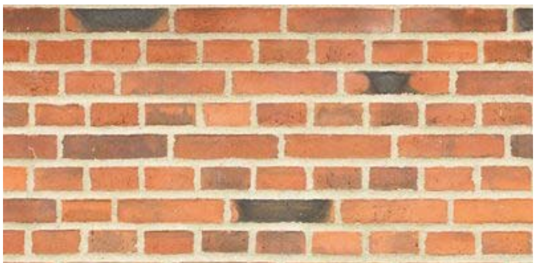
ENERGY DEMAND		
	LOW ENERGY CLASS 2, KWH/M²	LOW ENERGY CLASS 1, KWH/M²
REGULAR ENERGY DEMAND	71,4	50,9
SUBSIDIES	23,6	23,6
TOTAL ENERGY DEMAND	95	74,5

Ill. 133.1: The low energy class 2 demands with subsidies.

Larch wood
The vertical slat structure of the facade is in untreated larch wood

Pinewood
The bearing structure of the facade is in glue laminated pine wood

Light concrete
The cantilevered floors and rooms are in light concrete contrasting the light and smotth wooden facade



Red bricks
The administration building is in red brick varying in color complimenting the existing old building of De Gamles By.

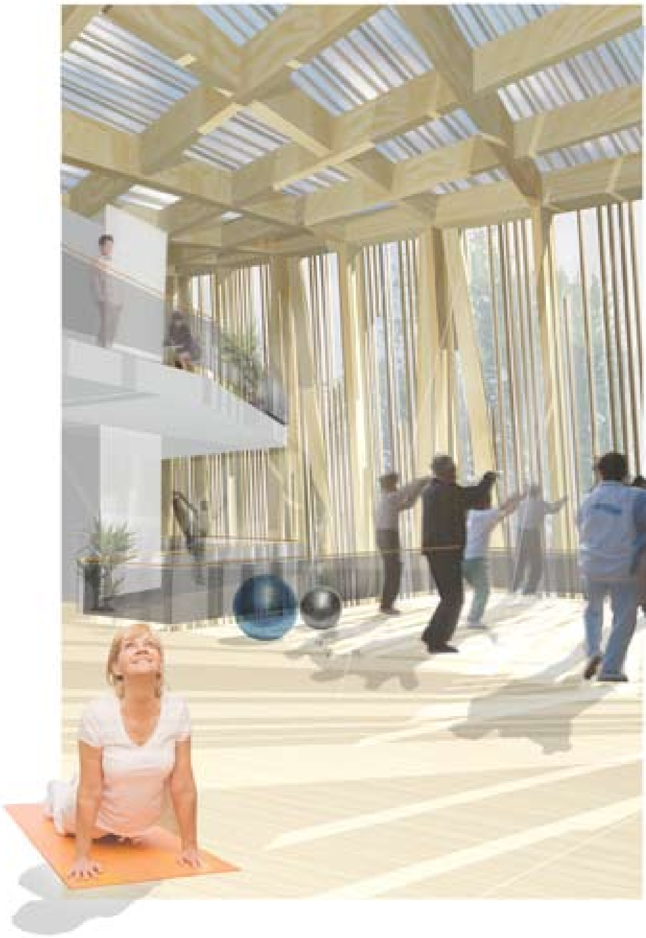
MATERIALS

The materials used for the Cancer Health Care Centre are raw materials complimenting each other and each used according to their structural abilities creating an honesty in the construction of the centre.
The wrapping facade structure of the rehabilitation building is in two layers with a vertical slat structure on the outside and a glue laminated wood structure on the inside as the bearing construction of the facade. The bearing facade structure is in glue laminated pinewood because of the good functional qualities that enables the wood to be used in large dimensions and spans. The vertical slats are in untreated larch wood creating a warm and light expression of the building through the smooth materiality and golden color of the wood. Larch wood almost only consist of pure heartwood thus it has natural ability to protect itself from various weather conditions. The wooden slats are untreated thus the color will change to a more greyish tone varying the expression of the centre through time. [Hatlehol Church Centre, 2009]
The wooden facade furthermore creates a warm atmosphere in the interior spaces as the wood colors the reflected light in warm and golden tones creating a pleasant lighting atmosphere.

The cantilevered floor plans and the walls of the enclosed rooms stand as a separate bearing structural system which is also shown through the change of materials to light concrete. The concrete elements furthermore serve as thermal mass, which is of high importance to stabilize the indoor temperature conditions. The heavy concrete furthermore contrast the warm smooth glow of the wooden facade structure emphasizing the materiality.

The floors however are covered with light ash plank floor reflecting the light through the lightly polished surface and creating a warm ambience as with the wooden facade structure.

The administration building is in red bricks varying in color and texture complementing the old red brick buildings of De Gamles By emphasizing the link to the composition along Nørre Allé. The red bricks creates a heavy rough expression of the administration building emphasizing the contrast between the two building volumes of the centre making the rehabilitation building stand out as a landmark in the area.

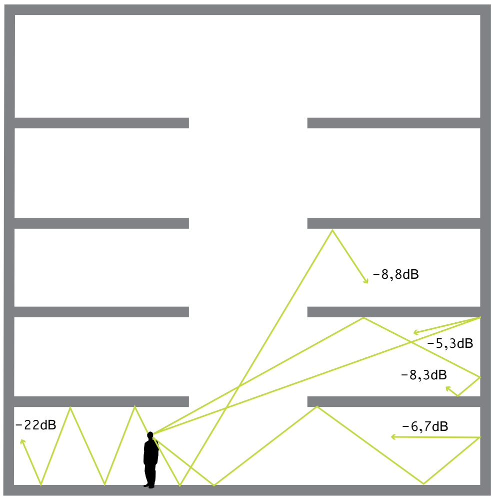


Ill. 135.1: View from the social zone.

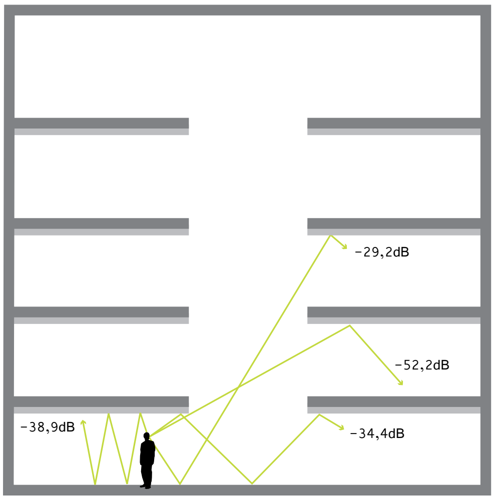
Ill. 135.2: View from the middle zone. The wooden facade and the floor gives a warm ambience, reflecting the light. The ceiling is of white acoustic plaster boards, and the walls stand in bright concrete, serving as thermal mass and bearing the floor plans.

REVERBERATION TIMES	RECOM-MENDED	CALCU-LATED
OPEN, COMMON SPACE	0,6 S	0,6 S
GROUP-, COMBI- AND MEET-ING ROOMS	0,6 S	0,6 S
CONVERSATION ROOMS	0,4 S	0,4 S

Ill. 136.1: The reverberation times obtained in the Cancer Health Care Centre.



Ill. 136.2:Sound distribution through the floor plans, with concrete ceilings. The sound levels are not reduced much, and rather serves as reflectors.



Ill. 136.3:Sound distribution through the floor plans, when there is acoustic ceilings. The sound levels are reduced markedly by the ceilings.

ACOUSTICS

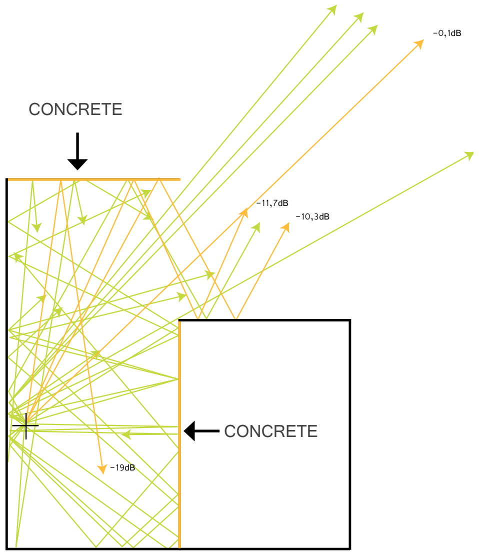
The Cancer Health Care Centre is designed with open plans horizontally as well as vertically to gain good connections between the functions, views through the building and to give the cancer patients an overview of the activities and the private as well as social zones in the building.
This, however requires special considerations of the acoustic conditions in the building. It is important that the functions on different plans do not disturb each other, and that the sound does not travel too far, ensuring a possibility for private conversations. For this reason low reverberation times are set as design values, which is taken into consideration when designing the interior. (See ill. 136.1)

THE SOCIAL SPACE

To prevent the sound from travelling through the different floor plans, it is necessary to have acoustic ceilings on each floor, which can absorb the sound and prevent it from disturbing in the floors above. Ill. 136.2-3 show the effect of the acoustic ceilings, through sound ray diagrams made in Ecotect.
The sound is lowered by a quite large factor, when acoustic ceilings are integrated.
Normal conversation will have a sound level of approximately 55 dB, and a reduction by circa 30 dB will leave a sound of 25 dB, corresponding to low whispering. (See ill. 146.1-2, app. 1.) In the big open space, the volume of the space is an essential factor, as the air volume has a profound effect on the reverberation time lowering it with many seconds.
Thus to gain the desired reverberation time it is sufficient to have the acoustic ceiling (see app. 7).

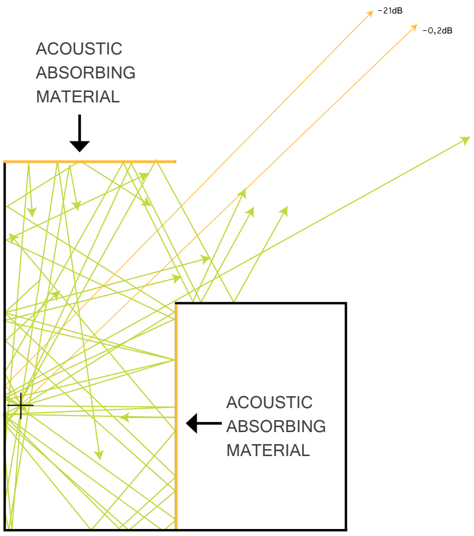
THE ENCLOSED ROOMS

The optimal reverberation time for conversation rooms and the group-, combi- and meeting rooms are 0,4 and 0,6 seconds, respectively.
These reverberation times are fulfilled by having a wooden floor and an acoustic ceiling, combined with the wooden facade structure being designed as an acoustic absorber, having a sound absorbing material in the wall and the wooden slats set with a small distance. (See app. 7)
From the building simulations and the estimations of thermal mass, it can be seen that the interior walls in the small rooms do not have to be bare concrete. However, to ensure the reverberation time does not become too low, there needs to be some reflecting material in the rooms, and it seems more relevant to use the wooden facade as acoustic wall than adding plaster on the concrete walls. Furthermore the thermal mass plays an essential role in the lowering of the temperature variation, why is decided to keep the concrete walls painted in white internally in the rooms.



