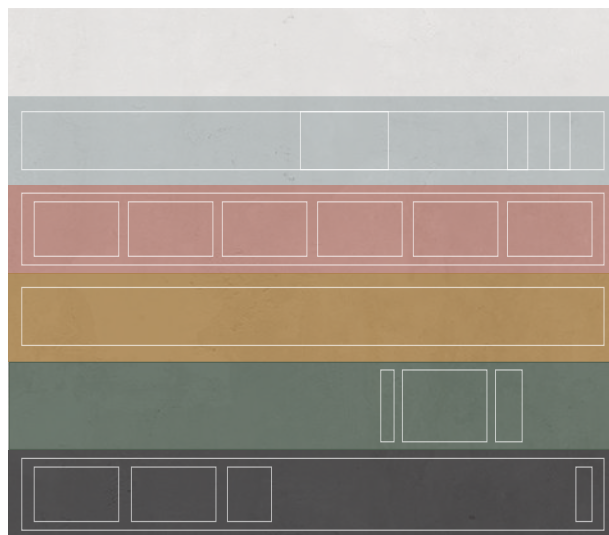


Albertslund New Youth Library



Master Thesis 2021

Master Thesis

Department

Architecture & Design

MSC04

Semester 4

Albertslund New Youth Library

Program, process & presentation

01/02/2021-29/06/2021

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153

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Sweta Zala Madsen

Abstract

This application outlines the proposal for the new youth library in Albertslund municipality as a project for a master thesis for the Department of Architecture and Design at Aalborg University. It finds its point of inception based on the proposed local plan and Udviklingsstrategi for Dagtilbud (Development Strategy for Day Care) 2016-2022, which focuses on developing a part of the city for children to promote learning, understanding, and integration of various cultural backgrounds as well as fulfilling set DGNB criteria to contribute to more sustainable development in the building sector. The library proposal raises the question of whether it's possible to combine measurable (DGNB-criteria) and unmeasurable (Gesture

& Principle) matters into a design that sparks curiosity, activity, and interaction. Furthermore, it should promote social interaction among children from different backgrounds to support easier integration, strengthen the community, and provide social sustainability. The project focuses on the current increasing immigrant population and evident lower grades among the children at the school within the municipality. This library will provide a platform for children where they can come together and develop their social and interpersonal skills. Here they can explore, get inspired and innovate, learn about different cultures and communities they are part of through the sensible design of reflective and interactive community spaces.

Reading Guide

The primary objective of this reading guide is to inform the reader about the structure and elements of the report for a better reading experience.

The project is divided into three sections, namely, program, process, and presentation. The program section clarifies the reader with obtained knowledge from research and sets the scope for further progression throughout the report. The program encompasses a motivation, a sustainability chapter, methodology, and analysis that is the driving force for developing the design.

The motivation is based on the investigations of an extensive problem that we all face in today's societies, namely social and cultural barriers due to integrational issues. It is a motivation to figure out how to solve these matters with research and acquired knowledge. The sustainability section explains the focus of sustainable development in the building sector from a broader perspective worldwide with the UN goals and the DGNB-certification tool

combined with tectonic principles to primarily support social sustainability.

The methodology is about how we have approached the task and explains the project's structure to reach the final goal.

The program is centered around the issues stated above, and it will argue for the relevance of our particular building on a selected site and various studies that support further process with sketching. Tectonics and the human scale are presented in the form of case studies and diagrams. At the end of this section, a room program and a room diagram have been made as a cover-up/conclusion on the analyses carried out and statutory requirements that we must comply with in terms of DGNB and BR18.

Notes

All maps are north oriented unless otherwise indicated.

If not shown otherwise the illustrations are self-made.

The report must be read in spreads of two pages.

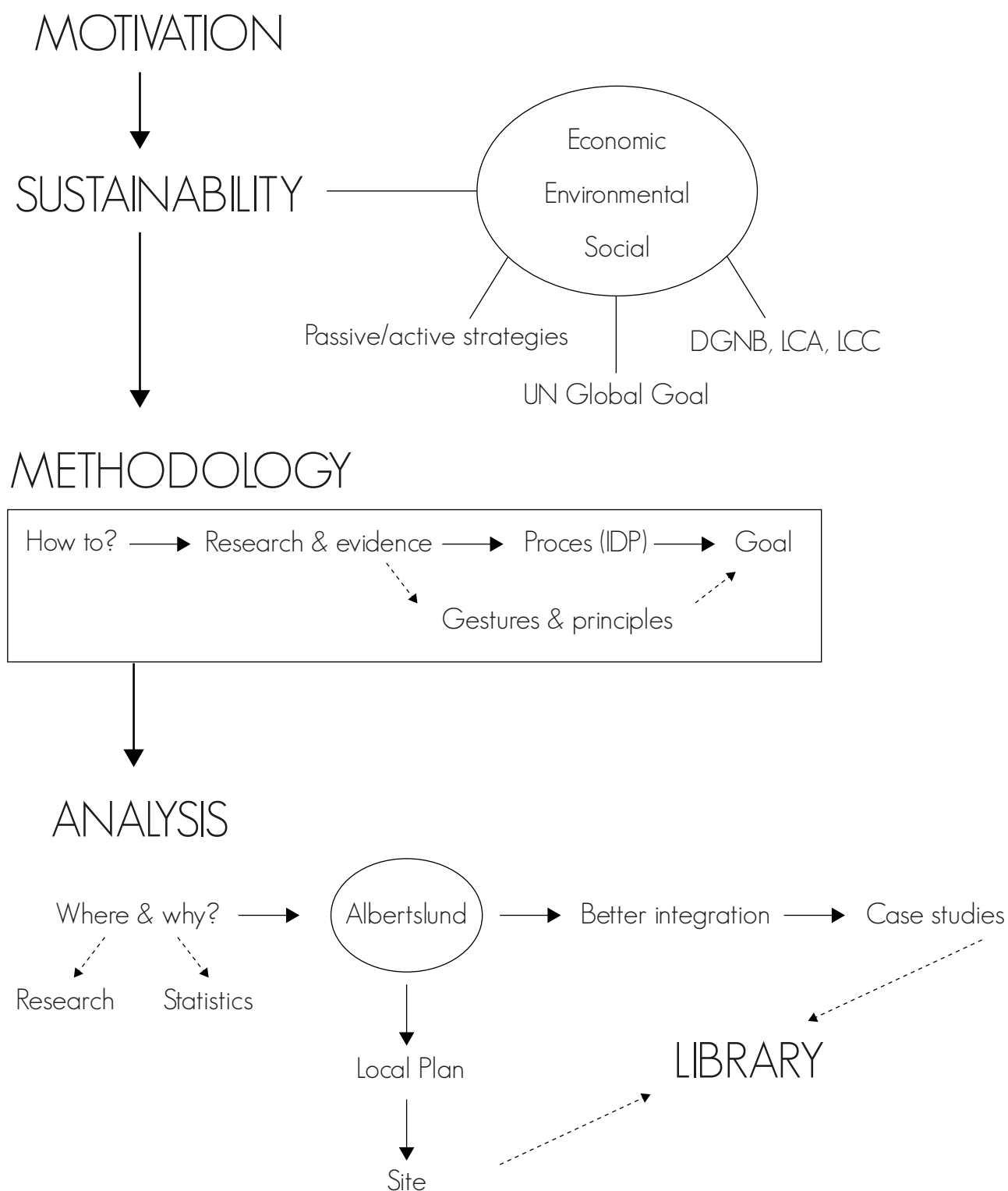


Fig. 1: Reading guide illustration

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Brief

Site

Hyldagerkvarteret, Albertslund

Function

Public institution, library

Main user group

Children

Gross area

1920 m²

Energy Classification

Low energy class 2020

Materials

Low CO²-emission materials

Material evaluation

LCA

Reflection

Motivation

With every technological leap in current times, the world is coming closer together, and we have all sorts of information and impressions available at our fingertips. However, nuanced knowledge can be sought from publicly available institutions, as this can expand one's horizons of new knowledge and cultural understanding, where one can at the same time be part of communities that contribute to a well-functioning society. Creative and innovative solutions are needed to contribute to sustainable development in the building sector, so social barriers, loneliness, socio-economic stagnation, and resource-intensive building conditions are prevented.

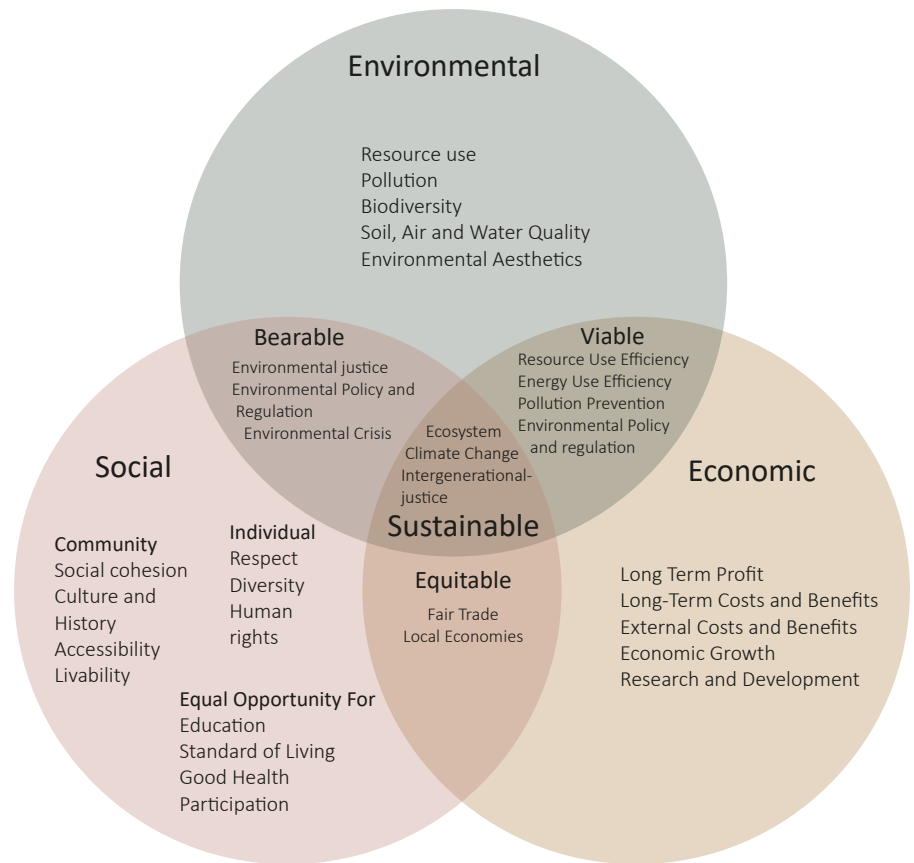
When working in an intersection between architecture and engineering knowledge, it is strived to make a unified design proposal through a process where an interdisciplinary understanding of form is connected with technology. The design proposal must therefore live up to requirements for sustainable development at a local as well as on a global level and at the same time have tectonic considerations

for aesthetics, usability, and durability.

The upbringing of young people is crucial for the development of a society. Therefore more focus has to be set on a positive view of humanity and social cohesion to help each other maintain a well-functioning community. The motivating factor in this project lies in addressing the problems seen in a society with cultural minorities, where language or cultural barriers have emerged, leading to more inferior grades in primary school, loneliness, and other general dissatisfaction. The aim is to strengthen social skills and inclusion, versatile personal development, linguistic development, body and movement, culture and cultural forms of expression, understanding of nature and natural phenomena. Overall, it's aimed to produce a unified design proposal, where the focus is set on children and interactions among them and their surroundings. The proposal is introduced as an offer to society and create awareness of sustainable development in all its aspects within social, environmental, and economic sustainability.

Sustainability Introduction

In this section on sustainability, we will address the importance of thinking in sustainable solutions and how we can approach this mindset on a global and local level. Different approaches to sustainability will be presented so that it becomes an underlying focal point for developing the project.



Sustainability, an Introduction

Fig. 2: Sustainability Parameters

Sustainability is an ongoing global topic across different sectors and professions and certainly also in the world of architecture. Brundtland Report, which was published in 1987, acted as a starting point for sustainable thinking. The UN made it of "The World Commission on Environment and Development." Here it is described that sustainability should be a holistic approach to a well-functioned, sustainable future and that the three paradigms, social, economic, and environmental sustainability, are inextricably linked.

It is defined that Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations General Assembly, 1987, p. 43). Through development in a society, it refers back to what we do and how to improve and optimize our systems. If this kind of development lacks within a nation, it's creating a negative spiral of poverty and environmental degradation. For

instance, an essential statement in the report underlines the importance of dealing with human resources:

"Human resource development is a crucial requirement not only to build up technical knowledge and capabilities, but also to create new values to help individuals and nations cope with rapidly changing social, environmental, and development realities. Knowledge shared globally would assure greater mutual understanding and create greater willingness to share global resources equitably." (Brundtland Report, p.18-19).

The report is further backed up by the UN's recently published global goals (17 in total), increasing the focus and providing guidelines to promote sustainable development. Changing the approach to circular problem solving integrates the three parameters within sustainability, social, economic, and environmental sustainability. Some of the goals and their sub-goals (targets) have been highlighted as

contributors to this project's sustainable awareness and development. Especially according to architects, building designers, engineers, and other actors in a construction project, tools such as DGNB and LCA have been made to verify and analyze a building and its components so that on paper one can meet a more sustainable building where, of course, one must also comply with the requirements set out in the building regulations.

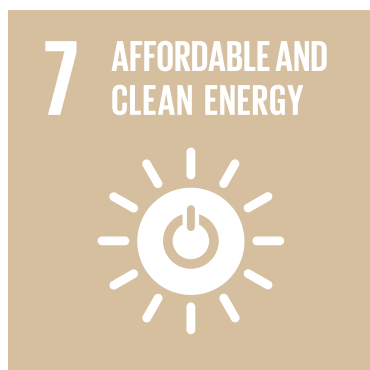
Another way to approach a more sustainable design is to make use of passive and active strategies. Passive strategies are based on utilizing what nature provides to maintain a comfortable indoor climate in a building without using "purchased energy." Active strategies are based on already purchased energy, including electricity and natural gas, to maintain the functions of a building and the indoor climate. Here you can work with air-conditioning, heat pumps, heat recovery, ventilation, and lightning.

UN Sustainable Development Goals

"In 2015, world leaders agreed to 17 Global Goals (officially known as the Sustainable Development Goals or SDGs). It's now five years on, and we have more work than ever to do. These goals have the power to create a better world by 2030 by ending poverty, fighting inequality, and addressing the urgency of climate change. Guided by the goals, it is now up to all of us, governments, businesses, civil society, and the general public to work together to build a better future for everyone." (Excerpts from UN Global Goals website).