137.1 Diagram showing an investigation of the open conversation space with concrete on the internal walls facing the open space.

CRITICAL RAYS



137.2 Diagram showing an investigation of the open conversation space with acoustic absorbing material placed on the internal walls facing the open space.

CRITICAL RAYS

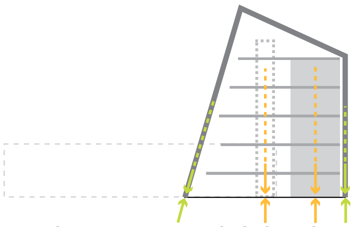
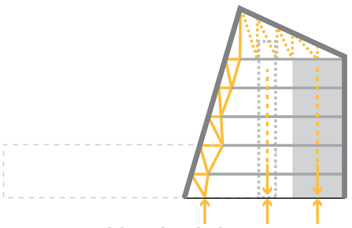
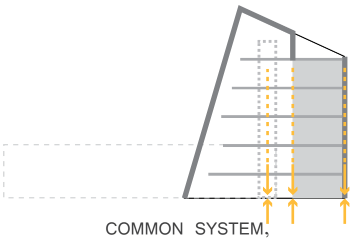
THE SEMI PRIVATE SPACE

To create the possibility for choosing various levels of privacy in the Cancer Health Care Centre, complying with the evidence based design guide, open conversation niches are created in the private zones, defining an informal atmosphere around the private zones of the building. (See p. 64)
However, these spaces should still have a private and intimate ambience suitable for confidential conversations, why it is desired to lower the sound traveling out of the room.
In relation to the indoor climate investigations, it is desirable to have a large amount of thermal mass inside the building thus the walls of the closed rooms are in concrete, also highlighting the bearing system of the internal building.
The insulated facade structure is designed with wooden sheathing on the inside created as an acoustic absorbing material.

Ill. 137.1 shows an investigation of the open conversation space with concrete on the internal walls. The sound source is placed in the most critical place of the room facing the concrete wall.
The investigation shows that some of the sound rays are reflected in the concrete walls and out into the open space. The rays are only lowered with 10 dB, which is not sufficient, as a normal voice will speak with approximately 55dB, and 45 dB can still be heard vividly. Thus, the acoustic environment of the space with these types of materials will weaken the confidentiality.
In relation to the section of indoor climate simulations and the calculation of reverberation times, it is possible to have less thermal mass on the outside of the closed rooms, when the internal walls are kept in concrete.
Thus the two walls facing the open space is covered with an acoustic absorbing material, such as plaster boards. (See ill. 137.2) The reflected sound inside the space is lowered as the surfaces absorb the sound, creating a private atmosphere, where people can speak in confidentiality without being heard by others.
Yet, there are still a few rays that does not strike any surfaces before continuing outside in the open space, but it is a small part of the total sound, and does not seem to obstruct the confidential atmosphere.

STRUCTURAL CONSIDERATIONS

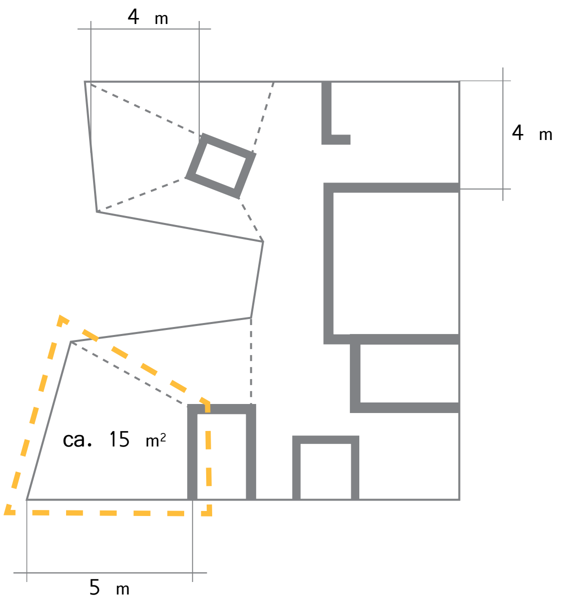
Different considerations of the structural systems of the building are carried out. It is important, that the bearing construction underlines the desired expression of the building, with the facade wrapping around the interior and protecting it from the sun and the outside world. The facade should be light and flexible underlining the embracing expression around the interior. The plans and the rooms inside are the interior element, and it seems important that the interior is separated from the facade structure underlining the relationship between the two.
From these considerations the two elements are separated into two separate bearing systems, one for the interior elements and one for the facade. (See ill. 138.1)
The walls of the rooms and cores bear the floor plans and vertical loads. (See ill. 139.1-2) Estimations are made on the dimensions of the bearing elements from diagrams of standard elements. [Ahler, 1997] The floor slabs cantilever a few meters, and to estimate the dimensions of the slabs as well as the bearing walls, exaggerations are made for the span widths and load areas. (See ill. 139.1-2)
The wooden facade is thought to be a structure of large glue laminated columns, of which some are tilting to stabilize the structure and withstand the wind loads. (See ill. 139.3)
The dimensions of the wood elements in the facade are estimated with reference to our 7th semester project with a self bearing facade construction of wood of similar character and dimensions. [Hatlehol Church Centre, 2009]

STRUCTURAL SYSTEMS	EXPRESSING THE WRAPPED STRUCTURE	EXPRESSING THE FLOORS PUSHING OUT INTO THE OPEN SPACE	A LIGHT, FLEXIBLE FACADE	EXPRESS OUTER STRUCTURE VERSUS INNER SPACES	FLEXIBLE SPACES
 SEPARATE BEARING SYSTEMS	+	+	+	+	(+)
 COMMON SYSTEM, FACADES BEARING FLOOR PLANS	(+)	–	–	(+)	–
 COMMON SYSTEM, CORES BEARING IT ALL	–	+	+	–	+

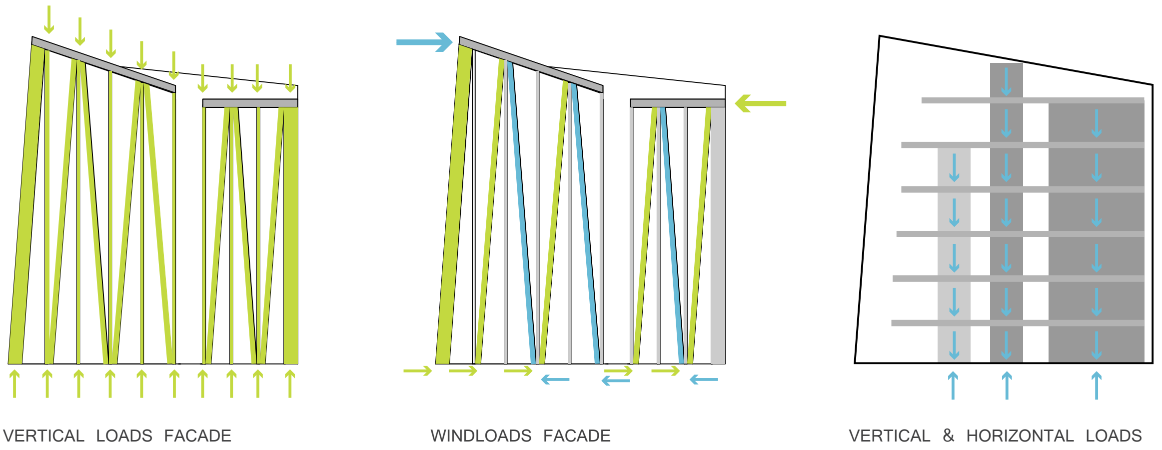
Ill. 138.1: Matrix of different options for the structural system.

ESTIMATED DIMENSIONS	
FLOOR SLABS, TT+6 PROFILE, PRE-STRESSED, ARMED CONCRETE	TT30/240+6 (276 MM)
BEARING WALLS, ARMED CONCRETE	180 MM
WOODEN FACADE STRUCTURE, CONSTRUCTION WOOD	700/185 MM 400/185 MM

Ill. 139.1: The dimensions of the constructional elements of the interior structure are estimated from diagrams of standard elements. [Ahler, 1997] The load is estimated as light commercial load, and the dimensions are estimated from an area load of 4 kN/m², as utility load, element weight e.g. The dimensions of the wooden facade structure are estimated from a previous university project.



Ill. 139.2: Exaggerated estimations are made of the floor slab spans and also of the load areas of the walls to cover the fact that the diagrams of the standard elements do not cover cantilevering elements.
For instance a load area of 15 m² pr. 4 meter wall, is said to be 75 m² for the 5 floors, but per 1 meter wall - an exaggeration 4 times the real case.



Ill. 139.3: Diagrams showing the load bearing structures of the facade and the internal rooms and floor plans.

CONCLUSION

The site of the Cancer Health Care Centre is on one side located in a scenic area, with the park to the North and the characteristic De Gamles By with classical red brick buildings in a strict symmetrical layout and an oasis like character, defined by greenery and tranquility. On the other side it is situated in the urban, dense area of Nørrebro, with busy main streets and large building blocks, such as the Panum Institute neighbouring the site and Rigshospitalet.

The Cancer Health Care Centre is divided in two units of administration and rehabilitation. The administration unit with the more formal character links to the existing buildings of De Gamles By through its horizontal shape, height and material, blending in with the area and continuing the edge of red brick facades facing Nørre Allé. Through its composition in line with the existing buildings, it protects the rehabilitation unit and the outdoor terrace to the South from the public street.

The rehabilitation unit stands out from the context with it's upward striving shape, opening up towards South West. The light wooden facade structure embraces the inner building, creating a protected, welcoming environment. The height conforms the tall buildings in the urban context, marking the building in the area.
The unit is pushed towards the North, opening up an outdoor space towards South, that creates a buffer and enables the sunlight to enter the building in spite of the shade from the existing building in front. As the administration unit follows the composition and morphology of De Gamles By, the outdoor area towards South furthermore allows the rehabilitation unit to stand out as a monument with a different character and scale.
Through the contrasting architectural expressions characterizing the Cancer Health Care Centre's two units, the centre stands as a focal point and at the same time respects the classical area of De Gamles By.

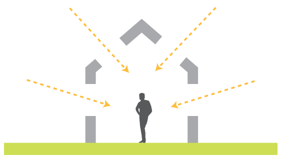
EVIDENCE BASED DESIGN

The evidence based design guide has formed the base of the project and will form the base of the further conclusion to describe the proposal for the Cancer Health Care Centre through the parametres from healing architecture.
Cancer patients suffer from various side affects as a result of their decease and the harsh treatment following it, comprising main issues such as fatigue, pain, stress, anxiety, depression, low self esteem, emotional vulnerability and low quality of life.
The evidence based design guide is based on architectural factors, which can reduce and relieve these conditions and hopefully contribute to an improved healing process of the cancer patients.