By clarifying some of the UN's global goals, highlighted goals and their sub-goals (targets) have been chosen of particular interest to this project. The goals will act as a guideline during the design process and serve as an evaluation tool when the final design is completed to see to what extent we meet the goals.

** The logos illustrated to each goal will appear on pages throughout the report where the goals have been considered to be implemented in the design.*



4. Education

4.5 By 2030

Eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

4.6 By 2030

Ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.

4.A

Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all.

7. Affordable and clean energy

7.2 By 2030

Increase substantially the share of renewable energy in the global energy mix.

7.3 By 2030

Double the global rate of improvement in energy efficiency.

11. Sustainable cities and communities

11.7 By 2030

Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

11.A

Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.

12. Responsible consumption and production

12.2 By 2030

Achieve the sustainable management and efficient use of natural resources.

12.5 By 2030

Substantially reduce waste generation through prevention, reduction, recycling and reuse.

12.8 By 2030

Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

16. Peace and justice. Strong institutions

16.6

Develop effective, accountable and transparent institutions at all levels

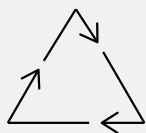
Fig. 3: Selected UN Global Sustainability Goals

Passive and Active Strategies

Passive and active strategies are most often implemented when preparing a new building to achieve a low energy framework. In addition to these strategies, indoor comfort must be simulated to see how the various measures impact the indoor climate. The strategies are thus implemented in the process phase, parallel with simulations from the BSim program, an energy frame calculation in Bel8, and visualizations in Revit. The indoor climate must

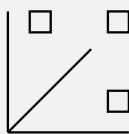
live up to the requirements of the DGNB certification and the Building Regulations and enrich the building aesthetically. Therefore it is a balance and an evaluation matter to what extent the strategies are met.

** The logos illustrated to each strategy will appear on pages throughout the process where the strategies have been implemented.*



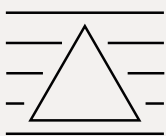
(1) Re-use

Adaptive re-use is about changing the use of a material, which no longer serves its purpose to something new, which is actually needed. A term called up-cycling is about optimizing a recycled material to an extent where it should work as intended and the lifespan is being extended.



(2) Site-optimization

Disturbances on the land should be minimized and thus the current vegetation is protected. One needs to reduce the need for additional infrastructure and make use of microclimatic conditions such as daylight, solar heating, natural shade, and ventilation. Therefore, it is good to choose a place where there are existing community resources in the form of schools, shopping facilities, entertainment, public transport, and existing traffic conditions (roads, sidewalks, sewers, water supply, etc.).



(3) Air-tightness

Air-tightness refers to resistance to internal or external air leakage through unintentional leakage points in the building envelope. In combination with a suitable ventilation strategy, an airtight building will result in lower heating and cooling demands, avoiding mold and rot trapped in cavities, and a more comfortable indoor space due to fewer draft nuisances.



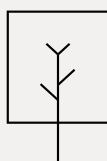
(4) Thermal mass

Thermal mass refers to the ability of materials to absorb, store and release heat. Most materials that absorb excess heat also absorb excess humidity. Thermal mass materials passively act as flywheels for temperature and humidity and reduce fluctuations in indoor temperature and humidity without energy consumption.



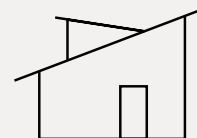
(5) Natural cross-ventilation

Natural cross-ventilation occurs when air through openings such as windows and doors on one side and exits on the other side, enters a building. Positive pressure on the windward side and negative pressure on the leeward side of the building, as well as vertically through the building via the stack effect, are hereby driven horizontally. Natural Cross-Ventilation decreases air-con energy consumption.



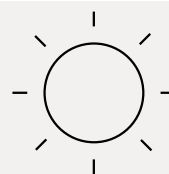
(6) Green roof

A green roof refers to a partial or complete covering of a building's roof. It should be done with well-selected vegetation so that it contributes to the reduction of an urban heat island effect, rainwater filtration, retention of stormwater, and keeping the building cool through evapotranspiration.



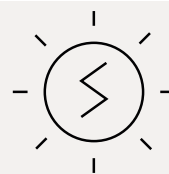
(7) Shading elements

With the right amount of window shading in a design regulated by orientation, position, size, depth, etc., you allow optimal solar heat gain in winter, while reducing overheating in summer. This can be regulated with eaves or other indoor shading devices as well as external instances on a building.



(8) Passive solar design

When developing passive solar designs, one can use the sun's energy to heat and cool the internal spaces of a building. This is done by utilizing the natural properties of materials as well as air and the contribution of the sun to contribute to the indoor climatic conditions, eg. with thermal mass, shading devices, or operable windows.



(9) Solar-electrical power (active)

Solar-electrical power is generated by photovoltaic modules that store energy from the sun and convert it into electrical energy. In the buildings, solar modules can be integrated into the roof design.



DGNB & BR18

Danish sustainability certification
Educational and children's institutions
Version: 2016

In this project, DGNB requirements are primarily used as a guideline throughout the project analysis and sketching phase and be reflected upon during the process. The selected requirements within economic, social, and technical quality support various initiatives in connection with design proposals. However, they only serve as guidelines and as principles for evaluation. To rationalize a strong sustainable concept, some requirements have been selected that match the project's character and vision. The overall function of the DGNB criteria is to provide a framework for more sustainable development in the building sector worldwide and acts as a common language in the development phase across disciplines and organizations easily and clearly. You can thereby obtain a certification corresponding to bronze, silver, gold, or platinum. BR20 requirements for indoor quality are set up against DGNB criteria, so the most strict requirements are selected to achieve the highest score.

One must be aware that when one meets a criterion in one segment, it can have an impact on another segment and/or the overall energy frame, therefore it is about finding a balance and uniting the criteria in a way that makes sense and so that it does not have a negative impact on the environment.

Environmental quality

Life-cycle Assessment (LCA).

Environmental impacts

Weighting: 7

Part of the overall assessment: 7,9 %

A building has an impact on the environment through all phases of its life cycle - from the production of materials, over the actual use of the building, and to the disposal and possible recycling of materials. The impacts are due to both the consumption of resources for the building and emissions to water, soil

and air. The potential consequences include depletion of renewable and fossil resources, global warming, depletion of the ozone layer, photochemical ozone formation, acidification and nutrient loading.

Conducting a life cycle assessment makes a holistic assessment of resource consumption and potential environmental impacts for the entire life of a building, including impacts from the materials' emissions and operating energy. It is the purpose to obtain a sustainable building where the various parameters are evaluated and materials are chosen based on their minimized impact on the environment. Here, we will make use of the program, LCAbyg, and selected EPDs for materials, mainly to evaluate CO₂-emissions for the entire life cycle. This will be set up against a reference building, as described in the DGNB segment.

Social quality

Thermal comfort

Weighting: 5

Part of the overall assessment: 4,3%

The thermal comfort of a building promotes health and well-being both at work and at home, and that is crucial for the assessment of the indoor climate and the experience of the quality of a construction. A room should neither be too cold nor too hot, and air shouldn't be too dry or humid and no nuisance is experienced.

This criterion is important when choosing the right materials, measuring material thicknesses, design of ventilation as well as size and placement of windows. For this, the BSim program will be used so that the operating temperature is simulated and does not exceed DGNB's requirements of more than 50 hours above 25.5 °C at an activity level or metabolic rate of 1.2 met and clothing with insulation value of 0.5 clo.

Visual comfort

Weighting: 3

Part of the overall assessment: 2,6%

User satisfaction is closely linked to the feeling of comfort. In this regard, daylight plays inside the building a particularly important role. Natural light has a positive effect on people's mental and physical health as well as on people's sense of comfort. Good light is needed to ensure a better learning environment. Therefore, there must be good light in all rooms that are not used sporadically.

This criterion will be included in the considerations for the design of the interior spaces in the sketching phase. This should appear in addition to the BR20 section for indoor climate requirements.

Quality of outdoor areas

Weighting: 2

Part of the overall assessment: 1,7 %

The quality of the building's outdoor areas deals with the outdoor areas in the immediate vicinity of the building, which are constructed in conjunction with the construction, which are accessible to the public or users. The purpose of assessment of the quality of these outdoor areas is to provide as many users as possible views and access to one wide range of outdoor environments with a high quality design. The outdoor areas have an impact on the users in general and with accommodation options, the contact between the users is promoted and it increases the general acceptance of the construction. The outdoor areas can also help to improve the local environment and microclimate, if they are designed for this.

This criterion will affect the design of the outdoor areas around the building. Open and accessible spaces will have an impact on users' well-being and activity level and can help to support social gatherings and raise the general perception of the building.

Safety and security

Weighting: 1

Part of the overall assessment: 0,9 %

The feeling of security fundamentally contributes to human well-being. Insecurity and anxiety on the other hand, restricts freedom of movement. Precautions that increase the sense of security usually have as well the effect of reducing the risk of abuse by others.

This criterion will be included in the sketching phase, where emphasis will be placed on clear access roads and parking spaces, road lighting of access roads and parking spaces, access roads to bicycle parking spaces, lighting of paths and living areas, as well as openness and overview.

Technical quality

Quality of the building envelope

Weighting: 2

Part of the overall assessment: 3,2 %

The quality of the building envelope must ensure a good indoor climate in the building. It must be designed so that the heat loss is minimized, which helps ensure thermal comfort. At the same time, the building envelope must consist of moisture-proof constructions so that moisture damage is avoided.

For this criterion, BSim will be used to simulate the quality of the building envelope. This is done mainly in the sketching phase, where several simulations will be performed, thus achieving an optimal building envelope.

Acoustic and sound insulation

Weighting: 3

Part of the overall assessment: 4,8 %

Ensuring a minimum acoustic quality is an indispensable prerequisite for a building to be used as intended. Sound conditions are of great importance for children and adults' learning and working en-

vironment in educational and children's institutions.

The aim is to ensure an appropriate room acoustic quality in accordance with the use of the room. The sound quality of a room determines the acoustic comfort and has a significant impact on the comfort and efficiency of the users.

Established requirements from Br18 and DGNB:

Visual comfort (DGNB)

$DF \geq 2\%$, 50% of the use area.

Alternatively, good daylight conditions can be documented by proving that the internal illuminance from daylight is 300 lux or more at at least half of the relevant floor area for at least half of the daylight hours.

Thermal comfort

Compliance with the upper limit according to DS/EN 15251 Category II, with a permissible exceedance of 50 hours: (Cat. II) operating temperature: 25.5°C .

Ventilation (Br18, § 420 - § 452)

In day care institutions, the supply air and outdoor exhaust must be at least 3.0 l/s per day. child and at least 5.0 l/s per adult, and 0.35 l/s per m^2 floor area.

In day care institutions and teaching rooms in schools and the like, it must also be ensured that the maximum CO_2 content in the indoor air does not exceed 1,000 ppm for the dimensioning conditions.

Acoustic comfort (DGNB)

Reverberation time, $T \leq 4$

Points are deducted according to Table 2 if the reverberation time in one or more octave bands exceeds the calculated mean value by 30% or above 50%.

7 AFFORDABLE AND CLEAN ENERGY



11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



LCA

LCA stands for Life Cycle Assessment and evaluates the environmental profile and resource consumption of material from the beginning of a production stage to the end of life stage. An LCA can be used several times during a design process, as seen in the diagram above [fig.xx], whereas you're constantly evaluating different materials and putting them up against each other to end up with a more environmentally sustainable building construction [fig. xx]

The life cycle assessment accounts for approximately 13% of the entire DGNB certification; therefore, the choice of materials is an essential parameter in the overall building's DGNB-assessment. LCA covers the product phase (extraction of resources, production of materials and transport to the place of production), operation and maintenance (energy consumption, renewal of materials

(including transportation and end-of-life of the replaced material), and end-of-life (waste processing and recycling). (Miniguide til DGNB, n.d.)

For a life cycle assessment, you can use the program LCAByg, where you type in information about the environmental profiles of different materials to compare with other materials or reference values from DGNB. However, the program has its limitations as it does not include all phases [see fig. 4]; but it gives a good clue on how the materials impact global warming and emissions of greenhouse gases [see fig.xx].

For this project, different building materials and compositions are evaluated initially for chosen materials that correspond to the expression strived to achieve [see style board fig.xx]. The viewing period is set to 50 years, where comparisons

are made for different material compositions for a construction section of 1 m². By doing so, you'll get an idea of the materiality and expression experienced outside and inside the building if you choose to use the materials that have the best environmental profile. Although one material or composition may be better to implement than another in terms of ecological profile, it is a matter of assessment to achieve the vision for the architectural expression the best. Therefore, materials and compositions should be evaluated in accordance with expression and resource consumption later in the process to reconcile architectural considerations with sustainable evaluations.