LIGHT

The utilization of daylight has been an essential parameter throughout the project, and it has been the goal to create therapeutic levels of light in the social zone, where people assummably will stay for longer periods of time. The exterior concept integrates light, as the

LIGHT



DAYLIGHT INCOME FROM ALL WORLD CORNERS

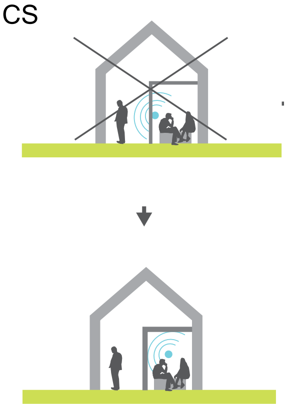
DARKER WOODEN MATERIALS IN BRIGHTLY LIGHT ROOMS

BRIGHT COLORS IN DARKER ROOMS

AVOID NORTH-SOUTH ORIENTATION

PREVENT GLARE THROUGH SOLAR SHADINGS.

ACOUSTICS



SOUND REDUCING WALLS AND DOORS SURROUNDING PRIVATE CONVERSATION ROOMS.

rehabilitation unit is pushed towards North to avoid the shade from the existing building to the South, and as the South facade is pushed a bit backwards to open up towards South West, where the largest amount of sunlight is directed from.

The interior concept integrates light, as the floor plans are cut open and pulled free of the facade, enabling the light to be distributed further into the building. The large glazed facades to the South, East and West enables light to enter the building from different sides, providing sunlight as well as diffuse skylight. The wooden slat structure shades from the sun, filtering the light and giving it a warm hue, as it is reflected into the building.
Even though the building is internally divided in a North-South orientation, the private zone towards North is opened up in places, creating small private niches and ensuring light to enter from this side as well, helping create even temperature levels in the building. The enclosed rooms to the North are optimized in their proportions as much as possible to gain good lighting conditions, and they are designed with sliding doors giving the rooms a more informal and flexible character, and thus enabling a more equally distributed illuminance.

ACOUSTICS

The division of the two building units gives the advantage of the two environments of administration and rehabilitation not disturbing each other acoustically. The staff are situated in their own building undisturbed by social conversations and activities, and at the same time the cancer patients can enjoy themselves in the centre undisturbed by a busy office atmosphere. This further underlines the rehabilitation unit as a non-institutional place.
The open plans in the rehabilitation unit needs special considerations regarding acoustic environment in the building, but having acoustic absorbing material in the ceilings prevents the noise from travelling between the floor plans, and further ensures a low reverberation time, minimizing the noise levels. The enclosed rooms have low reverberation times suitable for speech, and the open private zones are provided with acoustical panels ensuring that the sound does not flow into the social spaces, improving the confidentiality and privacy.

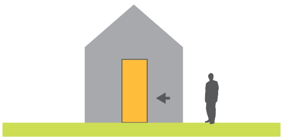
RELATION TO OUTDOORS

The green park which borders the site to the North provides a calm, recreative environment which can be accessed directly from the rehabilitation unit, and thus is integrated in the everyday activities of the centre.
The private rooms face the park, giving them a beautiful view into the old large beech trees and an atmosphere of contemplation and tranquility. Here one can get deep into difficult conversations without being disturbed by the view, or other people in the centre.
A roof terrace in the North East corner provides a private outdoor space with a view into the treetops and over the

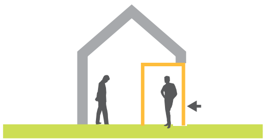
RELATION TO OUTDOORS

AN ACCESSIBLE GARDEN IN CLOSE CONNECTION TO THE CENTRE.
SEATING AREAS AND SHELTERS IN THE GARDEN.

FLOW



A CLEAR VISIBLE ENTRANCE.



AN UNEXPOSED WARDROBE AREA BY THE ENTRANCE. .

OPEN FLOOR PLANS AND FLOWING SPACES.

city, where activities can be taken outside and still be kept in privacy.
South of the rehabilitation unit, a wooden terrace is placed making it possible to extend the dining and lounge area outside in the summer. This outdoor space is protected from the public street of Nørre Allé by the administration unit and by small greenery towards De Gamles By.

FLOW

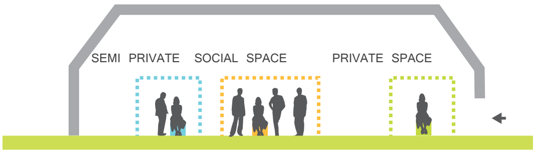
There is one main entrance to the rehabilitation unit of the Cancer Health Care Centre clearly marked in the East facade, as it is the place where the two ends of the embracing facade meet, leaving a small gap open, where passers by can get a peak into the building, revealing the five floors and the roof terrace.
The entrance faces Nørre Allé to the East and the junction from where most visitors will arrive. As the two units of the centre are pushed a little apart, with the rehabilitation unit reaching into the park, a small square opens up in front marking the entrance.

The entrance is in the semi-private zone of the building, and is in a niche behind the fire escape, giving a secluded area, where one can collect oneself and get an overview of the building in privacy before stepping further into the building.
There is a clear layout within the building, with enclosed rooms of privacy towards North and the open space with the cantilevering floor plans of social activities to the South. The semi private zone is a buffer in between the two, from where one can get an overview.
The zoning repeats itself on all floors, making it easy to recognize and find one's way.
The openings in the floors allow vertical views giving an over-view of the activities and the people upstairs or below. The lift provides an easy, comfortable straight flow line vertically in the building, suitable for people who are week from their cancer decease. Smaller stair cases serve as quick connec-tions between the floor plans two and two, connecting special activities, easing the movement and the interaction between the floors.

PERSONAL AND SOCIAL SPACE

The rehabilitation unit is zoned through the plans, with private rooms towards the calm, green park to the North and social spaces towards South connected through a big vertical room.
The private zone contains enclosed rooms with sliding doors, where one can choose level of privacy. It furthermore contains niches a bit aside of the social spaces, creating a buffer zone between the semi-private middle zone and the private rooms, making them appear less formal.
The semi-private middle zone offers a place to sit on the edge of the social activities. Here the possibility is created to take passively part in the social interactions, which may be

PERSONAL AND SOCIAL SPACE



SEATING AREAS NEAR THE ENTRANCE CREATES A TRANSITIONAL ZONE.
SEATING AREAS ON THE EDGE OF SOCIAL GATHERING POINTS PROVIDES DIFFERENT POSSIBILITIES OF SOCIAL PARTICIPATION.

UNEXPOSED WORKSTATIONS

the wish for many once in a while.
The social zone is open, vertically and horizontally, with the cantilevering islands defining the different activity zones.
There are views in between the functions, vertically as well as horizontally, encouraging the users to participate in the various activities, creating an uplifting and motivating environment.
The zones are like bands through the building, easily reachable, making it simple to change position according to mood. This makes it a place suitably for happiness and optimism as well as sorrow and woriness, and gives space to all kinds of people, whether they prefer privacy or sociality, or something in between.

INDOOR CLIMATE

Research behind evidence based design poorly deals with the importance of the indoor climate, however it is stated that it is of high importance and does have an impact on health care outcomes. Apart from healing architecture it is a known fact, that the indoor climate has a big impact on the comfort experience of the building users.
The rehabilitation unit is zoned through a North-South orientation, but the rooms towards North are opened up in places, evening the internal temperature levels.
The facade structure of wooden slats serves as solar shading protecting the building from the sun and preventing glare. It is seen from the indoor climate simulation that the slats are of high importance. The rehabilitation unit is tall and has a vertical open space from ground floor to the roof, making it optimal for natural ventilation.
To ensure the required amounts of daylight, implying large window areas, as well as to comply with the low energy demand, it is necessary to reconsider the high indoor climate demands, however, it all comes together and the indoor climate provides good air quality and temperatures with only small variations.

THE CANCER HEALTH CARE CENTRE, COPENHAGEN

Through careful analysis of the theme of healing architecture, the underlying evidence based design and studies of cases of buildings with a similar purpose, a proposal for a the Cancer Health Care Centre has been created.
The cancer patients and their specific needs and conditions have been taken into consideration all along the process represented by the evidence based design guide and the parametres it states. They are integrated in the design process and come together with contextual considerations, technical solutions and aesthetical parameters, forming a building complex which not only functions as a centre facilitating many activities for the cancer patients, but also has a healing atmosphere.

EVALUATION

The competition brief evolves around the creation of a centre which unites all the functions regarding the cancer support and rehabilitation in Copenhagen into one building.
In this project the centre is divided into two units, emphasizing the user related functions, removing the institutional like office atmosphere from the rehabilitation functions and creating a possibility for the staff to retrieve without disturbances.
These considerations result in parting the two building volumes , only connecting them through a basement. Parting them may seem to be inconvenient in relations to the staff and their relationship with the patients. However, in the project brief it is already stated, that the staff will work from schedules, and have divided their time into the social work and the administration work, why the parting of the functions should not cause any inconvenience.

The height of the rehabilitation unit exceeds the recommended heights from the municipality.
The choice is based on a desire to create a clear overview of the interior plan of intimate spaces, as well as to create space around the building. Furthermore it seems important to not only relate to De Gamles By, but also conform with the large scale of Nørrebro.
The administration building, which is the one standing close to the existing buildings of De Gamles By respects them in shape, height and material, whereas the other unit is pushed away from the existing buildings, relating more to the larger scale of the city.

Ill. 144.1: View from the ground floor into the kitchen and play area. The cantilevered plans reach out into the open rooms creating a connected social space in the vertical direction.

A multiple storey building may seem inconvenient for disabled people, however a low building in large scale will create large distances to walk from one end to the other. The multiple storeys are connected by a lift, which provides a quick and easy way to move through the building, convenient for disabled and week people. Each floor is moreover provided with toilets for the disabled, and the lift is placed centrally in the building, making it easy to access.

The competition brief moreover describes all functions as enclosed rooms. But in this project has been sought to open up as many spaces as possible as well as to double programme many functions as many closed rooms seems to diffuse the overview of the different functions as well as create a more formal atmosphere. Open, flexible spaces where some functions are double programmed creates more interactions and will result in less rooms being left empty, emphasizing a lively atmosphere and lowering the energy consumption.

High demands are set for the indoor climate, which is found to be an important parameter within a healing environment. The rehabilitation unit is mainly of glass which makes it difficult to comply with the low temperature variations and in spite of natural ventilation and solar shading will comprise in

over temperatures on very hot days.
However, the amount of glass is needed to obtain the required lighting levels and further to create the architectural expression of the light wooden structure embracing the inner environment.
Dispensation can be obtained to special buildings to have a cooling coil in the ventilation, which ensuring less hours of overtemperatures, and it can be assumed that a cooling system would be permitted in a centre of this scale for people who are ill and physically impaired.