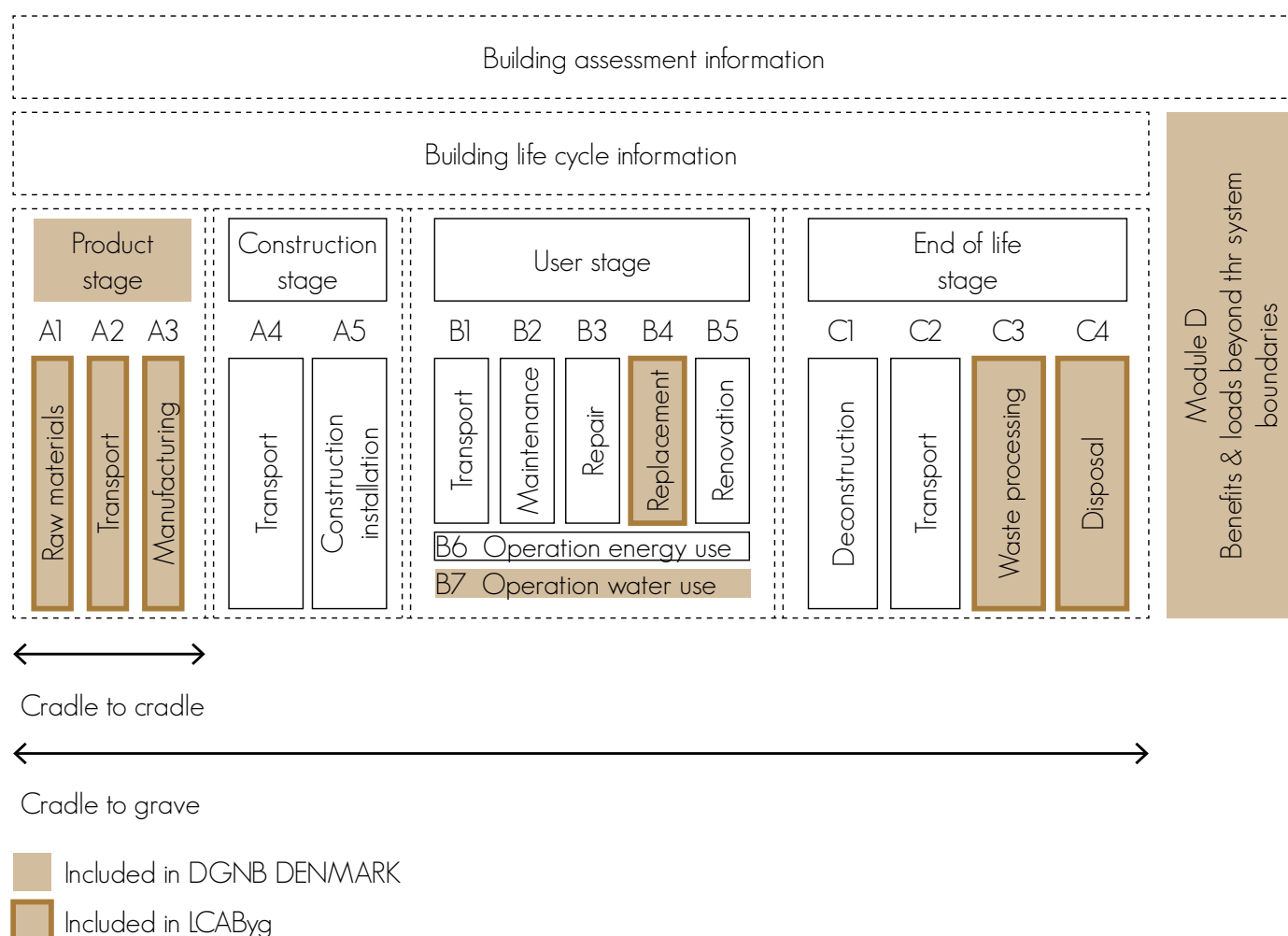


Fig. 4: LCA table on building life cycle

Category Global Warming Potential (GWP)	Category Acidification potential of soil and water (AP)	Category Depletion potential of the stratospheric ozone layer (ODP)
Unit CO ₂ -equivalents	Unit SO ₂ -equivalents	Unit Ethen-equivalents
GWP	AP	ODP
Target Must ensure a minimization of damage to the global environment caused by global warming.	Target Reduction of acidification of the environment. Acidification means increase in concentration of H-ions in the air, water and soil.	Target To reduce the emissions that contribute to the depletion of the ozone layer.
Category Formation potential of tropospheric ozone (POCP)	Category Eutrophication potential (EP)	DGNB Weighting key
Unit R11-equivalents	Unit PO ₄ -equivalents	GWP: 40% AP: 15% ODP: 15% POCP: 15% EP: 15%
POCP	EP	
Target To reduce the photochemical ozone formation near the earth's surface, which occurs when gases such as nitric oxide or hydrocarbon are exposed to UV radiation.	Target To reduce the load of the nutrients that occur when soil and water areas transitions from a nutrient poor to a nutrient rich condition.	



Wood as a Sustainable Material

With sustainability on the global agenda, the construction sector has begun to operate with more sustainable initiatives. Construction procedures have for many years been associated with the mass production of materials that can harm the environment, of which it has been estimated that the construction sector accounts for up to 40% of CO₂ emissions worldwide. Therefore, it has been necessary to find alternative ways to build and improve the environmental performance of buildings and the materials used. Wood could be the answer to a more sustainable future in the construction industry since it is a renewable resource that defeats the current carbon footprint compared to human-made materials. Choosing wood over human-made materials such as concrete and steel reduces environmental impact and construction and operation costs. It is said that 1 m³ of wood for construction material instead of 1 m³ of concrete or steel saves the atmosphere from the emission of 2 tons of CO₂, and with constant advances in building technology, it is today possible to use wood in a wide

range of various buildings, including residential buildings, multi-story buildings as well as institutions. In line with these advances, construction codes have also been formulated to accommodate these wood construction methods. (Bipat, 2021)

"We can easily use more wood than we do today. At least for 50 years we have planted more and more forest in Denmark, and from a climate perspective you have the advantage that if the tree is in the forest, or if it is in a building, it stores the same carbon" - Jette Bredahl Jacobsen, professor (KU) og medlem af Klimarådet

Wood, a Construction Material
Wood is an organic material that can work in many respects in a building, making it very versatile. Today, wooden constructions are much more durable than what has been seen in the past due to the streamlining of the material and construction techniques. The material possesses specific properties that make it both durable and robust. With the proper treatment, wood can be a reliable building material with a long span

of life. Wood must have a particular strength for it to be used in the load-bearing structures, and here it can be an advantage to use CLT. The term stands for cross-laminated timber and covers several layers of boards glued together in at least three layers. These elements of solid wood are rigid and robust and are used instead of concrete and steel in the load-bearing structures of taller multi-story buildings. Since 2000, CLT has emerged as a building material, and coniferous wood is most often used, but experiments have shown that a mixture of coniferous timber and beech is also strong - and this makes it possible to utilize both Danish coniferous trees and Danish deciduous trees for building elements. However, a wooden construction also has its limitations when exposed to moisture, such as in wet rooms. There may be a risk that moisture damage in the structure can affect more prominent parts of the construction. Therefore, it can be advantageous to choose a hybrid solution where concrete is used in selected places, but that wood is still the dominant material. (Boding and Boding, n.d.)

Thermal Properties

Wood has a low thermal conductivity (high heat-insulating capacity) compared to other materials such as metal, glass, and concrete, making it a good insulation material. Wood fiber insulation is an example of natural insulation material, mainly made out of wood chips, used for walls, floors, and roofs. The insulation boards are adjustable and dimensionally stable and can therefore quickly adapt to different wall constructions.

Hygroscopic Properties

Wood fiber insulation have good hygroscopic properties, meaning that the material can easily handle moisture and reduce moisture damage.

Sound insulating properties

The wood fiber insulation acts as good sound-absorbing material due to its high density, making it a suitable choice for insulation in rooms where noise-canceling is necessary. (Hunton Nativo® Træfiberisolering Plade - Hunton Danmark, n.d.)

Mechanical properties

Wood is both durable and has high strength and high breaking length, also making it the strongest material compared to its' weight. (Taasinge.dk, 2021).

Aesthetic Properties

Wood can be used in many different respects and can vary in color, shape, smell, and texture. It can serve as a construction and insulation material, but it can also be used for decorative dishes with its rustic exterior and tactile qualities. This kind of versatility can contribute to a rustic decor of furniture and other interiors.

Limitations to Wood

Wood also has its limitations if it is not processed correctly and gets the proper surface treatment. As wood is said to be hygroscopic, when it is exposed to moisture, it can shrink and swell as it absorbs moisture. And as wood is an organic material, it is a source of nutrients for plants, animals, and insects, leading to attacks by fungi, termites, beetles,

and ants. Antibiotic deterioration can also occur, i.e., a non-biological deterioration caused by the sun, wind, water and chemicals, and fire. With all this in mind, it is crucial to impregnate the wood to withstand these conditions and prevent deterioration of the wood. Fortunately, techniques have been developed that can make the wood more durable in a sustainable way. Superwood is a company that specializes in the production and impregnation of wood, where their impregnation techniques use recycled carbon dioxide to dissolve and transport wood protection into the boards during a high-pressure process. The agent is dissolved in particles and sticks to the wood cells, and this leads to a multiplication of the life of the wood, where the properties of the wood remain the same before and after the impregnation (Bæredygtig imprægning - Superwood.dk - Verdens Bedste Bræt., 2021).



Fig. 5: Wood as a sustainable material



Fig. 6: Lendager Group, Upcycle Studios

Upcycling

It is no secret that humans consume more than the climate allows. With the high consumer mentality we see worldwide, the earth will always be in deficit on natural resources, as we use up these resources faster than the earth can regain them (I dag er jordens naturressourcer opbrugt for i år - WWF Danmark, 2020). Therefore a relatively new term, namely Upcycling, has become a popular initiative in particularly the construction sector

This behavior change has become necessary because our growing global society, which Western countries led, has been created to consume and throw away, and where resource consumption has escalated since the post-war period. Industrialization and globalization have made the phenomena of waste and pollution generated in unmanageable quantities with

significant environmental, economic, and human consequences. (Lendager, 2017)

Lendager Group is an example of an architectural firm working with construction waste to give used materials new life and sometimes a new purpose. By upcycling, you are recycling waste and give it optimized qualities. It is recycled materials that are used for other/new purposes, where the recycled material will be in better condition in which it was found. An example of this is if you mix new concrete with demolished concrete from, e.g., an old house, making the concrete more robust, or use old bricks, which can be reassembled and form a new facade cladding. These measures not only save CO₂ but also form part of a circular economy, keeping materials and other products in an economic circle with the highest possible value for as

long as possible, breaking from the linear value chain. (About - Lendager Group, n.d.)

Upcycle Studios is an example of a project by Lendager Group located in Ørestad Syd in Copenhagen, where 75 percent of the windows are recycled from public housing in North Jutland and 1400 tons of recycled concrete is cast from Copenhagen Metro's concrete waste, and the wood for the floors, the walls and facades are surplus wood from a wood company. In this way, CO₂ is saved as well as the extraction of raw materials by recycling materials for new building components, where at the same time adding recent buildings history and character from "birth" (Materials, Lendager Group, n.d.).



Fig. 7: Lendager Group, upcycled facade cladding

In the project, the upcycling mentality is kept in mind to create added value to a new building with recycled and refined waste materials. However, it is also about finding a balance so that the optimization process of a waste material does not emit as much CO₂ as creating new material for the same purpose. Upcycled materials will be shown in the material section (xx.).

Methodology Introduction

This section will present the methods used in this project as a background for the project's development and approach. It is shown how acquired knowledge will be processed and what we would like to achieve with the process based on various methodological tools.

Methodology

The idea of promoting learning, innovation, and integration within a community requires a methodology to translate socially and environmentally sustainable initiatives into an architectural experience. IDP (Integrated Design Process) is used as a part of a problem-based learning environment. It is often observed that due to the complex multidisciplinary and iterative nature of the process, some of the aspects tend to overpower the other and ultimately the final output in terms of architectural experience, and thereby creativity is compromised.

To address this issue, we will be working with an own perception of IDP combined with "Principle and Gesture" methods developed by Marie Frier.

Process

The integrated design process can be explained by the concept of co-evolution (Maher and Poon (1996) as cited by Lawson B. 2005). Here we work in "problem space" and "solution space". As shown in fig. 8, the problem space helps to understand the problem and all information related to it, while solution space is where all the ideas are synthesized. Thus the most important task here is

to connect the problem and explore them in the creative design solution. IDP is quite effective in problem space since with five phases; problem, analysis, sketching, synthesis and presentation, architectural and engineering design solutions are constantly evaluated repeatedly. For the solution space, the Principle and Gesture method is used. It is a strategic method of working with tectonics in architectural practice. The tectonic theory provides an approach for bringing aesthetics and technique together by translating the physical surrounding into experiential spaces through form, scale, tactility, and acoustic. (Pallasma). The substantial framework of tectonic theories establishes mutual critical dependency of the two notions, Gesture and Principle. Where 'gesture' is the envisioned and experienced quality of space, which explains what space does, and 'principle' defines the mean applied in its realization. (Hvejsel, 2017). The close connection between physical construction design solutions and embedded meaning in architecture design forms the core of tectonic thinking. Further, these two aspects are connected to a wider context and involve tectonic analysis of various aspects such as cultural, historical,

social, economic, or ecological considerations, making it inclusive and open. The tectonic methodology of Principle and Gesture provides a system of consciously working with the transformation of measurable principles into an unmeasurable spatial experience, gestures. In comparison, an integrated design process will aid in achieving and measure these aspects through architectural and engineering knowledge.

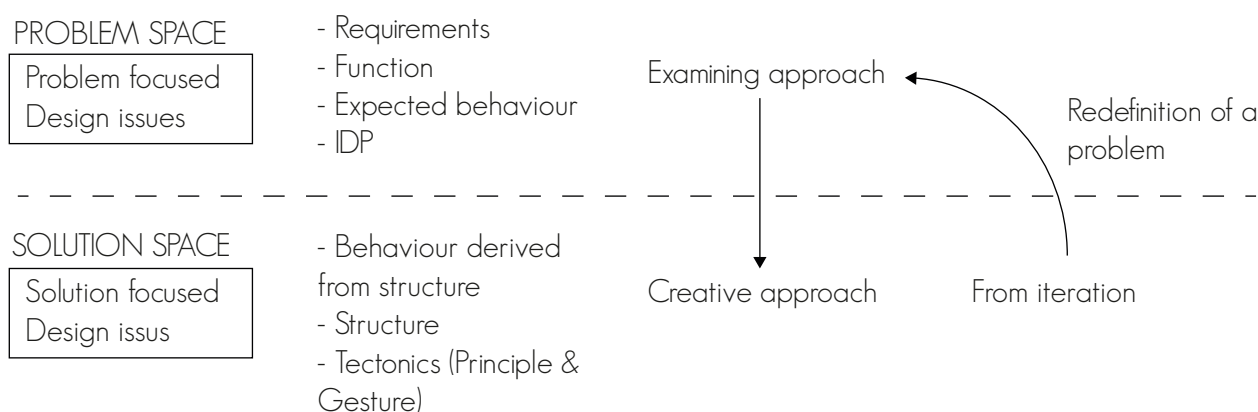


Fig. 8: Design process concept

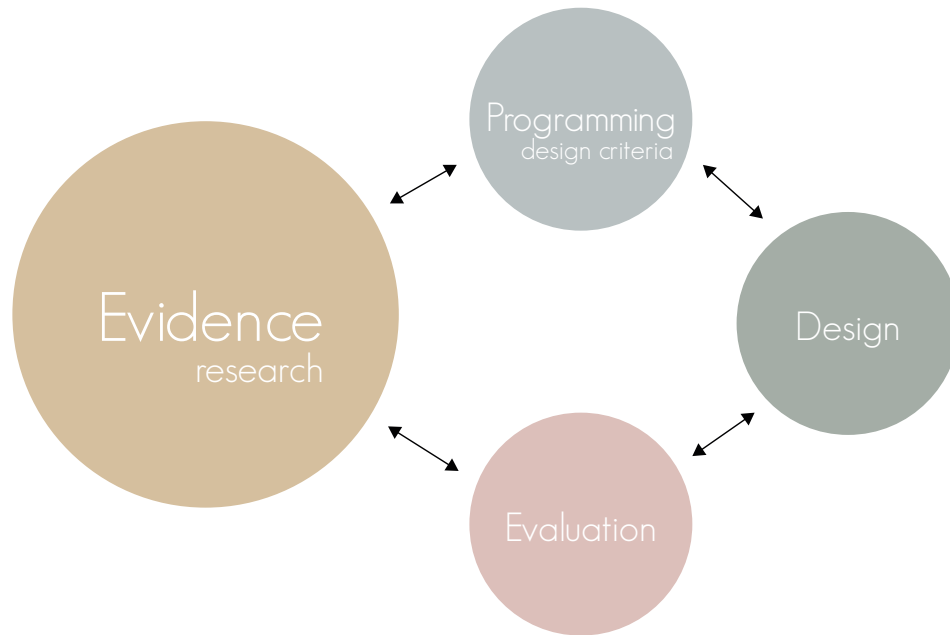


Fig. 9: Evidence- and research based design
(based on: Longino, 2015)

Evidence- and Research-based Knowledge

The methods used in this project are based on evidence- and research-based knowledge. It degenerates into two different ways of acquiring knowledge and how to process it.

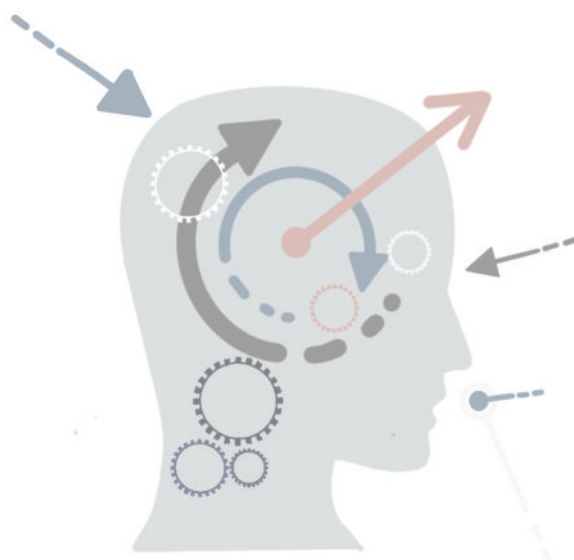
Evidence-based knowledge is an approach to information based on established data, without reservation of personal views/opinions. This type of knowledge is made based on independent scientific evaluations in the form of, e.g., statistics, medical journals, and test results. Here it is important to collect different sources and process them to make valid conclusions, which form the basis for a broader understanding and new knowledge. (Lawson, 2010).

Research-based knowledge degenerates into acquired knowledge from other people's (often experts) research studies. By evaluating this type of study, you can support theories relating to your specific problem area and agenda. It is, however, vital that you are critical in your assessment of reusing knowledge from others, as you must be sure that suitable sources and data have been used. It can be supported by examining their references and validating them; however, one can also find other case studies, articles or journals, etc., that support the same topics and get the same result. The purpose of evidence-based design in this project is to combine

scientific evidence with creative design solutions; however, it can be challenging to translate scientific data into definite design parameters. Also, strict use of evidenced-based knowledge can result in limitations where imagination, creativity, and experimentation are undermined. Using both evidence- and research-based knowledge in the project, we strive to solve problems based on technical and architectural principles and with sociological and creative aspects of so-called and ever-changing state-of-the-art development.

Gesture and Principle

The diagram below illustrates tectonic thinking in how sustainable initiatives (principles) should be transformed into architectural experience (gestures).



Principle		Gesture
Cultural diversity	← ----- →	Integration Learning diversity
Activity space	← ----- →	Social cohesion
Shared space	← ----- →	Sense of belonging
Individual space	← ----- →	Reflection
Material properties	← ----- →	Tactility
Flexibility	← ----- →	Innovation Inspiration
UN Goals/DGNB	← ----- →	Sustainable behaviour Welfare
User specific design	← ----- →	Interpersonal growth Playful Creative

Fig. 10: Principles and gestures, for transformation of sustainable initiative into architectural experience

Site Introduction

In this section, we will justify the location of our site. We introduce the area with a local plan for the site, including municipal future visions and wishes and the expected target group. Some microclimatic analyzes further support the site. Microclimate analysis is used to understand the basic yet fundamental aspects of the site, such as sun path, wind, and temperature. It helps decide the placement of the building, open interaction area, or semi-covered spaces. Further, during the design phases, it also aids technical aspects such as natural ventilation, shading, and comfortable daylight and temperature conditions.

Where and Why?

The increment of immigrants and descendants in Denmark may result in a greater occurrence of cultural and language barriers. Today, ethnic minority children and young people do worse than their peers in a wide range of areas. Thus, some indication that the current integration efforts for children and young people are not adequate and do not manage to meet the integration challenges that the children and young people experience during their upbringing in Denmark. For example, we know that several ethnic minority children are already linguistically behind their classmates at the start of school, and there is not much to suggest that the difference is evened out during school time. (Lovende Integrationsindsatser for Børn og Unge - 15 Konkrete Eksempler, 2018). It is on the political agenda how to deal with immigrant's and descendants' integration and maintain or create cohesion in a society that has become more ethnically and culturally mixed in recent decades. It is basically about how new citizens can become part of the Danish society and community (integration of immigrants in Denmark, Kristina Bakkaer Simonsen).

According to a table compiled by Danmarks Statistik, the population of immigrants from non-western and western origins and descendants per the 1st of January 2018 was 28.2% (7825 people out of 27743) in Albertslund. (Statistikbanken hos Danmarks Statistik, FOLK1C). It testifies to a varied population composition almost twice as high as the percentage population composition in all of Denmark, which in 2019 was 14% of the population for immigrants and descendants. A table also shows that the proportion of pupils in 9th grade with non-Western origin in Albertslund who pass tests in both written Danish

and mathematical problem solving is seven percentage points lower than the national average. (udlændinge- og Integrationsministeriet, nd).

Therefore, some assets must be invested in this municipality to help young immigrants and descendants in the best possible way and raise their educational skills to equalize with the rest of the population and promote social cohesion despite ethnic minorities.

Albertslund

Albertslund is a suburb approx. 14 km west of Copenhagen and has a population of 27,548 and 106 nationalities. In the post-war period, a larger part of Copenhagen's population moved to the suburbs. With the "Finger Plan" originated in 1947, the principles for expanding, e.g., Copenhagen's Vestegn, were determined. In short, the Finger Plan went before it was revised to form the overall framework for spatial planning in the metropolitan area, where the focus is on the design of a good infrastructure between housing, trade, companies, public institutions, etc. and secure green springs between and outside the "finger-city." In post-war urban planning, the ideal was a functionally divided suburb with city centers, homes, industrial districts, and recreational areas, shown in Albertslund's overall infrastructure and planning. However, the new suburbs were scolded by critics when they found them boring because residents left their neighborhoods in the morning to go to work and therefore were only home in the evenings and at night. This monotonous and organized character was much criticized in the media, but to accommodate more lively residential neighborhoods, they have since focused on sporting, social and cultural activities. With the

many developed areas, part of the future investments will go to the renovation of the existing building stock with a view to energy savings to achieve the municipality's goal of being CO2-neutral by 2025.

Local Plan

Several reviews have been made of various local plans from Albertslund to support the choice of the site where local plan 12.7, "local plan for Hyldagerkvarteret," is the one corresponding the most with the project vision. Some points have been highlighted for overall guidance in designing an appealing building that also matches Albertslund's municipality's vision.

Initially, in the local plan, it is said that the vision for Hyldagerkvarteret is part of a larger narrative, where Albertslund was originally founded with "the good family life" in mind. It was mainly young families from Copenhagen who sought out where there were light, air, and better welfare, which are qualities that have always characterized Albertslund and which are found in the municipality's overall vision and strategy of being "a city for the children, the green and the community."

Hyldagerkvarteret is facing a major urban development for the first time since the city's establishment, and as the Hyldagergrunden is almost empty today, there is great potential for thinking the overall vision of the town from the start.

Site character

In addition to Hyldagerhallen, which is open for all citizens to still use, today's area appears as an unused meadow area. The site is not very well maintained, and the natural quality of the area is low. Hyldagerkvarteret plays a crucial recreational role as a transition zone between the town and Vridsløselille Village on one side and the parking area on the other. On the plot, four rings of trees are seen in different sizes, and in terms of their size and height, they have

a significant presence in the area. The tree groups are characteristic of many of Albertslund's city parks and are laid out in well-defined circles, ellipses, or the like.

Target group

Although the families with children are in focus, Hyldagerkvarteret must appeal to a broad target group. It is done by offering housing, institutions, and good living conditions for a more comprehensive section of the population while creating interaction across the population and moving internally in the area when the life situation changes. In the local plan, four target groups have been formulated that are particularly important for the future development of Hyldagerkvarteret, resp.: the young families, singles with and without children, housing associations, and seniors.

Application

It is possible to establish both housing and functions within the area for public purposes, such as school, sports hall, institutions, parks, and the like. Also, standard functions can be established naturally linked to residential purposes, e.g., playgrounds, communal houses, and other communal facilities.

The local plan sets out principles for:

- Planting belts in the northern and southern part of the area
- The transition between Hyldagerkvarteret and Vridsløselille village
- A desire for a modern village expression
- A desire for a continuous path connection
- Outdoor living areas on different scales

Besides, outdoor spaces that support the community must also be organized. The outdoor areas need to be designed to help communities at different levels. Hyldagerkvarteret must offer a good framework for various forms of social life - from the random meeting on the road to planned joint events. The district's green areas and squares must be social opportunities spaces - spaces in which the residents can interact. It will be crucial for Hyldagerkvarteret to offer variation in the range of social meeting places.



Fig. 11: Proposed local plan area boundary

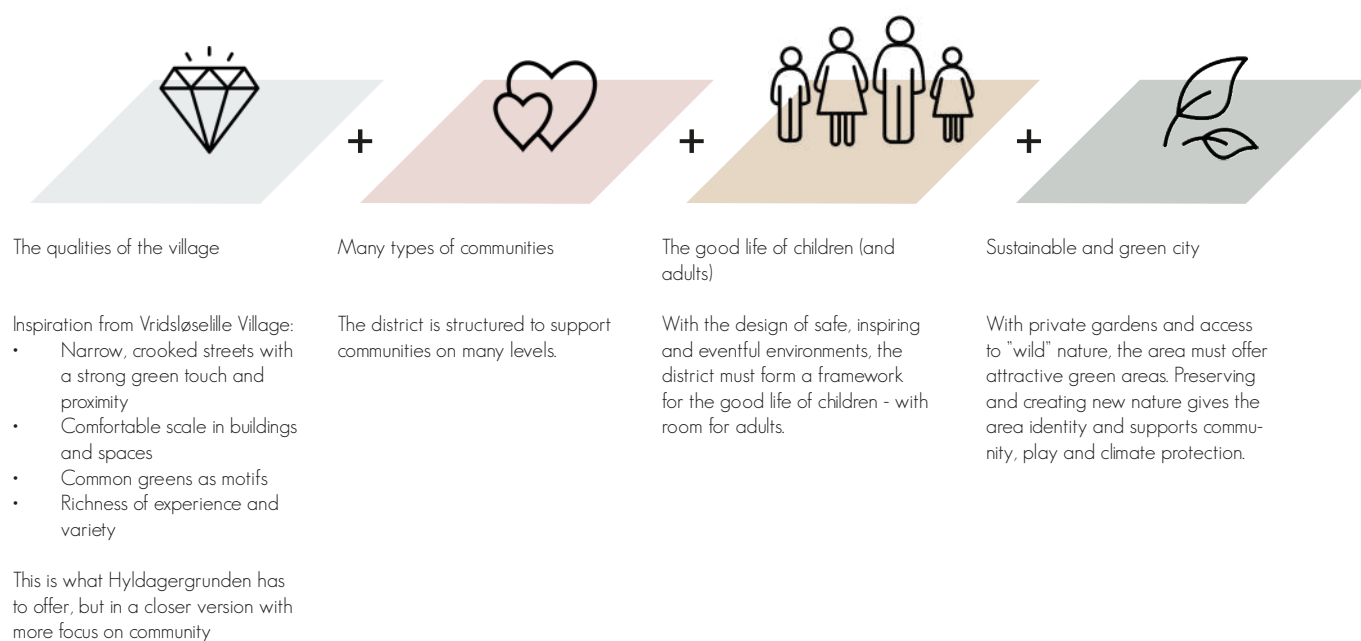


Fig. 12: Overall vision and targets for the local plan area

Site Registration, Hyldagerkvarteret





Fig. 13. Site registration



Fig. 14: Mapping

Accessibility

The site is connected via roads, bicycle paths, and walk pathways, as shown in the figure. Also, as a part of local plan development, further measures are proposed that can better bind the surrounding areas' physical structures and strengthen the sense of community. Direct access to the local plan area will take place from Vridsløsestræde, where the site is located. At the meeting with Vridsløselille Village, it is proposed that the existing road and path paths be extended into the Hyldagerkvarteret and newly developed activity area Hyldagerbakker in the form of walking and cycling paths. It creates strong physical connections

that form a natural integration to be experienced as natural to move in and around the site and the surrounding areas.

Conclusion

Better connectivity is needed to firmly connect the site and the new development area to the adjacent areas. To preserve the planting belt in the north-western corner and comply with the conceptual proposal for the development, the building can be pulled out towards Vridsløsestræde, increasing the visual connectivity. This enhances the experience of a cohesive city.

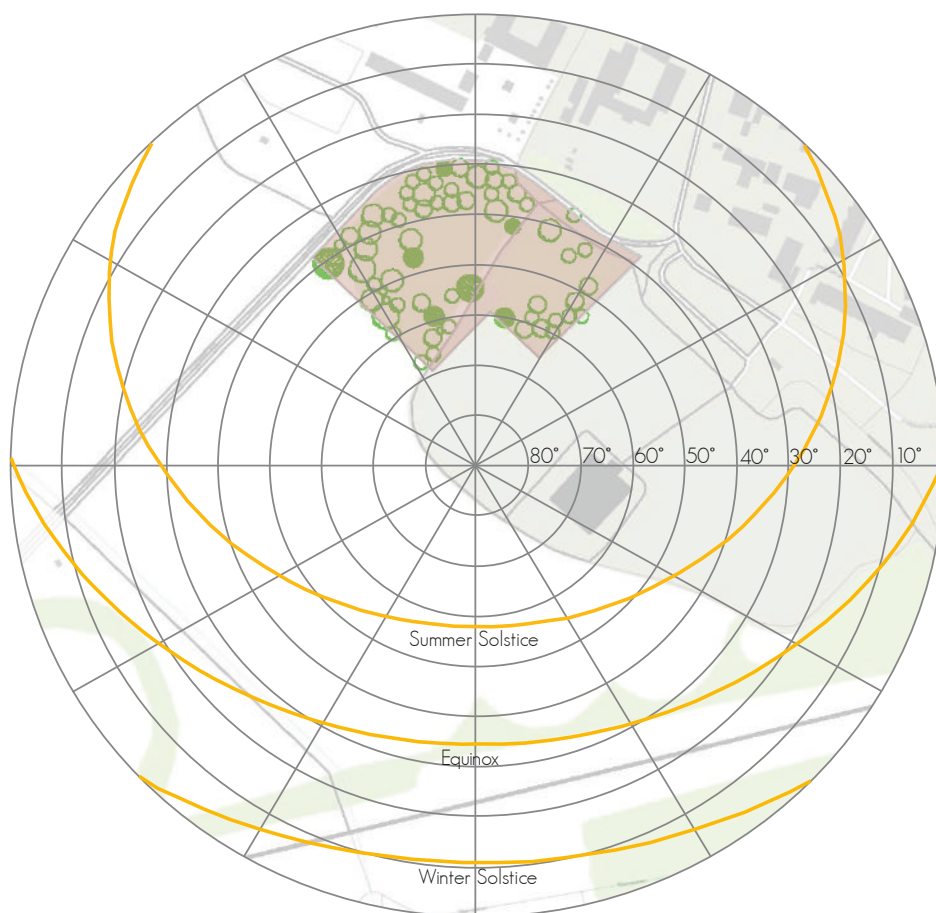


Fig. 15: Sun path diagram

Sun

To get an insight into the sun's orbit around the site and how it affects shadows on the site, a sun path analysis has been made, where two days have been chosen, respectively; summer solstice and winter solstice. (shadow diagrams can be seen in the appendix on s.xx). These two days are selected as the sun here has the highest and lowest point in the sky. At the summer solstice, the sun rises at 4.27 am, and sunset is at 21.56. When the sun is at its highest point in the sky, it has a 57-degree angle during the summer solstice. At the winter solstice, the sun rises at 8.38 am, and sunset is at 15.39. When the sun is at its highest point in the sky,

it has a 12-degree angle during the winter solstice. With this information, one can distribute the site's various functions to take into account both sun and shading elements.