The indoor climate simulations have been carried out in the software B-SIM, and only for summer and winter. To obtain a more precise picture of the indoor climate, the entire year should have been simulated. However, as the summer months are the most critical in term of overtemperatures, they are used as the deciding parameter.
The model in the software is approximated, where the amount of thermal mass is a little less than the actual possible amount in the building, and where especially the wooden slat structure has not been possible to detail, why the simulation is an estimation. Yet, the simulation paints a rough picture of the problems related to the building and forms the base of considerations on how to deal with them, why an estimation seems sufficient.

The daylight simulations are carried out in Ecotect and Radiance, where it in some cases have been difficult to obtain precise results in complex models. For this reason, many of the light investigations are done from approximated models, why a complete picture of the lighting levels in the entire building has not been obtained. Yet, the approximated models are easily applicable to the overall building and has further made is easier to deal with exact issues in certain places of the building.

Ill. 145.1: View from the first floor in the workshop area. The open space is defined by the cut in the plan creating visual connections between the various social functions encouraging for participation.

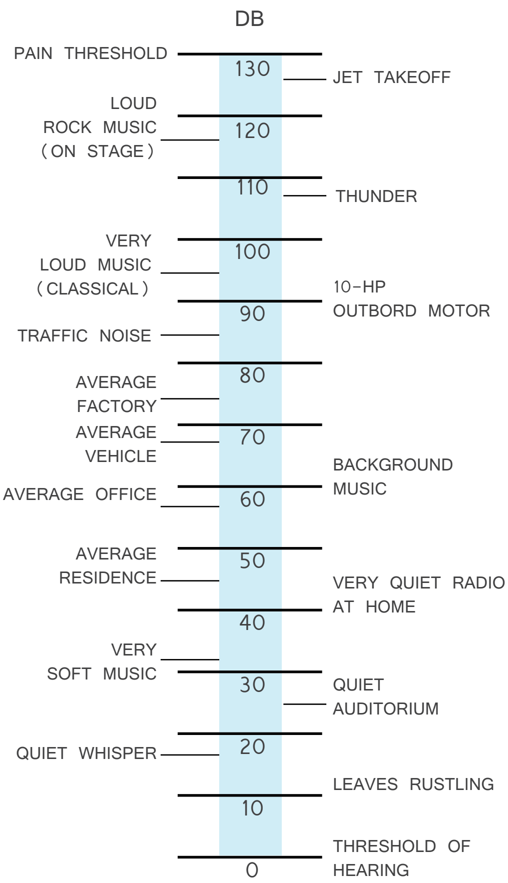
APPENDIX 1: ACOUSTICS

BUILDING ACOUSTICS

Relevant acoustical themes in relation to the described consequences of noise and sound in health care environments are building acoustics and architectural acoustics.
Building acoustics concern the construction of a building in relation to avoiding traffic or other unwanted noise through building components and joints. In this project it is important concerning the close location to the busy road of Nørre Allé, why traffic noise should be prevented from entering the building.
There are several rooms implemented in the room programme functioning as conversation rooms that require special concern considering the wish for creating a feeling of confidentiality, where the users feel safe and undisturbed. Thus is very dependent on the acoustical quality of the rooms.
Ill.146.2 shows the reduction numbers of different building components and the effect is has on lowering the sound entering or leaving a room. For instance the sound level of a normal conversation will be in between 44-55dB (see ill. 146.1) which require building components with a reduction number between 44dB and 60dB in order to lower the sound sufficiently. [Kirkegaard, 2004]

ARCHITECTURAL ACOUSTICS

The feeling of confidentiality in terms of acoustics is also highly dependent on the reverberation time and the distribution of sound.
The acoustic qualities of the room should facilitate speech clarity and thus the possibility to speak in normal voice levels and still be understood, why these parameters also affect the

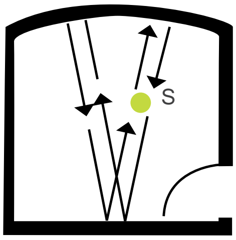


Ill.146.1: Sound levels of different functions.
[Kirkegaard, 2009]

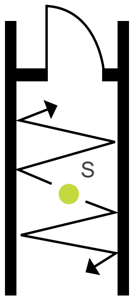
PERCEPTION OF SOUND SOURCE

R´W FOR BUILDING COMPONENT	OFFICE MACHINES	NORMAL CONVER-SATION	LOUD CONVER-SATION	YELLING	TV, RADIO NORMAL SOUND LEVEL	NIGHT CLUB
25DB						
30DB	IS HEARD	IS HEARD				
35DB						
40DB	CAN BE HEARD	CAN BE HEARD	IS HEARD	IS HEARD		
44DB			CAN BE HEARD		IS HEARD	
48DB						
52DB				CAN BE HEARD		
55DB					CAN BE HEARD	
60DB	DOES NOT DISTURB	IS NOT PERCEIVED	IS NOT PERCIEVED	IS NOT HEARD	IS NOT HEARD	IS HEARD

Ill.146.2 diagram showing the reduction numbers of different building components and the effect is has on lowering the sound entering or leaving a room. [Kirkegaard, 2009]

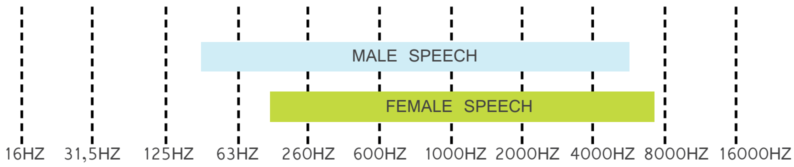


Ill. 147.1 Diagram showing flutter sounds paths in a small room with concave walls.



Ill. 147.2 Diagram showing flutter sounds paths in a small corridor. [Egan, 2007]

development and prevention of noise.
Reverberation time describes the amount of time is takes for the sound to drop 60dB in a given room.
Considering the different functions in the new centre it is preferable to obtain a very low reverberation time in most rooms of approximately 0,4s (see page 56-57).
When calculating the reverberation time three factors can be changed, that is the choice of materials, whether more or less absorbing, the area of the surfaces and the volume of the room.
The acoustic qualities of materials are presented through their absorption coefficient, which indicates how much sound is absorbed in different frequencies.
Hard materials such as stone or metal usually have low absorption coefficients whereas soft or porous materials such as carpets and fabric have high ones (see ill. 147.4). [Kirkegaard, 2004]
The reverberation time does not consider the shape of the room and the ray distribution of sound, why this is necessary to consider to obtain satisfactory acoustical qualities. The sound distribution in this project will mainly consider the prevention of flutter echo, as the rooms in general are not very big, why the calculation of time delays does not seem relevant.
Flutter echo is usually caused by the repetitive reflection of sound energy between opposing parallel or concave sound-reflecting surfaces (See ill. 147.1-2).
It can be prevented by changing the building shape to avoid parallel surfaces, by providing absorbing materials that absorb the sound before reflected or by placing porous materials that will diffuse the sound. [Egan, 2007]



Ill.147.3 Diagram showing frequency area of male and female speech. [Kirkegaard, 2009]

MATERIAL ABSORPTION COEFFICIENTS

MATERIAL	125HZ	250HZ	500HZ	1000HZ	2000HZ	4000HZ
OPEN TO THE FREE	1	1	1	1	1	1
WOODEN FLOOR	0,15	0,11	0,10	0,07	0,06	0,07
LINOLEUM	0,02	0,02	0,03	0,04	0,04	0,05
CURTAINS 9MM FROM A WALL	0,05	0,06	0,39	0,63	0,7	0,73
SMOOTH PLASTER ON A HARD WALL	0,01	0,01	0,02	0,02	0,02	0,04
UNPLASTERED TILED WALL	0,02	0,03	0,03	0,04	0,05	0,07

Ill.147.4 diagram showing the absorption coefficients of different materials in different Hz.[Kirkegaard, 2004]

APPENDIX 2: INDOOR CLIMATE ANALYSIS

The following describes the indoor climate analysis made in order to obtain design values for the further process of designing the Cancer Health Care Centre. This section mainly refers to the Danish Standard of DS/CEN/CR 1752.

The indoor climate category A is chosen as a design demand, as it is the highest and most qualitative, which seems relevant when designing a healing environment for cancer diagnosed people. In terms of the thermal indoor climate, it requires a maximum percentage of dissatisfied (PPD) of 6% in regards of thermal comfort in general and 15% in terms of draught. The issues of local discomforts, except draught, are not analysed, as they refer to a detailed treatment of the indoor climate, which is not dealt with in the scale in this project. (See ill. 148.1)

In regards of the atmospheric indoor climate, category A requires a maximum percentage of dissatisfied of the perceived air quality is 15%.

Ill. 148.2 shows estimated indoor climate related values of different room categories in the Cancer Health Care Centre, based on average room sizes, occupancies and activities.

CATEGORY	THERMAL STATE OF THE BODY AS A WHOLE		LOCAL DISCOMFORT			
	PREDICTED PERCENTAGE OF DISSATISFIED, PPD	PREDICTED MEAN VOTE PMV	PERCENTAGE OF DISSATISFIED DUE TO DRAUGHT, DR	PERCENTAGE OF DISSATISFIED DUE TO AIR TEMPERATURE DIFFERENCE	PERCENTAGE OF DISSATISFIED DUE TO WARM OR COLD FLOOR	PERCENTAGE OF DISSATISFIED DUE TO RADIANT ASYMMETRY
A	<6%	-0,2<PMV<+0,2	<15%	<3%	<10%	<5%
B	<10%	-0,5<PMV<+0,5	<20%	<5%	<10%	<5%
C	<15%	-0,7<PMV<+0,7	<25%	<10%	<15%	<10%

Ill. 148.1: Diagram of the indoor climate categories.