Conclusion

It is a challenge that there are so many trees on the site as they cast a lot of shadows in the outdoor spaces; therefore, a strategy needs to be laid out for what activities to place around the building. However, the trees can have a positive effect in the summer when they have sprouted out, and they can thus prevent overheating as they act as natural shading elements.

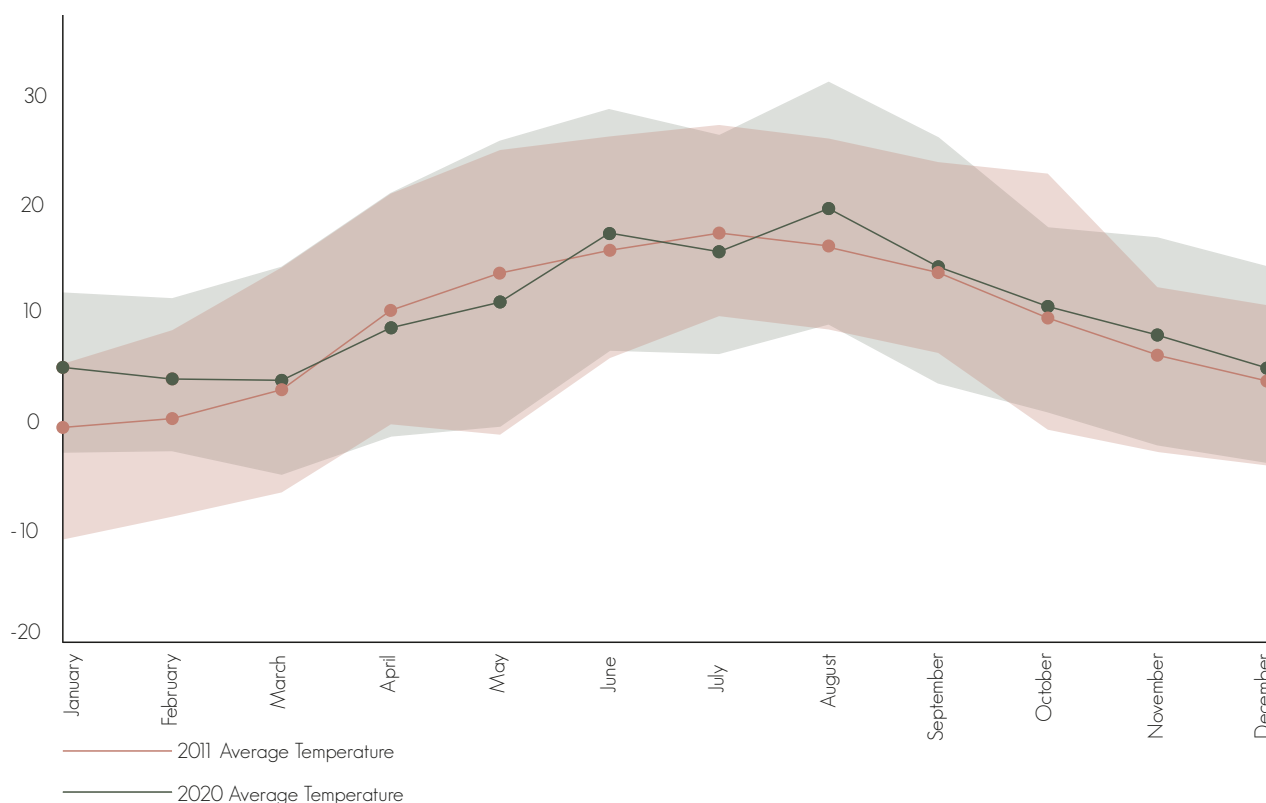


Fig. 16: Monthly average, maximum and minimum temperature for the year of 2011 and 2020 (based on: DMI; 2020)

Temperature

A temperature analysis has been made for the area, with an average temperature for each month for the respectively year 2011 and the year 2020. In addition, you can also read in the graph the lowest and highest temperatures for each month in each of the two years. This analysis is done to see what thermal conditions should be taken into account when preparing the building. The warm season lasts for about three months, from the first week of June until the second week of September, where the average daily temperature is around 18-degrees. The cold season is four months long, starting from November to March, where the average low temperature is registered to be around -1.6-degrees and the average high temperature is 3-degrees. On the graph, you can also see the consequence of global warming. According to the Ministry of the Environment and Food of Denmark,

the average temperature has risen by 1.5-degree since 1873 and continues to rise year by year. Through the Paris Agreement from 2015 under the auspices of the UN Climate Convention, a target has been set to keep the global temperature rise below 2 °C and preferably 1.5 °C. (Temperatur og klimaforandringer, 2020).

Conclusion

With the changing temperatures, it is essential to look at the building's envelope, which must be flexible to varying outdoor temperatures and preferably for several years to come if temperatures continue to rise despite the global target of keeping the temperature rise under 2 °C.

The temperature analysis is used to prepare the indoor thermal conditions in the building to take into account when natural ventilation can be used without experiencing

discomfort from drafts and cold and when it is necessary to have mechanical ventilation in the colder months.

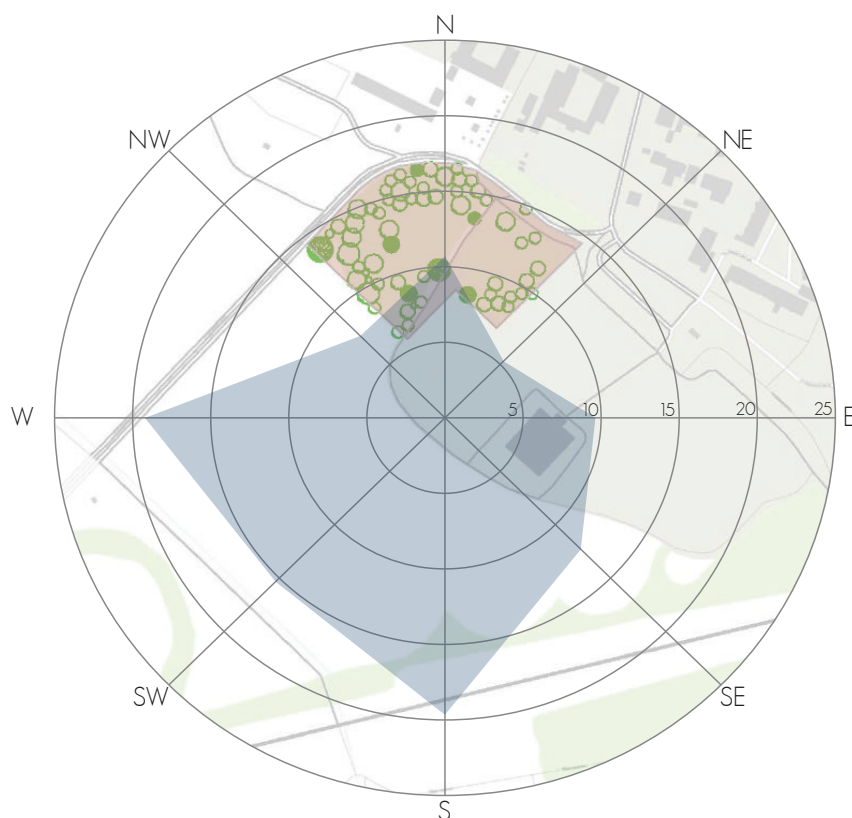


Fig. 17: Windrose based on wind direction for Albertslund

Wind

The average hourly wind speed in Albertslund has substantial seasonal variation for the year. From the later part of September to the last week of March is the windier part of the year, with an average wind speed of more than 13.0 miles per hour. The rest of the year is comparatively more wind-still, with mid-July being the most wind-still part with only 10.6 miles per hour average hourly wind speed. The windrose also suggests that the maximum percentage of wind comes from the south, west, and southwest direction. The wind has a significant impact on human comfort since it also affects the temperature. Perceived temperature can be lower or higher than the actual temperature due to the wind conditions. Based on the wind speed and wind direction, different ventilation strategies can be incorporated in the design, such as single-sided, cross, or stack ventilation. Single-sided ventilation is achieved with an

opening only in one façade. It is the least efficient mode since the room depth is limited only to 2-2.5 times the room height. However, this could be manipulated by providing several openings on the same façade. Cross-ventilation is achieved by providing two openings or more on different façades, creating efficient airflow across space. It is more efficient than single-sided ventilation and is practical for areas with a depth of 5 times the room height. The principle of thermal buoyancy is achieved by stack ventilation. It lets the fresh air in at lower levels and exhausts the old hot air at the top. Even though natural ventilation is adequate in terms of energy and cost, it might result in heat loss during the cold winter period, resulting in an uncomfortable indoor thermal environment. In this case, hybrid ventilation systems can be introduced, primarily for wintertime use (Anne Kirkegaard et al., 2-14). It

also provides strategic information required to create outdoor leeward open spaces to act as an activity generator.

Conclusion

With the changing temperatures, it is essential to look at the building's envelope, which must be flexible to varying outdoor temperatures and preferably for several years to come if temperatures continue to rise despite the global target of keeping the temperature rise under 2 °C.

The temperature analysis is used to prepare the indoor thermal conditions in the building to take into account when natural ventilation can be used without experiencing discomfort from drafts and cold and when it is necessary to have mechanical ventilation in the colder months.

Library Introduction

In the following section, we will discuss the importance of providing society with a public institution, which aims to improve social inclusion, promote learning and communities for socially sustainable development. This type of institution is particularly relevant to the project's vision and focus and is supported by case studies with a follow-up conclusion by an institution that primarily has had the same agenda and vision for a community just like Albertslund.

Library

Libraries continue to be relevant - vital - public institutions. And this vitality is now encoded in new physical forms. Unlike their turn-of-the-twentieth-century and mid-century predecessors, today's libraries do not fit a mold. Many of them don't even look like libraries'. In rejecting an obligation to conform to an architectural type, today's public libraries are free to choose shapes and styles that speak to the cities and populations they serve. (Mattern S, 2007).

Libraries have faced radical transformation in the last two decades. From a building designed almost exclusively to house a collection of books and other research materials, libraries now are as much about creating places where people meet, read, discuss and explore ideas as they are about the collection and administration of books in an ordered form. However, today's library faces a challenge, as the advent of digital media makes it easier to access knowledge online. Therefore, we see today that the need for public libraries is not as great as it once was. Thus, municipalities and library organizations will need to reconsider and rethink the library's role in society and the functions and services it must offer. Today we often see that libraries contain more functions than just lending books, and some libraries are more closely regarded as cultural centers rather than classical libraries. Various initiatives such as cooking, art exhibitions, and debate groups can help promote the use of the public institution and increase the number of visitors; however, it also decreases the number of books lent from the libraries. (Bøger forsvinder fra bibliotekerne, 2014). Instead of people in the past being able to immerse themselves and entertain themselves by visiting the library, it is now the libraries that engage them.

It can have a major impact on the debate on better integration and the fight against loneliness and inactivity.

The idea of the modern public library as a living room in the city is becoming a vital feature of modern urban culture. (Worpole K. 2013) looking at the role libraries play in society, urban sociologists such as Ray Oldenburg have termed libraries as a 'third place' - a vital place distinct from the two other prominent sites of human existence, the home and the establishment of work. These 'third places' are where both conviviality and sanctuary are offered in a range of highly public and more intimate gestures. A library is a building where you collectively do something individually. The exciting thing about the phenomenon of the library is that everyone wants to create a private domain, even if only for ten minutes. You see also that visitors nearly always consciously choose a place.

"I don't think there's any other building where the tension between the individual and working in a collective space is so emphatically present as in a library. That's why we also said - discovered actually - that as soon as you enter a library, you're also involved with other people." (Wiel Arets, architect of Utrecht University Library, Living Library, 2005)

Library and social integration

Social integration refers to the quantity and quality of social connections and interactions that people have with others. In the context of immigration, the term integration is often used to refer to a type of acculturation strategy in which immigrants have regular contact with host nationals and maintain their original cultural identity (e.g., Berry, 1997). A new globalized world in which increasing migration and ethnic diversity

have become the norm. In other respects, however, Denmark, like the other nations of Europe, has also developed a particular national version of the cultural anxiety that has swept the continent in recent decades in response to the arrival of growing numbers of immigrants and refugees (Grillo 2003; Hervik 2006). A public library can play a major role in bringing people together from different cultural backgrounds by offering functions where people gather and interact with each other for a common purpose. It can strengthen a sense of belonging and cohesion. A library is perfect for this purpose, as it can accommodate many functions and be flexible in its range of services, while at the same time being considered a "knowledge center," where you still have the opportunity to use the classic functions, like borrowing and reading books. It thus hits the target group broadly so that you can achieve an institution with a lot of diversity and activity.



Modern Day Library

The idea of modern-day libraries was coined in the USA and UK about 150 years ago, where the influx of millions of immigrants created the need to introduce them to the political and social American background for integration. Creating an educational and cultural arena capable of transferring the skills, competencies, and values necessary when society was changing to a predominantly industrial economy, and culture, as opposed to an agricultural economy and culture, was also an important background for the idea of modern public libraries. (Harris, 1978)

Two profound and seemingly unrelated developments can characterize today's global society; one is cultural and social changes caused by migration that result in the multicultural community. The other is the digital revolution and unprecedented growth of information technology as an integrated part of everyday life. This development is linked to the digital revolution, which opens up for

increased communication but might increase an effect where people live in segregated cultural niches without being exposed to other values and interests. It is a general challenge to create meeting places with the potential of promoting that degree of cross-cultural communication. The challenge of achieving cultural community and accepting and promoting cultural diversity has two major tasks. One is integrating newcomers into the existing social and political culture of the receiving community while giving them possibilities to cultivate their own culture. And second is creating arenas where people from different cultural groups can meet, communicate, and discourse can take place across social and cultural borders. Both demand a structured approach that allows gradual introduction into the new society. (Audunson 2005).

The local public library is an institution firmly embedded in the local community with links to all sectors of activity in the community.

Therefore, using the local library is a form of participation in the community with links and channels to a broad spectrum of areas and activities. Via the public libraries, newcomers and excluded can be offered exactly that gradual introduction to the local community. It is probably hard to find an institution that is better suited to serve such a purpose than the public library, and this provides one path for rethinking and revitalizing the library's role as a meeting place in today's multicultural society. (Aabø and Audunson 2010).

Even when libraries are not community-driven by nature, millennials have found multiple reasons to visit the library. According to Pew Research Center, due to the increasing financial burden and decreasing size of the houses, Young people living in shared or small spaces longs for escape. This encourages people to visit libraries that provide spaces for gathering and socializing, particularly during winter in more cold parts of the world. This is one of



Fig. 18: Modern library, Oodi Library, Helsinki

the primary reasons public libraries resemble the civic / community center in the current time.

The research study on 'Envisioning the libraries for the future' published by Arts Council England in 2013 suggested four priorities for the libraries: (1) place the library as the hub for the community. (2) Make the most of digital technology and creative media. (3) Ensure the libraries are resilient and sustainable. (4) Deliver the right skill for those who work in the library.

Oodi library at Helsinki addresses these issues by providing ample space for interaction. While the number of books is far less compared to library size, it offers digital alternatives. The reduced storage requirement also allowed an indoor public space that hosts more than 2.5 million visitors every year. With the motto of 'learning over loaning,' Oodi provides room for innovation, such as 3D printers, which are often

out of broad public reach.

Calgary's new Central Library by Snøhetta works as a civic space connecting the diversity of the community. Taking a cue from the changing requirements of the community, it provides a lively public space on the lower level and a quiet study and co-working environment on the higher levels. The library enhances the connection between indoors and outdoors with a string of multipurpose spaces that wraps the perimeter -this strategically designed porous boundary enriches the users with a multitude of activities. The same strategy has been used in the Tingberg library and culture house designed by COBE, where there are various facilities such as classes, workshops, lectures, and musical performances. It functions as a positive social nucleus to the marginalized areas with a high crime rate.

Conclusion

It proves that libraries are powerful enough to remedy social ills, and many municipalities are preventing measures even if a utopian ideal. With more than six library projects in Australia in the last six years, architect Stewart Hollenstein refers to libraries as urban living rooms. By keeping the design adaptable, he makes sure that the architecture can respond to evolving neighborhoods and their requirements.

Since these libraries are designed to involve communities early, they integrate into their respective urban fabric, enhancing and enriching the communities. As humans' relationship with media changes, libraries must adapt and keep doing so to stay relevant. The next generation of libraries strives to be a fluid space accessible to the broader community and is a mix of social and quiet rooms.

Library - a Playground for Kids

Through the years, many theorists have described the importance of play in children and what it means for their cognitive development, self-understanding, social and emotional development, as well as giving them tools to strengthen language skills, problem-solving, and negotiating skills. A good foundation where children can freely unfold, think for themselves, and enter into relationships with other children provides a better precondition for better learning and general behavior as they get older. (Singer et al., 2006). Parents, caregivers, and educators are often given the responsibility to activate children, but in these times where technology has primarily set the course for children's daily life and thereby well-being, an institution to inspire children and young people can be part of the solution. Thus,

this fixation on digital media does not prevent them from engaging in physical play and unfoldment.

That play is a big part of one's upbringing is a widespread realization. A theory developed by Lange in 1902 and Claparde in 1911 goes so far as to say that play completes the ego and shapes children's personality and individuality in cognition, social and other skills (Ginsberg K., 2001). One can go more in-depth about different types of play and how it affects the child. Formalized learning and language development are enhanced by play, where children engage in communicative relationships with each other that are of great importance for children's ability to write and read. In contrast, play, which incorporates critical thinking,

including play with bricks, play with water, and sand, puzzles, drawing and painting, help to develop problem-solving skills. (Huertwitz S., 2002). If children find themselves in inspiring environments where they can freely unfold themselves, it will facilitate further learning. But no two children are alike, and it is therefore essential that an institution allow children to play based on own interests. According to Ginsburg K (2001), when children are allowed to pursue areas of their own interest, they are likely to develop a more positive attitude towards learning. Another important aspect is that children should have the opportunity to play with other children, including children from different ethnic backgrounds, as this interaction between them makes them better at socializing, collaborating, and



Fig. 19: Playing kids at Vittra School Telefonplan

listening to other people's ideas and, over time, becoming more open-minded towards different cultures and traditions. If conflicts arise among children, play can be a good tool for negotiating for better continuous play. A social and healthy child who possesses this intrapersonal character can better fit in at school and perform better in academic contexts. (Smith D., 1995). Play can also be used to counteract fear, depression, and anxiety in children if exposed to situations that may be frightening to some children, such as hide-and-seek games in dark rooms, which give them tools to process this fear and realize that darkness in itself is not dangerous. (Coolhan K. et al., 2000). Therefore, this freedom for children to play, discover, and enter into relationships is fundamental to promote. However, play today is

significantly reduced due to the advancement of technology, which has led to a busier everyday life, changes in family structures, and increased attention on academic choices. (Hurtwitz S., 2002).

Conclusion

The library, therefore, aims to activate children and young people indirectly, meant in the sense that it must be the architecture itself that "encourages" play and gives them this free space to unfold. With initiatives in the internal and external spaces, including elements of the construction, a dynamic plan layout with diverse functions, and tactile surfaces, the architecture can cause a certain behavior so that children become curious and feel like playing. Studies will be carried out in human-scale architecture

during the process, where children's perception of space and which elements/tools for play are to be included in the library are considered. A room diagram should provide the delegation on the functions in the library, where children and young people can be involved in different situations and learning environments. Shared spaces for play is thus also used as an activity to bring children together across ethnicities and cultures. It helps to reduce the cultural and social barriers, as all parties can participate and unfold in a fun and dynamic way.

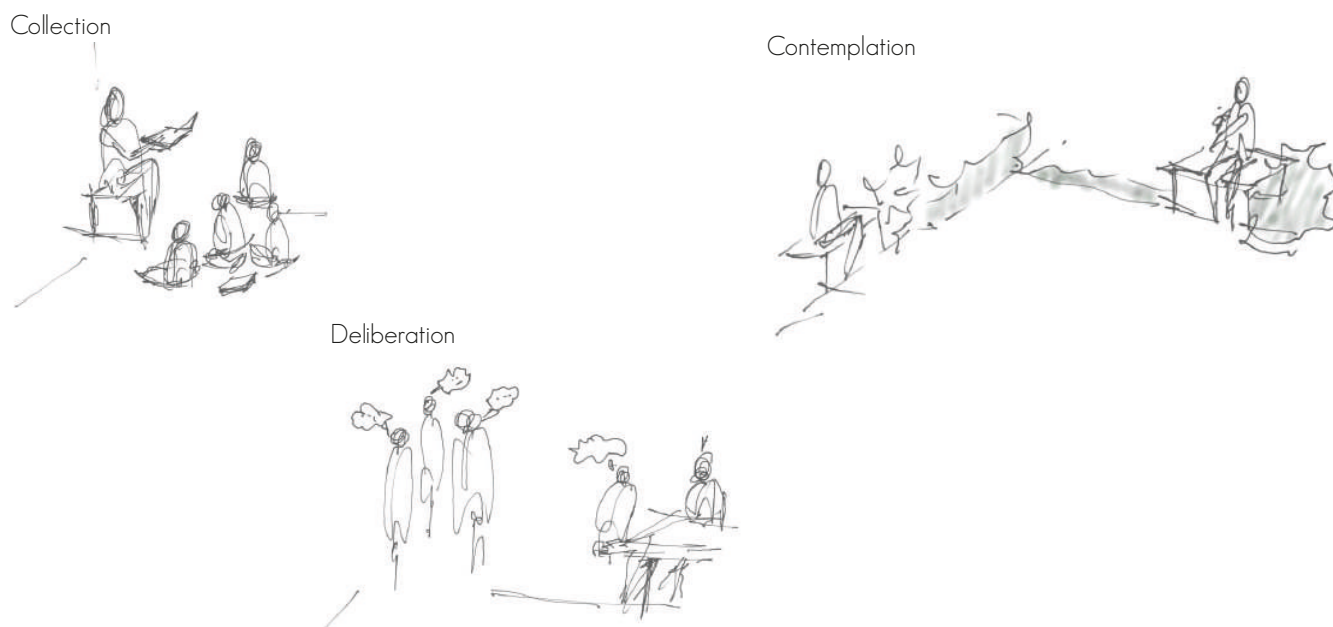


Fig. 20: Alternative arrangements for multifunctional space

Creative Learning Environment

When we think of the learning environment, school is one of the relevant spaces for inspiration to create a creative learning environment. Engaging and adaptive spaces energizes individuals and the community and inspires creative, productive learning. As shown in Fig. 21, flexibility, inclusivity, collaboration, creativity, and efficiency are five guiding principles for generating a creative learning environment at school. (Learning spaces framework, 2008).

According to Winie Ricken, consultant of Architectural Learning Environments, there are three different learning activities, 'collection, contemplation, and deliberation, that support childrens' influence on the learning situation. The collection provides a base where children assemble to participate in the presentation and one-way teaching activity, 'contemplation' offers smaller spaces for studying knowledge, skills, or practical work individually or in small groups. Whereas, 'Deliberation' can be the space in between, as it works as a marketplace, where new activities can be shaped in the

process of going from 'collection' to 'contemplation' [Ricken, 2010, p. 39]. These three distinct activities represent the importance of the collection of knowledge and the social dimension to the learning process in terms of deliberation where informal interactions occur. Fig. 20 shows the interaction between spaces during the different learning stages. Since different stages of learning have distinct functions, it required spaces designed for a particular configuration. This can be achieved by providing flexibility within the space. Flexibility within the space can be achieved by different means. In a multifunctional space, you can achieve different stages of learning. This approach provides an opportunity for the user or group of users to create their own learning environment. However, this moving of elements may not be appropriate for library space where users want to contemplate and focus, but it may serve an excellent purpose for the places for collection and deliberation, which will increase social interaction among the user and help reduce the area required for the library.

Ultimately the goal of the learning space is to go beyond the idea of acquiring knowledge and develop innovative and creative thinking as well as increase social cohesiveness within the community it serves. To promote wellness, individuality, and community within the learning space, one needs to design spaces that connect with nature, either visually or via informal outdoor learning spaces. Provide open spaces that allow for formal, casual, and autonomous learning experiences and relationship building and consider the environmental factors of air quality, noise, and density in the design process. Last but not least, encourage participatory involvement to explore what spaces promote a sense of wellbeing in children. (Andrews K. 2019). It is scientifically proven that all these attributes improve the learning experience and wellbeing of the user, it can be used in a variety of combinations to suit the requirement and the function of the space.

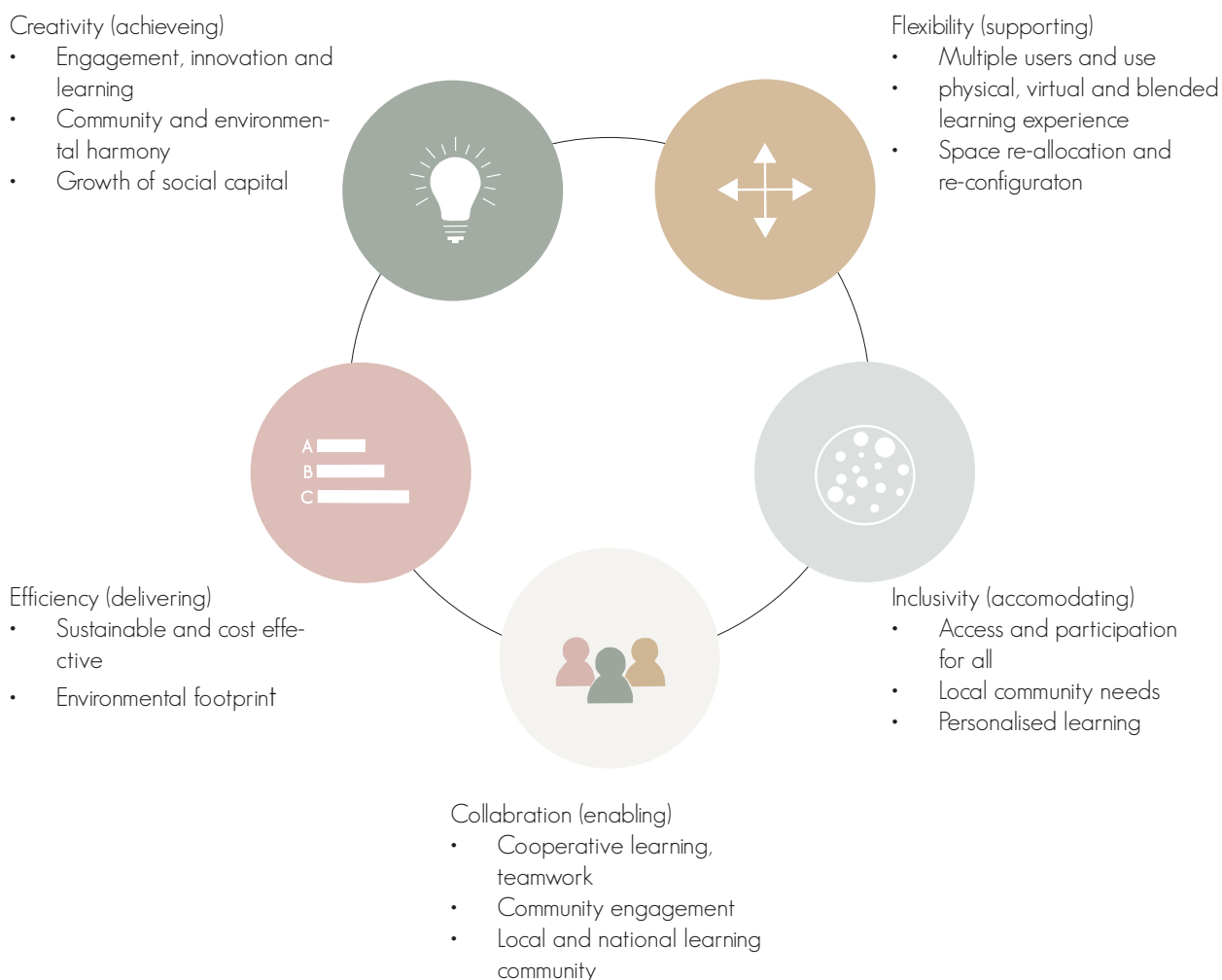


Fig. 21: Guiding principles for generating a creative learning environment



Case study, Vittra School Telefonplan

Architects: Rosan Bosch

Size: 1900 m²

Built: 2011

Vittra School Telefonplan is the user-specific design that acknowledges that everybody learns differently and every child needs variation. This resolve alone resulted in the absence of traditional learning spaces; here, the learning landscape itself serves as an educational tool and catalyst for learning. At the beginning of the design phase, a survey was conducted among the students, which showed the demand for an innovative and engaging learning environment. Thus, the spatial design is quite flexible and represents the different learning situations where furniture, modules, and spaciousness encourage playfulness and creativity.