ROOM TYPE	NET M2 (AVE.)	PERS./ ROOM (MAX.)	ACTIVITY		CLO		OPTIMUM OPERATING TEMP.		MEAN AIR VELOCITY		AIR CH.
			W/M^2	MET.	SUM	WIN	SUM	WIN	SUM	WIN	
ENTRANCE, KITCHEN/DINING, LOUNGE, LIBRARY, PLAY AREA, WORKSHOP, ACTIVITY ROOM, YOUTH CLUB	185	60	70	1,2	0,5	1	25 °C ± 0,5 °C	22 °C ± 1 °C	0,18	0,15	5 H^{-1}
GYM	70	20	116	2	0,3	0,5	23 °C ± 0,5 °C	21 °C ± 1 °C	0,15	0,13	7 H^{-1}
CHANGING ROOMS	40	20	70	1,2	0	0	28 °C ± 0,5 °C	28 °C ± 0,5 °C	0,2	0,2	8 H^{-1}
COUNSELLING OR CONVERSATION ROOMS,	10	3	46	0,8	0,5	1	27 °C ± 0,5 °C	25 °C ± 0,5 °C	0,2	0,18	1,5 H^{-1}
PHYSICAL THERAPY	16	3	46	0,8	0,3	0,5	28 °C ± 0,5 °C	27 °C ± 0,5 °C	0,2	0,2	3 H^{-1}
MEETING-, GROUP OR COMBI ROOM	20	12	70	1,2	0,5	1	25 °C ± 0,5 °C	22 °C ± 1 °C	0,18	0,15	8,5 H^{-1}
SCHOOL KITCHEN	50	50	70	1,2	0,5	1	25 °C ± 0,5 °C	22 °C ± 1 °C	0,18	0,15	8 H^{-1}
LECTURE ROOM (TWO GYMS)	140	90	70	1,2	0,5	1	25 °C ± 0,5 °C	22 °C ± 1 °C	0,18	0,15	9 H^{-1}
OFFICE	15	2	70	1,2	0,5	1	25 °C ± 0,5 °C	22 °C ± 1 °C	0,18	0,15	2 H^{-1}

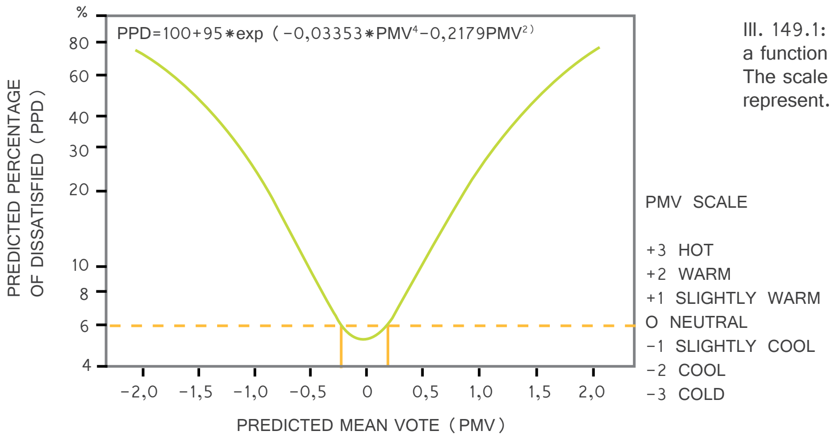
Ill. 148.2: Diagram of the indoor climate values estimated for different room categories in the Cancer Health Care Centre.

ROOM TEMPERATURE

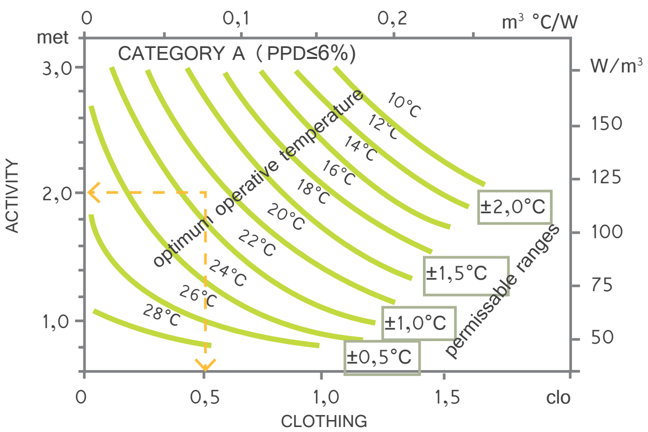
The optimum operating temperatures are based on the PPD of max. 6%, implying a Predicted Mean Vote (PMV) of -0,2 till +0,2, which is the evaluation an average group of people would give an actual thermal climate. (see ill. 149.1) The optimum room temperatures depend on the activity in the room (met) and the clothes people would wear, summer and winter (clo). Ill. 149.2 shows the example of the gym room, where the activity is a bit above average and the clothing would be less.

DRAUGHT

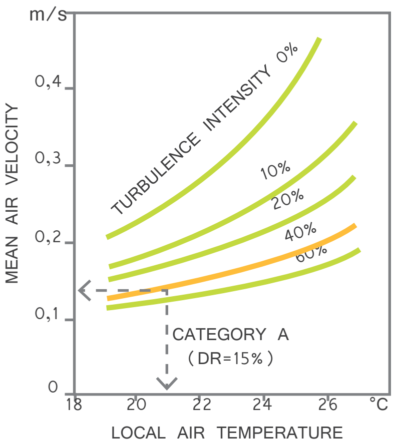
Draught means an unwanted cooling of the body as a result of air movement and temperatury. The maximum mean air velocity implies the maximum speed the air can have without being experienced as draught, and it is based on a Draught Rating (DR) of 15%, the percentage of people dissatisfied due to draught.
It depends on the temperatures in the room and the air turbulence intensity, which in this project is estimated to be 40%, which is an average number for rooms with mixing flow ventilation, but which will be lower in cases of displacement ventilation or without mechanical ventilation. [DS/CEN/CR 1752, 1998, s. 17]
Ill. 149.3 shows the example of the gym room as a result of the estimated optimum operative temperature.



Ill. 149.1: Diagram of the predicted mean vote, PMV as a function of the predicted percentage of dissatisfied. The scale to the right indicates the perceptions the PMV represent.



Ill. 149.2: Diagram of the optimum operative temperature. The gym is marked as an example. The activity is 2 met, meaning light or medium activity, and the clothing in the winter is 0,5 clo, as in short sleeves, long pants etc. The optimal operative temperature is 21°C with a range of ±1°C.



Ill.149.3: Diagram of the maximum mean air velocity. The gym is marked as an example. The optimal operative temperature is 21°C, indicating a mean air velocity of maximum 0,13 m/s in the winter.

APPENDIX 2B: ATMOSPHERIC INDOOR CLIMATE

To estimate the required ventilation rate in the Cancer Health Care Centre and to see which gives the highest demands, three options are analysed: The requirements from the Danish Working Environment Authority; A ventilation rate estimated from the perceived air quality; A ventilation rate estimated from the CO^2 pollution. A meeting room of 20 square meters with an estimated room height of 3 meters, and with an occupancy of 12 people will serve as an example.
The analysis based on the CO^2 gives the highest demands for the indoor climate, why it seems more qualitative. This analysis method will be the base for the ventilation rate design demands in the room program.

REGULATORY REQUIREMENTS

The Danish Working Environment Authority recommend a ventilation rate of 5 l/s per person in a school class room and 0,4 l/s per square meter. [Arbejdstilsynet 2010]

qv = 5 l/s /person * 12 persons + 0,4 l/s /m2 *20 m2
qv = 68 l/s = 244,8 m3/h ≈ 4 h^{-1}

CATEGORY	PERCEIVED AIR QUALITY		REQUIRED VENTILA-TION RATE, L/S·OLF
	DISSATISFIED, %	DP	
A	15	1,0	10
B	20	1,4	7
C	30	2,5	4

Ill. 150.1: Diagram of the perceived air quality related to the percentage of dissatisfied, decipol and olf.
[DS/CEN/CR 1752, 1998, s. 23]

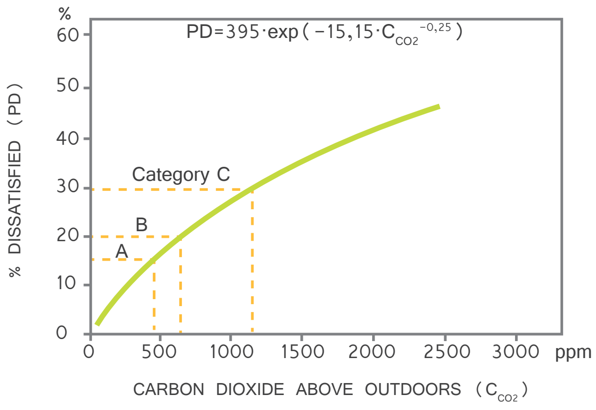
PERCEIVED AIR QUALITY

A ventilation rate estimated from the perceived air quality implies a maximum number of dissatisfied of 15% and depends of the person pollution sources (olfs), which depends on activity, but is for mean activity set to be 1 olf pr. person.
It may also be expressed in decipol (dp), and for category A, 1 dp is the air quality in a space with a pollution source strength of one olf, ventilated by 10 l/s, meaning 1 dp = 0,1 Olf/(l/s). (see ill. 150.1)

qv = 10 l/s * 12 olf
qv = 120 l/s = 432 m3/h ≈ 7,2 h^{-1}

CO^2 POLLUTION

Humans produce carbon dioxide, proportional to their activity, and this can be a crucial factor in the air quality of an indoor climate. Ill. 150.2 shows the maximum amount of carbon dioxide in the air above the outdoors level in relation to the number of dissatisfied.
Category A of 15% dissatisfied implies 480 ppm above outdoor levels, which for a building in a clean urban environment such as Copenhagen will be approx. 800 ppm.
An excel spreadsheet representing the equation of dilution has been used to estimate the ventilation rates of different rooms. For the meeting room of 60 m^3 occupied by 12 people of sedentary activity (1,2 met), and which is set to be occupied for 1½ hours at the time, the equation of dilution shows the need for ventilation rate to be 8,5 h^{-1}, in order to avoid an CO^2 pollution of more than 800 ppm. The ventilation rate of 8,5 h^{-1} implies a need for a 15 minutes break between sessions, in order to keep a good air quality.



Ill. 150.2: Diagram of the CO^2 pollution related to the percentage of dissatisfied. For category A it is 480 ppm aboive outdoor levels, which are 350 ppm for a clean urban environment. [DS/CEN/CR 1752, 1998, p. 24 and 27]

FORTYNDINGSLIGNINGEN REV. 31.01.05/HB

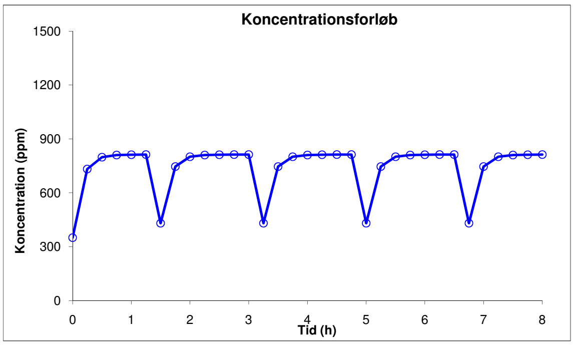
CO2 PRODUKTION

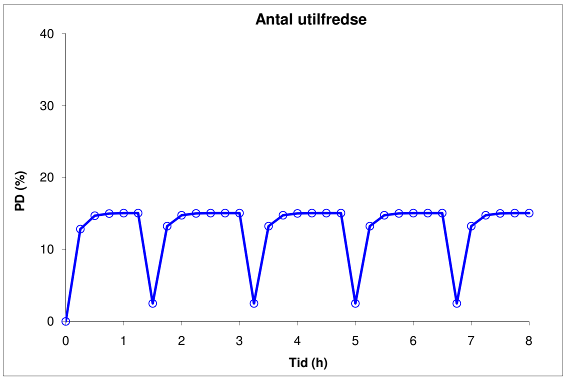
qCO2 = 17*M [l/h pers.] (M = stofskifte i met)

Antal personer		12	stk.					
Aktivitetsniveau		1,2	met					
qCO2	244,8	l/h	(kildestyrke q)					
qCO2	0,2448	m3/h	(kildestyrke q)					
Luftskifte	8,5	h-1						
Rumvolumen		60	m3					
Konc. i indblæsning		350	ppm	(ci)				
Startkoncentration		350	ppm	(c0)				
Startkoncentration		0,00035	m3/m3	(c0)				
Forureningsmængde		0,2448	m3/h		Stationær værdi	830	ppm	

CASE 1 KONSTANT LUFTSKIFTE

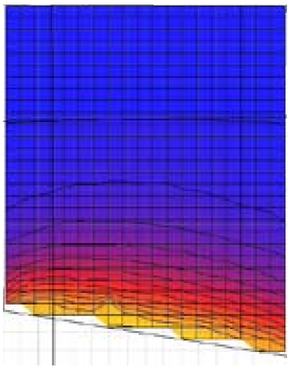
Tid	Delta Tid	Luftskifte	Konc. Indbl.		Konc. indbl.		Forurening	Konc.	Konc.
PD (CO2)									
[h]	[h]	[h-1]	[ppm]	[m3/m3]	[m3/h]	[m3/m3]	[ppm]	%	
0	0	8,5	350	0,00035	0,2448	0,000350	350	0	
0,25	0,25	8,5	350	0,00035	0,2448	0,000773	773	14	
0,5	0,25	8,5	350	0,00035	0,2448	0,000823	823	15	
0,75	0,25	8,5	350	0,00035	0,2448	0,000829	829	15	
1	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
1,25	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
1,5	0,25	8,5	350	0,00035	0	0,000407	407	2	
1,75	0,25	8,5	350	0,00035	0,2448	0,000780	780	14	
2	0,25	8,5	350	0,00035	0,2448	0,000824	824	15	
2,25	0,25	8,5	350	0,00035	0,2448	0,000829	829	16	
2,5	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
2,75	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
3	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
3,25	0,25	8,5	350	0,00035	0	0,000407	407	2	
3,5	0,25	8,5	350	0,00035	0,2448	0,000780	780	14	
3,75	0,25	8,5	350	0,00035	0,2448	0,000824	824	15	
4	0,25	8,5	350	0,00035	0,2448	0,000829	829	16	
4,25	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
4,5	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
4,75	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
5	0,25	8,5	350	0,00035	0	0,000407	407	2	
5,25	0,25	8,5	350	0,00035	0,2448	0,000780	780	14	
5,5	0,25	8,5	350	0,00035	0,2448	0,000824	824	15	
5,75	0,25	8,5	350	0,00035	0,2448	0,000829	829	16	
6	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
6,25	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
6,5	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
6,75	0,25	8,5	350	0,00035	0	0,000407	407	2	
7	0,25	8,5	350	0,00035	0,2448	0,000780	780	14	
7,25	0,25	8,5	350	0,00035	0,2448	0,000824	824	15	
7,5	0,25	8,5	350	0,00035	0,2448	0,000829	829	16	
7,75	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	
8	0,25	8,5	350	0,00035	0,2448	0,000830	830	16	





APPENDIX 3: LIGHT INVESTIGATION, CUTTING THE PLANS

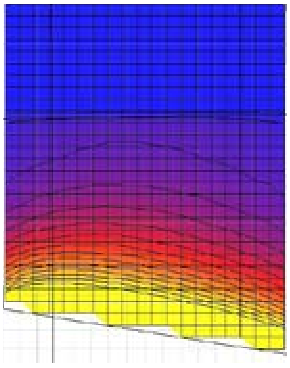
It is desired that the plans are cut to create spaces in the open common space.
The investigations show, that cutting the plans further increases the amount of daylight coming in and makes it come further into the room. It is required to have 2500 lux a couple of hours a day for the light to have a therapeutic effect, and therefore it is relevant to see, what can be done to get this amount of light far into the room.
Withdrawing the floor plans from the facade makes the room more open and increases the vertical connection between the plans. Furthermore it can be seen that it increases the daylight levels markedly, and makes the 2500 lux reach farther into the room.
The wider and deep the cuts are, the higher the illuminance level and the farther the light reaches into the room.



Plan without any cuts in the floor above.

Mean illuminance: 573,49 lux

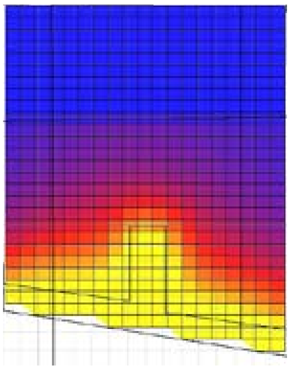
2500 lux ca. 1,5 m into the room.



Plan without any cut, but with floor above taken 1500 mm further into the building.

Mean illuminance: 1049,85 lux

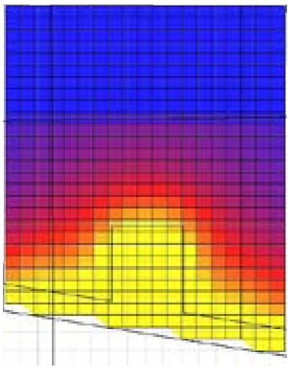
2500 lux ca. 3,7 m into the room.



Plan with cut, 2000x4000 mm, in the floor above, taken 1500 mm backwards.

Mean illuminance: 1240,49 lux

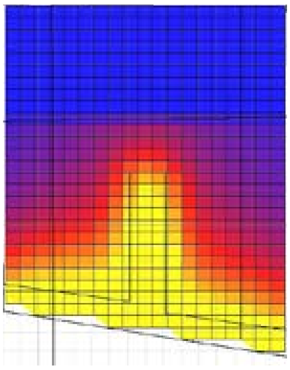
2500 lux ca. 4,1-7 m into the room, 5 m av.



Plan with cut, 4000x4000 mm, in the floor above, taken 1500 mm backwards.

Mean illuminance: 1388,92 lux

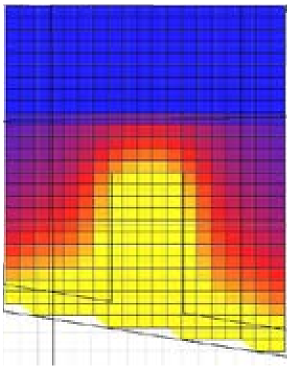
2500 lux ca. 4,1-7 m into the room, 5 m av.



Plan with cut, 2000x7000 mm, in the floor above, taken 1500 mm backwards.

Mean illuminance: 1347,49 lux

2500 lux ca. 4,1-9,7 m into the room, 5,9 m av.



Plan with cut, 4000x7000 mm, in the floor above, taken 1500 mm backwards.

Mean illuminance: 1602,88 lux

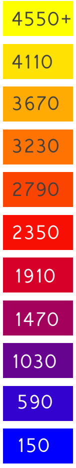
2500 lux ca. 4,1-10,3 m into the room, 6,2 m av.

APPENDIX 4: LIGHT INVESTIGATION

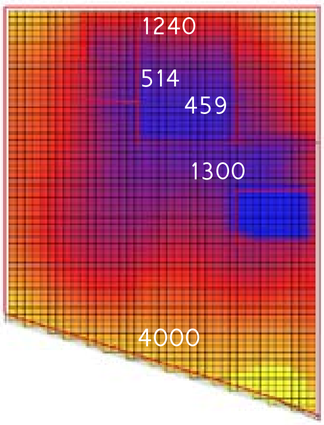
Light investigations are made for the entire floor plans to gain an understanding of the light distribution and the illuminance levels. As a result of the limitations of the simulation software, Ecotect, the diagrams are not entirely precise and especially the closed rooms seem darker, than when they are examined individually. However, the investigations gives an approximate picture of the light distribution.
Again as a limitation of the software, the model is made with 100% glass in all facades, why the illuminance levels cannot be seen as final, but still gives a picture of how the light varies in the room.

The investigations are used as comparison of more simplified examinations made with the realistic slat facades, presented in the facade section. (See p. 114-115). The investigations have furthermore been integrated in the process of modifying the enclosed rooms, but this has been examined more carefully in individual lighting analyses presented in the planning section.

It can be seen that with 100% glass, in all facades, there is a mean illuminance of approximately 2100 lux, with a maximum of around 4000 lux and a minimum of 300 lux.
To obtain the desired 2500 lux in parts of the building, it is assumed that a mean illuminance of 1500 lux will be sufficient, which means that the slat facades should let in approximately 60% of the light compared to the facades of 100% glass, meaning around 40% can be blocked. This is used as a for comparison, with the simplified light analyses made with the different slat facades.