The design of the school is focused on six principles that connect constellations for learning focus and interaction with the physical framework:

Mountain top

Supports the learning process where an individual addresses the group, sharing knowledge and views from one to many.

Cave

Offers a space to individuals for concentration and reflection. They are small, cozy, and away from the activity area that creates noise.

Campfire

Provides group-based learning spaces where students can focus on the dialog with the group and develop their interpersonal skills.

Watering Hole

Acts as an informal learning space that is located at the junction of the movement paths. It's a place where children encounter unexpected ideas, knowledge, and skill that might inspire and motivate them.

Hands-on

It's a place for nonverbal communication and learning processes where a link between body and mind, insight, and play is established.

Movement

Movement design is an integral part of all the places that introduce playfulness within the space and enhances the learner's cognitive skills. It also adds energy to the learning process.



Fig. 22: Creative learning environment, Vittra School Telefonplan

Conclusion

The Vittra School Telefonplan is designed based on academic research that explains the importance of the physical space in the creative learning process. The research suggests that students enhance their creative skills in an area that is flexible and supports play and co-creation. With Vittra School Telephone Plan, some reliable principles have been established that promote gestures. The principles will be used in the preparation of the library and the room program so that desired behaviors are achieved on the basis of a professional justification.

** The logos representing each principle will appear in the planlayout for the final presentation to show where the principles are prominent in different spaces.*



Fig. 23: Symbols illustrating different learning spaces

Functions in the Library

The basic understanding of a library is that it is a place where one can acquire knowledge. Therefore, it is important to look at different ways it can be made possible. Howard Gardner is an American cognitive psychologist and is known for his theory of different types of intelligence. His theory is that intelligence is not static but can be activated, learned, and developed. He talks about it being a multidimensional phenomenon present on many levels in our body, mind, and brain system. He talks about seven intelligences that all humans possess, but each is more or less prominent. Everyone can learn something within all intelligences, and based on the acquisition of knowledge it lays a foundation for more sustainable development in a society. Normally, humans are more attracted to the intelligence(s) they have a talent for (Gardner, 1983).

(1) Visual / Spatial

The ability to perceive the visually-spatial world accurately and to make a transformation in recognition of these perceptions. This intelligence involves sensitivity to colors, lines, shape, form, spaces, and relationship between them. It includes the ability to visualize, graphically present visual or spatial ideas, and orient oneself appropriately in a spatial form. Children who are highly visual love to design, draw, visualize, do puzzles, fantasy games, and mazes.

(2) Verbal / linguistic

The ability to use words effectively, either orally or in writing. It is about the ability to use or structure the language, phonology or the sounds of language, semantics or the meaning of language, and the pragmatic dimensions or the sensible use of language. Children who are highly linguistic like to read, write, tell, debate, having conversations,

and play with words. Most often, they have books, tapes, and writing utensils.

(3) Musical / Rhythmic

The ability to perceive, distinguish, transform and express musical forms. This intelligence includes sensitivity to rhythm, pitch, or melody and the mood of a musical piece. Children who are strong in this field like to sing, whistle, hum, and clap. They need sing-along, concerts, music, and musical instruments.

(4) Logical / Mathematical

The ability to use numbers effectively and to reason in a good way. This intelligence includes sensitivity to logical patterns and conditions, statements and assertions, functions, and other related abstractions. Children who are highly logical like to experiment, ask questions, figure out logical puzzles and do arithmetic. They need things they can explore and think about.

(5) Body / Kinesthetic

The ability to use the whole body to express ideas and emotions and using the hands to produce or transform things. This intelligence includes specific physical skills such as coordination, balance, dexterity, strength, flexibility, and speed, as well as depth-sensitive, tactile, and haptic abilities. Highly bodily children like to dance, run, jump, build, touch, and move. They need role-playing, drama, sports, things to build with, physical games, and practical learning.

(6) Interpersonal

The ability to perceive and distinguish moods, intentions, motivations, and emotions in other people. It may include sensitivity to facial expressions, voice, and movements, the ability to distinguish between many different

interpersonal signals, and the ability to respond effectively to these signals in a pragmatic way. Children who are strongly interpersonal like to manage, organize, relate, mediate, and party. They need friends, group games, social gatherings, and community events.

(7) Intrapersonal

Self-awareness and the ability to act in a way that is adapted to this knowledge. This intelligence includes having an accurate picture of oneself, awareness of inner moods, temperaments, desires as well as the ability for self-discipline. Strong intrapersonal children like to meditate, dream, be quiet, and have tasks/plan stuff. They need secret places, time alone, self-governing projects, and choices.

Conclusion

Based on this knowledge, design measures must be taken that stimulate the different intelligences both directly and indirectly in one's consciousness by architectural installments. The physical space within the library should provide the right framework to encourage people to improve their intelligences.

Furthermore, the professional knowledge will be used as evidence to create space, based on some principles that promote a gesture - in this case, one or more intelligence. It will constitute a room program together with the Vitra School Telephone Plan principles, so you have an idea of the room's design and what activities should be included in the different spaces of the library.



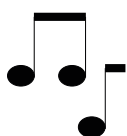
(1) Visual / Spatial

- Logistical overview
- Visual design
- Patterns, forms, structures



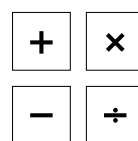
(2) Verbal / linguistic

- Dynamic common rooms/spaces for conversation
- Acoustical silence for concentration (reading and writing)



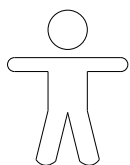
(3) Musical / rhythmic

- Acoustical comfort
- Non-responsive/soundproof space for musical expression



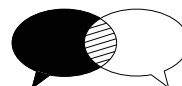
(4) Logical / mathematical

- Systematic patterns/structures
- Controlled environment
- Clear visual connection to nature



(5) Body / kinesthetic

- Tactile surroundings
- Flexible rooms for movement
- Audial and visual disturbances to activate excitement



(6) Interpersonal

- Flexible rooms/spaces for social gatherings
- Expressive design



(7) Intrapersonal

- Acoustical silence for reflection
- Symbolic design reflecting the inner-self

Fig. 24: Symbols illustrating different intelligences

Tectonic Layout

The literature in the program points out the importance of activating senses for learning. Therefore, different iterations be made, with the purpose of activating different senses that simultaneously stimulate the different forms of intelligence. However, the general focus is to create space for knowledge sharing, both in terms of professional knowledge and knowledge within culture, tradition, people, and sustainability. Before the process phase and in connection with the preparation of the room program, it is analyzed how various measures can activate sensory impressions and the 7 intelligences combined with already chosen DGNB criteria (highlighted in text):

Visual / spatial

The visual aspect of the library should be elaborated and integrated in the plan in terms of visual connections to the various spaces, indoors and outdoors, and patterns in the construction. Visual appealing elements such as; claddings, furnituring, and different light fixtures in the library should also help to activate this type of intelligence. (DGNB: Visual comfort)

Verbal / linguistic & Interpersonal

The verbal intelligence and the interpersonal intelligence can be united and executed utilizing several different kinds of meeting rooms, both created for scheduled meetings and random meetings. Here, shared spaces should be provided in various places in the library so that visitors can control the degree of feeling of privacy/publicity. In addition, the plan should also envisage a reading room where there will be complete silence for reading and writing.

Musical/rhythmic

The rhythmic/musical intelligence is represented by the acoustic comfort and how to express oneself with sounds and music. Therefore, there must be a space specifically suitable for musical expression, shielded from the other areas. In addition, the acoustic qualities inherent in the use of the library's materials should also be considered. Acoustic qualities will be evaluated in terms of the reverberation time in a selected room, where this type of comfort is especially prominent. (DGNB: Acoustic and sound insulation).

Logical/mathematical

The logical and mathematical intelligence is governed by man's ability to think in systems and is at the same time enhanced by visual contact with nature. The area of interest lies within the way the library is constructed. It should be appealing to this intelligence, where several places in the library should have a strong visual connection to the surrounding nature as well. (DGNB: Quality of outdoor areas).

Body / kinesthetic

With bodily intelligence, it is vital to have tactile surfaces and flexible spaces for play and immersion. Therefore, the library must have a room for children to play and stay freely, without being a nuisance to the other visitors. The tactile aspect is also very much in the use of surface materials, where wood is primarily used, as it gives a warm and natural impression, so you feel safe and comfortable. (DGNB: Life-cycle Assessment).

Intrapersonal

Interpersonal intelligence includes the human ability to reflect on things and understand the symbolism. This

intelligence is integrated into the preparation of the entire library in that awareness of sustainability and sustainable initiatives are sought. It aims to get people to reflect on sustainable initiatives, which is done by mainly working with natural materials and working with passive/active strategies that are visible in the library's design. (DGNB: Life-cycle Assessment).

Conclusion

The tectonic considerations of spaces are crucial aspects since it creates gestures for people to direct them in doing activities that promote intelligence. Based on the use of the space and privacy level, required principles are arranged strategically to achieve or prevent visual or physical connection.

Familiarity with human senses - how they function and the areas in which they function is an important prerequisite for designing and dimensioning all outdoor and indoor spaces. (Jan Gehl 2001). A horizontal spread-out layout helps increase the possibility of potential interaction of different characters. Spaces such as reception, self-service counters, public reading spaces, canteen area, and common spaces can promote different activities such as board games, discussion, or social meetings. The orangeries are located to the south in the central area, creating transparency between indoor and outdoor. From the reception, it is possible to have an overall view of the surrounding spaces' activities. The orangery acts as a breathing space, hang-out space during early springtime, and a transitional, transparent space from very general public space to the kids' area.

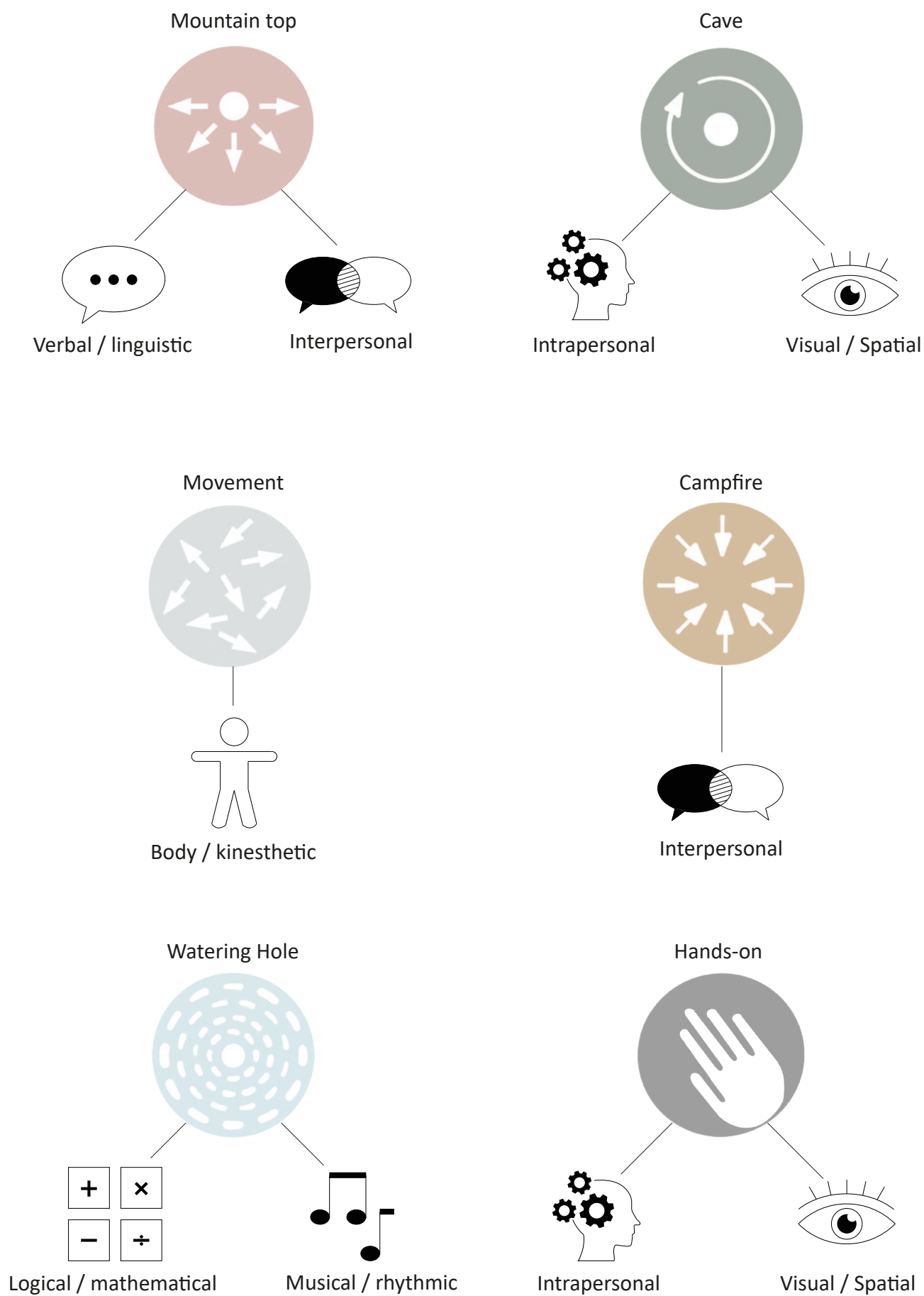


Fig. 25: Combination of different learning spaces and intelligences

Room Diagram

Based on acquired knowledge from case studies of what a library can provide of various functions, a diagram has been made that corresponds with the section about the "Seven Intelligences," the Creative Learning Environment," and "Library - a Playground for Kids."