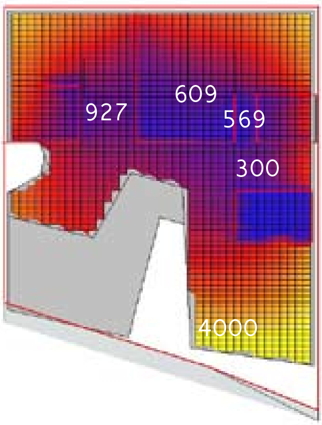


GROUND FLOOR



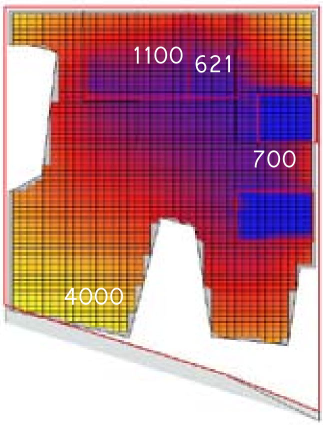
100% Windows
Mean illuminance:
2155 lux

2ND FLOOR



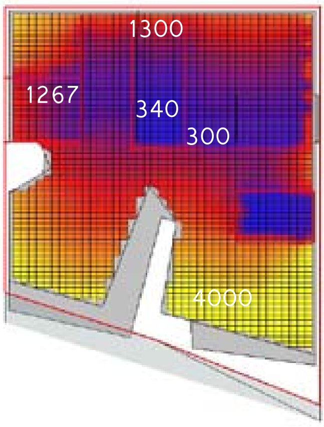
100% Windows
Mean illuminance:
2027 lux

1ST FLOOR



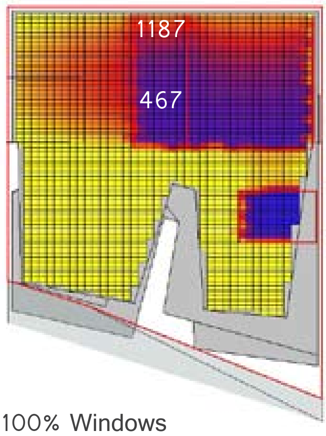
100% Windows
Mean illuminance:
2128 lux

3RD FLOOR



100% Windows
Mean illuminance:
2276 lux

4TH FLOOR



100% Windows
Mean illuminance:
3625 lux

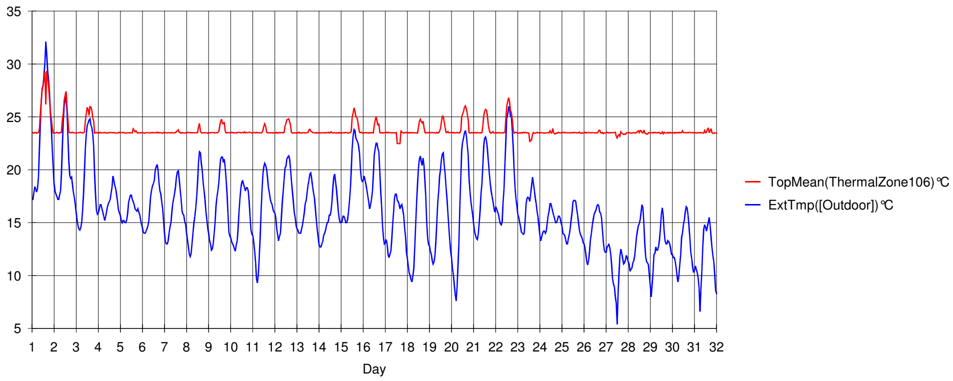
APPENDIX 5: BUILDING SIMULATION

Final building simulations are done for the summer, meaning Juni, July and August and for winter, January and February (B-SIM cannot simulate over 2 years, why December is left out). The model contains an area of thermal mass of approximately 3000 m2 corresponding to having the floor plans with acoustic ceiling and wooden floor, the walls in small rooms with plasterboards and everything else in concrete.
The summer simulation is done for the model, where a cooling coil is added. The cooling coil reduces the need for the natural ventilation, so the venting rates are set to a basic air change rate of 8 h^{-1} and a maximum air change rate of 10 h^{-1}.

Ill. 157.1 shows the values generated from the summer simulation, and the graphs of ill. 156.1 -2 and 157.3 show the temperatures and CO_2-levels during all three months and one representative day, respectively. The day represented show, that the temperatures are kept within a range of 4 degrees, as it is recommended from the indoor climate category B. For hotter days, this range is increased, but only few days a year seems to have this problem.

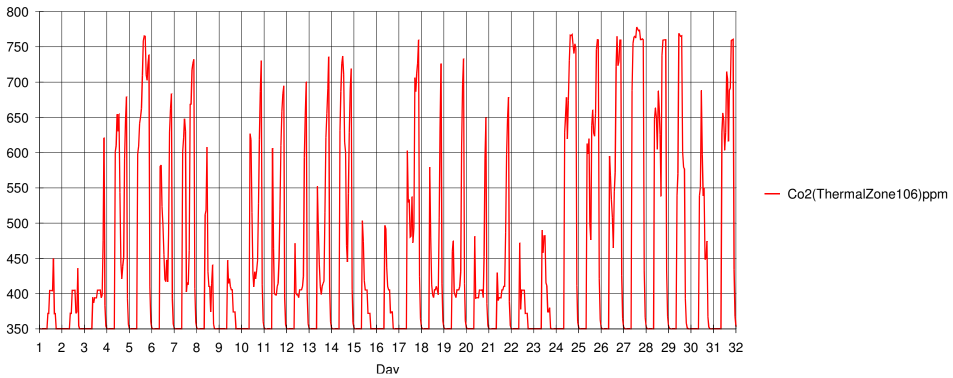
Ill. 157.2 shows the values from the winter simulation made for January and February. B-SIM cannot simulate over two years, why the last winter month of December cannot be included in the simulation. However, as the winter months are more stable, the two month similations seem sufficient. The two graphs ill. 157.3-4 show that the tempera-tures are very stable and only swing very little during a day and a month.

INDOOR AND OUTDOOR TEMPERATURES, AUGUST



Ill. 156.1: Graph of the indoor and outdoor temperatures of August. The indoor temperatures are more stable than the outdoor, but when it is hotter outside, the indoor temperatures also rise a little.

CO_2-LEVELS, AUGUST



Ill. 156.2: Graph of the CO_2-levels in the building. The level is kept under the desired 800 ppm.

B-SIM RESULTS, SUMMER

Month	Sum/Mean	6	7	8
qHeating	12472,28	4298,20	3796,06	4378,01
qCooling	0,00	0,00	0,00	0,00
qInfiltration	-2399,52	-882,43	-736,56	-780,53
qVenting	-14270,71	-4673,98	-4996,11	-4600,62
qSunRad	16778,46	5818,32	5759,30	5200,83
qPeople	11189,40	3678,80	3818,20	3692,40
qEquipment	30,16	9,28	9,28	11,60
qLighting	45,20	14,67	15,17	15,36
qTransmission	-15140,96	-5306,73	-4857,87	-4976,36
qMixing	0,00	0,00	0,00	0,00
qVentilation	-8584,95	-2933,50	-2778,90	-2872,55
Sum	119,35	22,63	28,58	68,14
tOutdoor mean	15,8	15,0	16,4	16,2
tOp mean	23,8	23,8	23,8	23,8
AirChange/h	4,1	3,7	4,5	4,1
Rel. Moisture(%)	53,7	51,5	56,5	53,1
Co2(ppm)	449,2	463,2	438,4	446,0
PAQ	0,2	0,2	0,1	0,2
Hours > 22,3	2208	720	744	744
Hours > 26,3	68	26	25	17
Hours > 27,3	31	14	8	9
Hours < 22,3	0	0	0	0
FanPow	6089,04	1993,70	2051,16	2044,19
HtRec	12377,36	4645,88	3701,84	4029,65
ClRec	0,00	0,00	0,00	0,00
HtCoil	1713,15	693,21	513,37	506,57
ClCoil	-4720,22	-1384,75	-1694,83	-1640,64
Humidif	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00
HeatPump	0,00	0,00	0,00	0,00
HeatPumpElCons	0,00	0,00	0,00	0,00

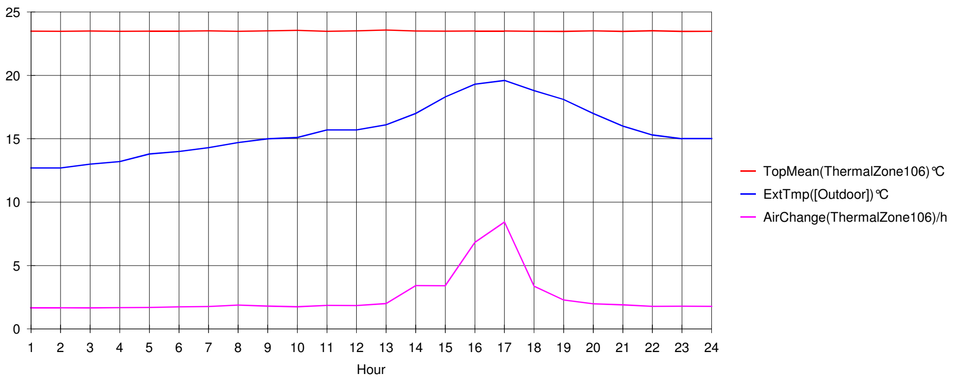
Ill. 157.1: Results from the summer simulation.

B-SIM RESULTS, WINTER

Month	Sum/Mean	1	2
qHeating	23968,62	12390,82	11577,80
qCooling	0,00	0,00	0,00
qInfiltration	-5525,17	-2864,44	-2660,73
qVenting	-20,81	0,00	-20,81
qSunRad	3161,63	1173,88	1987,75
qPeople	7155,30	3755,30	3400,00
qEquipment	19,72	10,44	9,28
qLighting	31,45	16,79	14,66
qTransmission	-22139,64	-11357,78	-10781,86
qMixing	0,00	0,00	0,00
qVentilation	-6427,60	-3028,18	-3399,42
Sum	223,49	96,82	126,66
tOutdoor mean	-0,8	-0,5	-1,0
tOp mean	22,1	21,9	22,3
AirChange/h	1,1	1,1	1,2
Rel. Moisture(%)	26,0	27,3	24,7
Co2(ppm)	558,9	563,8	553,9
PAQ	0,5	0,5	0,6
Hours > 19,1	1416	744	672
Hours > 23,6	18	0	18
Hours > 24,6	0	0	0
Hours < 19,1	0	0	0
FanPow	3191,15	1579,30	1611,86
HtRec	32899,46	16335,74	16563,72
ClRec	0,00	0,00	0,00
HtCoil	896,80	452,77	444,03
ClCoil	0,00	0,00	0,00
Humidif	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00
HeatPump	0,00	0,00	0,00
HeatPumpElCons	0,00	0,00	0,00

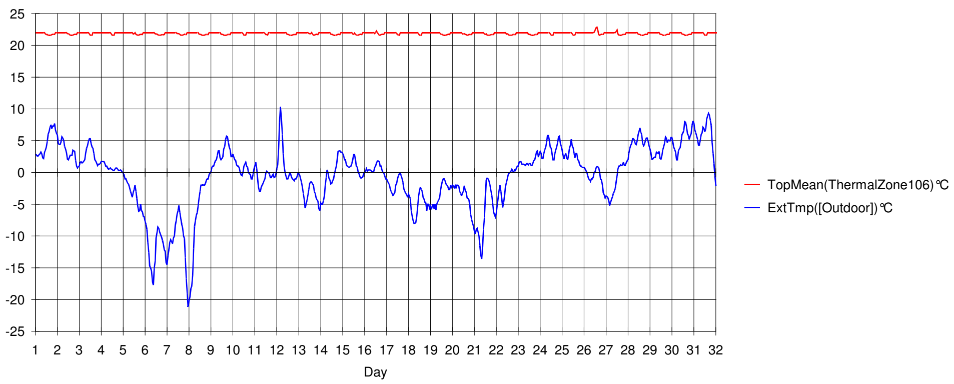
Ill. 157.2: Results from the winter simulation.

AIR CHANGE RATE, INDOOR AND OUTDOOR TEMPERATURE



Ill. 157.3: A day in August (14th of August 2009). The air change rate rises when the outdoor temperature rises, keeping the indoor temperature constant.

INDOOR AND OUTDOOR TEMPERATURES, JANUARY



Ill. 157.4: Graph of indoor and outdoor temperatures in January. The indoor temperatures are very stable compared to the changing outdoor conditions.

APPENDIX 6: ENERGY DEMAND, BE06

The diagram shows the results from the BE06 analysis, which has been generated from the results reached in the B-SIM analysis. Ventilation rates turns out to be smaller than estimated in the indoor climate analysis, but the energy consumption of the ventilation system is bigger than expected because of the cooling coil.
U-values are listed in ill.158.1 and the window area is 80% to the South, 70% to East and West and 40% towards North, complying with the facades and the need for high levels of daylight income.
Ill. 158.1 shows the estimation of the energy demand of the cooling coil from the values taken from B-SIM (see app. 5). The energy demand is added on to the SEL-value of BE06.

Ill. 158.3 shows the calculations of the energy subsidies from the high ventilation rates as well as the longer opening hours. To calculate subsidies, the actual energy demand is analysed first and then afterwards with a ventilation demand of 1,2 l/s /m^2 and opening hours of 45, respectively. The difference of the energy demand from the two analyses is added on to the regular energy demand, and the result becomes the new energy demand.

COOLING COIL	
	COOLING COIL, 80 W
ENERGY DEMAND, KWH/MONTH (AUGUST)	1640
ADDITION TO SEL (KJ/M^3)	0,45

Ill. 158.1: The energy demand on the cooling coil seen from B-SIM is translated to an addition on the SEL-value in BE06. The cooling coil is only used during summer months, thus the addition is an average for the whole year calculated for the entire ventilated air volume of 1,2 m^3/s for 3855 m^3.

U-VALUES + COLD BRIDGES	
EXTERIOR WALLS	0,18 W/M^{2}K
ROOF	0,08 W/M^{2}K
GROUND FLOOR	0,07 W/M^{2}K
WINDOWS	0,7 W/M^{2}K
FOUNDATION	0,12 W/MK
WINDOWS	0,03 W/MK

Ill. 158.2: The U-values and values for transmission losses.

SUBSIDIES			
	THE CANCER HEALTH CARE CENTRE	REGULAR CASES	DIFFERENCE IN ENERGY DEMAND
OPENING HOURS	76 H	45 H	+10,6 KWH/M^2
VENTILATION	3,75 L/S/M^2	1,2 L/S /M^2	+13 KWH/M^2
LIGHTING	2500/500 LUX	200 LUX	0 KWH/M^2
TOTAL SUBSIDY			23,6 KWH/M^2

Ill. 158.3: The subsidies to the energy demand.

Model: 20100524_be06 final_new u-values	SBi Beregningskerne 4, 8, 3, 25
Be06 key numbers: Cancer rehabilitation 2010_04_29	
Transmission loss, W/m²	
Building envelope excl. of windows and doors	4,9
Energy frame, kWh/m² year	
Low-energy buildings class 1	50,9
Low-energy buildings class 2	71,4
Total energy frame	119,5
Total energy frame, kWh/m² year	
Energy frame in BR, no addition	96,9
Supplement for heigh air change because of BR demand for venting	0,0
Addition for special terms	22,6
Total energy requirement, kWh/m² year	
Energy requirement	86,8
Contribution to energy requirement, kWh/m² year	
Heating	46,4
El. for service of buildings, *2,5	16,2
Excess temperature in rooms	0,0
Net requirement, kWh/m² year	
Room heating	46,4
Domestic hot water	0,0
Cooling	0,0
Selected el. requirements, kWh/m² year	
Lighting	6,9
Heating of rooms	0,0
Heating of domestic hot water	0,0
Heat pump	0,0
Ventilators	9,2
Pumps	0,0
Cooling	0,0
Heat loss from installations, kWh/m² year	
Room heating	0,0
Domestic hot water	0,0
Output from special sources, kWh/m² year	
Solar heat	0,0
Heat pump	0,0
Solar cells	0,0
Total el. requirement, kWh/m² year	
El. requirement	16,7

APPENDIX 7: ACOUSTICS, REVERBERATION TIMES

The diagrams show calculations of the reverberation times of the different rooms, that is the large common space, the group rooms and the conversation rooms.
The calculations are done in a spread sheet.
The desired demands are fulfilled and comply well with the need for thermal mass as well as the aesthetic expression.

Reveberation time **Open, common space**

Equation for reveberation time	T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))
Equivalent absorption area	(Σα∗s)
where	
α = absorption coefficient	
and	
S = surface area	
Absorption from persons	(Σn*A)
where	
n = number of persons	
and	
A = absorption coefficient for person	
Absorption in air	(4*m*V))
where	
m = air absorption	
and	
V = volume of room	

Reveberation time														
Equivalent absorption area	**Material**	**Areal** S(m^2)	**125 Hz** α	Sα	**250 Hz** α	Sα	**500Hz** α	Sα	**1000Hz** α	Sα	**2000Hz** α	Sα	**4000 Hz** α	Sα
Floor	Wooden	602	0,15	90,3	0,11	66,22	0,1	60,2	0,007	4,214	0,06	36,12	0,07	42,14
Ceiling	Acoustik ceiling	602	0,35	210,7	0,6	361,2	0,7	421,4	0,6	361,2	0,55	331,1	0,55	331,1
			0,01		0,01	0	0,01	0	0,02	0	0,02	0	0,02	0
Window area	Glass, Low-Energy 2-layered	800	0,35	280	0,25	200	0,18	144	0,12	96	0,07	56	0,04	32
Construction	Wood, timber	750	0,14	105	0,1	75	0,06	45	0,08	60	0,1	75	0,1	75
Inner walls, Rooms towards North	Concrete, painted	435	0,01	4,35	0,01	4,35	0,01	4,35	0,02	8,7	0,02	8,7	0,02	8,7
Kitchen + fire escape cores	Concrete, paintet	400	0,01	4	0,01	4	0,01	4	0,02	8	0,02	8	0,02	8
			0,02	0	0,06	0	0,14	0	0,37	0	0,6	0	0,65	0
Absorption from persons		**N**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**
persons		170	0,15	25,5	0,3	51	0,44	74,8	0,45	76,5	0,46	78,2	0,46	78,2
Absorption in air														
		Volumen [m3]	**125 Hz** 4*m*v		**250 Hz** 4*m*v		**500Hz** 4*m*v		**1000Hz** 4*m*v		**2000Hz** 4*m*v		**4000 Hz** 4*m*v	
		2408					4,816		12,5216		33,712		110,7680	
Total absorption				719,9		761,8		758,6		627,1		593,1		685,9
Efterklangstid	T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))			0,5		0,5		0,5		0,6		0,6		0,6
Gennemsnitlig efterklangstid														**0,6**

Reveberation time group rooms etc.

Equation for reveberation time T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))

Equivalent absorption area (Σα∗s)
where
α = absorption coefficient
and
S = surface area

Absorption from persons (Σn*A)
where
n = number of persons
and
A = absorption coefficient for person

Absorption in air (4*m*V))
where
m = air absorption
and
V = volume of room

Reveberation time

Equivalent absorption area	**Material**	**Areal** S(m^2)	**125 Hz** α	Sα	**250 Hz** α	Sα	**500Hz** α	Sα	**1000Hz** α	Sα	**2000Hz** α	Sα	**4000 Hz** α	Sα
Floor	Wooden	26	0,15	3,9	0,11	2,86	0,1	2,6	0,007	0,182	0,06	1,56	0,07	1,82
Ceiling	Plaster ceiling	26	0,2	5,2	0,2	5,2	0,15	3,9	0,1	2,6	0,5	13	0,5	13
			0,01		0,01	0	0,01	0	0,02	0	0,02	0	0,02	0
Window area	Glass, Low-Energy 2-layered	3,5	0,35	1,225	0,25	0,875	0,18	0,63	0,12	0,42	0,07	0,245	0,04	0,14
Construction	Wood, timber	7	0,14	0,98	0,1	0,7	0,06	0,42	0,08	0,56	0,1	0,7	0,1	0,7
Inner walls,	Concrete, painted	40,25	0,01	0,4025	0,01	0,4025	0,01	0,4025	0,02	0,805	0,02	0,805	0,02	0,805
facade	Wood, timber	8,25	0,14	1,155	0,1	0,825	0,06	0,495	0,08	0,66	0,1	0,825	0,1	0,825
			0,02	0	0,06	0	0,14	0	0,37	0	0,6	0	0,65	0
Absorption from persons		**N**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**
persons		20	0,15	3	0,3	6	0,44	8,8	0,45	9	0,46	9,2	0,46	9,2
Absorption in air														
		Volumen [m3]	**125 Hz** 4*m*v		**250 Hz** 4*m*v		**500Hz** 4*m*v		**1000Hz** 4*m*v		**2000Hz** 4*m*v		**4000 Hz** 4*m*v	
		65					0,13		0,338		0,91		2,9900	
Total absorption				15,9		16,9		17,4		14,6		26,3		29,5
Efterklangstid	T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))			0,7		0,6		0,6		0,7		0,4		0,4
Gennemsnitlig efterklangstid														**0,6**

Reveberation time conversation rooms

Equation for reveberation time T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))

Equivalent absorption area (Σα∗s)
where
α = absorption coefficient
and
S = surface area

Absorption from persons (Σn*A)
where
n = number of persons
and
A = absorption coefficient for person

Absorption in air (4*m*V))
where
m = air absorption
and
V = volume of room

Reveberation time

Equivalent absorption area	**Material**	**Areal** S(m^2)	**125 Hz** α	Sα	**250 Hz** α	Sα	**500Hz** α	Sα	**1000Hz** α	Sα	**2000Hz** α	Sα	**4000 Hz** α	Sα
Floor	Wooden	10,5	0,15	1,575	0,11	1,155	0,1	1,05	0,007	0,0735	0,06	0,63	0,07	0,735
Ceiling	Acoustik ceiling	10,5	0,35	3,675	0,6	6,3	0,7	7,35	0,6	6,3	0,55	5,775	0,55	5,775
			0,01		0,01	0	0,01	0	0,02	0	0,02	0	0,02	0
Window area	Glass, Low-Energy 2-layered	1,87	0,35	0,6545	0,25	0,4675	0,18	0,3366	0,12	0,2244	0,07	0,1309	0,04	0,0748
Construction	Wood, timber	3,5	0,14	0,49	0,1	0,35	0,06	0,21	0,08	0,28	0,1	0,35	0,1	0,35
Inner walls,	Concrete	26,25	0,01	0,2625	0,01	0,2625	0,01	0,2625	0,02	0,525	0,02	0,525	0,02	0,525
facade	acoustic timber lamels	4,38	0,4	1,752	0,18	0,7884	0,11	0,4818	0,1	0,438	0,07	0,3066	0,05	0,219
														0
Absorption from persons		**N**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**	A	**n*A**
persons		2	0,15	0,3	0,3	0,6	0,44	0,88	0,45	0,9	0,46	0,92	0,46	0,92
Absorption in air														
		Volumen [m3]	**125 Hz** 4*m*v		**250 Hz** 4*m*v		**500Hz** 4*m*v		**1000Hz** 4*m*v		**2000Hz** 4*m*v		**4000 Hz** 4*m*v	
		26,25					0,0525		0,1365		0,3675		1,2075	
Total absorption				8,7		9,9		10,6		8,9		8,6		9,8
Efterklangstid	T=(0,16*V)/((Σα∗s)+(Σn*A)+(4*m*V))			0,5		0,4		0,4		0,5		0,5		0,4
Gennemsnitlig efterklangstid														**0,4**

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