The different functions are placed in relation to each other, thus creating a flow through the library, which is the basis for behavior that promotes social interaction, as well as better learning and creativity among the visitors. As shown in the diagram, the rooms originate from an open "living room" and associated courtyard, which is to be the library's core, where informal meetings occur either outdoors or indoors, creating a dynamic and diverse environment among visitors. From the living room, you can go directly to the various book and media sections, which are grouped, so you can quickly and easily get an overview of the provided material in the library. The other functions shown in the diagram are connected either directly or

indirectly to each other in the form of visual connection or physical/spatial connection. However, there are individual spaces (the circles with the outlines) that are disconnected from the others, as here greater privacy without interference from the other spaces is obtained. The different types of spaces are further assigned a color that indicates the qualities of the space and the type of learning that is focused on. The more private spaces are gathered, where there is an opportunity to retire, so you have a more individual learning environment, and the same applies to the more active and social spaces so that activities from these functions do not interfere with the other functions in the library. This type of organization helps optimize space distribution and provides an insight into the overall flow. The sizes of the different functions are based on an expected number of people who will use the room at the same time (see room program p.56-57) so that you also achieve a satisfactory indoor climate level.

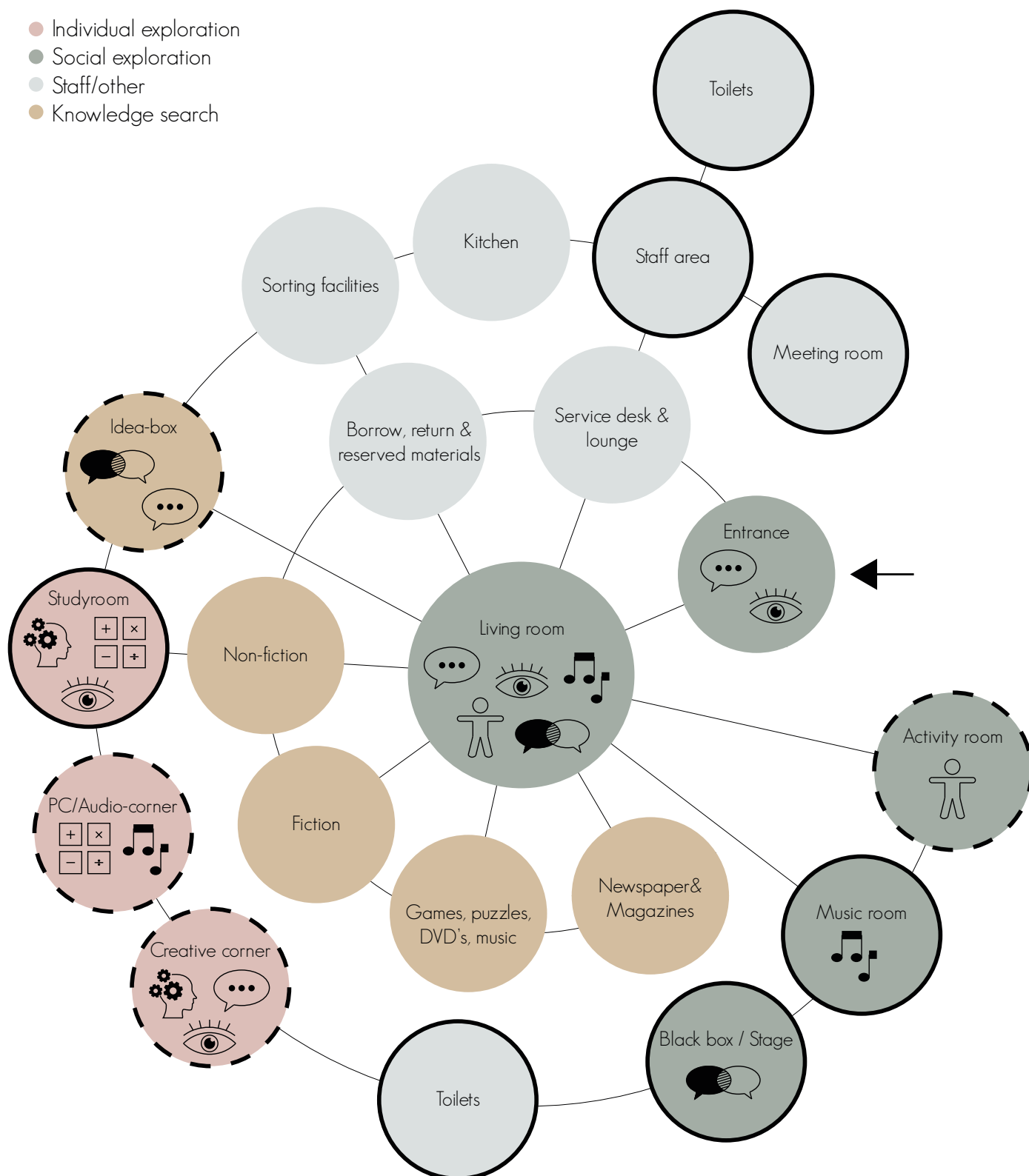


Fig. 26: Room diagram showing room distribution

Room diagram

	People	Area m ²	CLO Summer/winter	Activity level MET	Operative temp. Summer/Winter °C
Social exploration					
Meeting room 1	5	14 (x4)	0,5/1	1,4	<24,5 / 22-25
Meeting room 2	5	13	0,5/1	1,4	<24,5 / 22-25
Workshop	15	64	0,5/1	1,4	<24,5 / 22-25
Work stations	15	69	0,5/1	1,4	<24,5 / 22-25
Lounge area 1	10	51	0,5/1	1,2 - 1,4	<24,5 / 22-25
Lounge area 2	10	48	0,5/1	1,2 - 1,4	<24,5 / 22-25
Activity area 1	5	49	0,5/1	1,4	<24,5 / 22-25
Activity area 2	10	80	0,5/1	1,4	<24,5 / 22-25
Sitting/reading area	10	49	0,5/1	1,2 - 1,4	<24,5 / 22-25
Black box/music area	10	69	0,5/1	1,4	<24,5 / 22-25
Green house, social	10	138	-	1,4	-
Canteen	30	150	0,5/1	1,4	<24,5 / 22-25
Kids area	20	119	0,5/1	1,4	<24,5 / 22-25
Knowledge search					
Shelving area 1	-	239	-	-	-
Shelving area 2	-	47	-	-	-
Newspaper reading	10	241	0,5/1	1,2 - 1,4	<24,5 / 22-25
Shelving/reading area	20	72	0,5/1	1,4	<24,5 / 22-25
Individual exploration					
Reading area (silent)	20	74	0,5/1	1,2 - 1,4	<24,5 / 22-25
Creative box	5	40	0,5/1	1,4	<24,5 / 22-25
Orangery	10	76	-	1,4	-
Self-service area	5	23	0,5/1	1,4	<24,5 / 22-25
Computer space	15	46	0,5/1	1,4	<24,5 / 22-25
Staff/other					
Reception	5	30	0,5/1	1,4	<24,5 / 22-25
Staff area	10	115	0,5/1	1,4	<24,5 / 22-25
Waiting area	5	35	0,5/1	1,4	<24,5 / 22-25
Entrance	-	26	0,5/1	1,4	<24,5 / 22-25
Circulation island 1	-	56	-	-	<24,5 / 22-25
Circulation island 2	-	123	-	-	<24,5 / 22-25
Kitchen	3	31	0,5/1	-	<24,5 / 22-25
Toilet	5	13 (x2)	-	-	-

Total area: 2255 m²

Daylight factor	Minimum ventilation rate	Atmosphere	Other aspects
2	0,35 l/s pr. m ²	Quiet	Withdrawn from public space
2	0,35 l/s pr. m ²	Quiet	Withdrawn from public space
2	0,35 l/s pr. m ²	Inspirering, clear open space, dynamic	Open space for different activities
2	0,35 l/s pr. m ²	Inspirering, clear open space, dynamic	Open space for different activities
2	0,35 l/s pr. m ²	Cozy, semi-quiet, intimate	Visual connection to other spaces
2	0,35 l/s pr. m ²	Cozy, semi-quiet, intimate	Visual connection to other spaces
2	0,35 l/s pr. m ²	Open space, cozy, public	Space for movement
2	0,35 l/s pr. m ²	Open space, cozy, public	Space for movement
2	0,35 l/s pr. m ²	Semi-quiet, social	Space for deliberation
-	0,35 l/s pr. m ²	semi-enclosed space	Contemplation space
-	-	Sunny, humid, social	Close by kitchen
2	0,35 l/s pr. m ²	Open space, social, light	Close by kitchen & entrance
2	0,35 l/s pr. m ²	Open space, dynamic, playful	Open space for different activities
-	0,35 l/s pr. m ²	Organised, private	Easy access and overview
-	0,35 l/s pr. m ²	Organised, private	Easy access and overview
2	0,35 l/s pr. m ²	Social, cozy	Space for deliberation
2	0,35 l/s pr. m ²	Organised, quiet, semi-private	Space for deliberation & collection
2	0,35 l/s pr. m ²	Quiet, intimate, private, cozy	Space for contemplation
2	0,35 l/s pr. m ²	Inspirering, dynamic	Transparent enclosed area
-	-	Sunny, intimate, embracing nature	Transition zone
2	0,35 l/s pr. m ²	Overview	Close to reception
2	0,35 l/s pr. m ²	Semi-private, semi-quiet	Visual connection to nature
2	0,35 l/s pr. m ²	-	Central space
2	0,35 l/s pr. m ²	-	Private, completely enclosed
2	0,35 l/s pr. m ²	Semi-quiet, social, cozy	Close to meeting rooms
2	0,35 l/s pr. m ²	Welcoming	Central
2	0,35 l/s pr. m ²	-	Distribution zone
2	0,35 l/s pr. m ²	-	Distribution zone
2	20 l/s	-	Easy to clean
-	15 l/s	-	Easy to clean, no odours

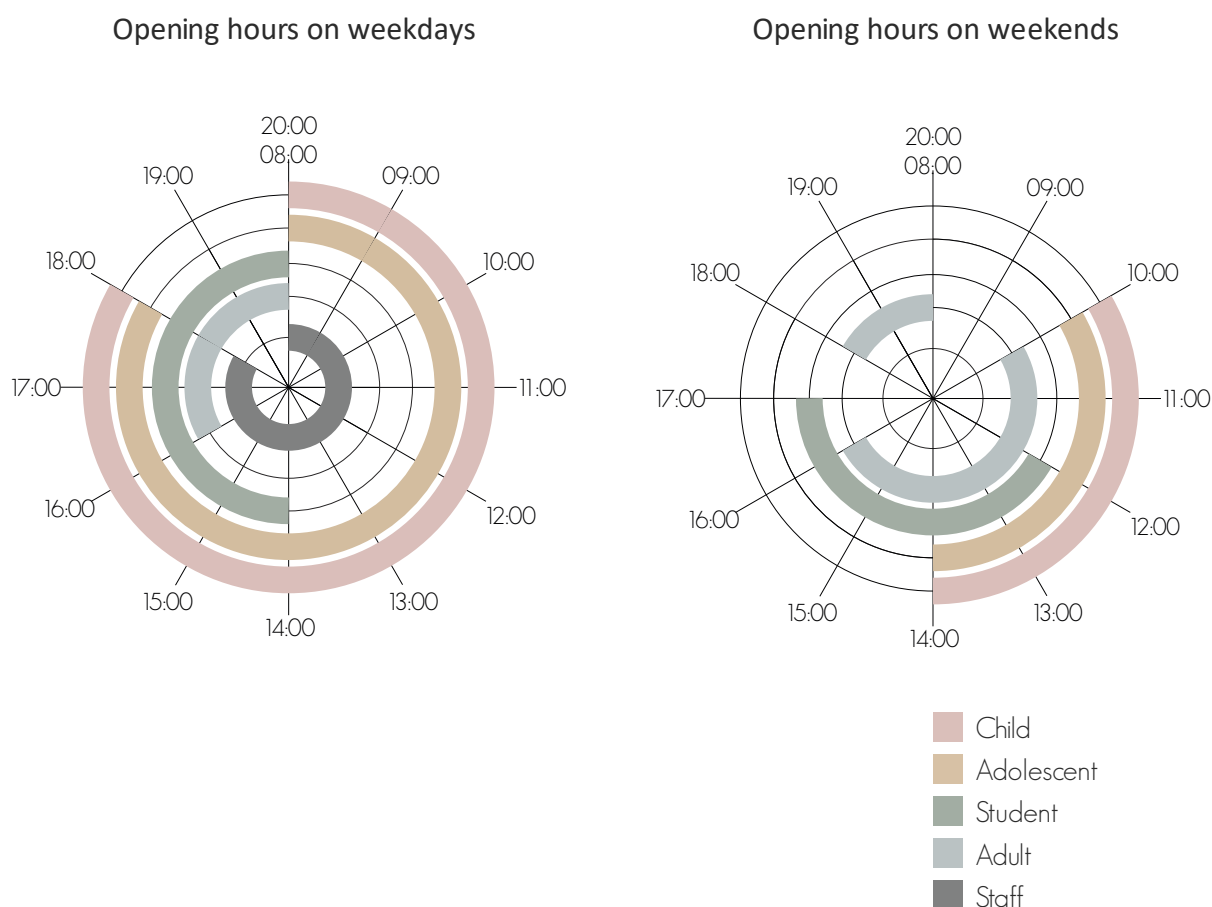


Fig. 27: Time schedule for the Libraries' opening hours

Users of the Library

The library in must be a municipal offer to all residents in the area but mainly be targeted at the more younger audience, hereby children and adolescents.

To get an overview of the usage time of the library, an estimate has been made of the time period for usage of the library by the various users groups. The library can be visited in relation to school excursions and teaching as well as leisure activities. It is expected that children and adolescents will be the two groups who use the library for a more extended period of time on weekdays, where teachers or

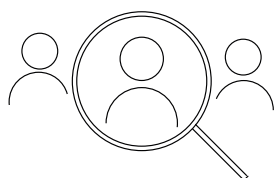
staff may supervise the children. Students also have the opportunity to read, rent books and make use of the library's facilities, but will mainly use the library in their spare time and outside of their studies. Adults are expected to use the library after work and in the evening, where the municipality, the staff and the citizens can initiate various presentations and events. The intention is that the time periods for the different user groups will overlap and contribute to a more dynamic environment across all ages promoting possibilities of local integration and the feeling of cohesion. The staff has a significant

role in helping visitors with literature search and use of the various facilities in the library and an overview of the children's and adolescent's well-being during their working hours. As the library is also open on weekends, it is at your own risk when using the library. Therefore children and young people are advised to be supervised by an adult or a guardian. It is also assumed that young people and students during the weekends have greater freedom to study and dive into a hobby such as theater, drawing, painting, and music without being disturbed by school trips and larger groups of children.

Activities for contemplative and social spaces

	Contemplative spaces	Social spaces
Child (years 0-10)	Reading Drawing/painting Puzzles Audio-books	Playing Music Games Literature search Theater
Adolescent (years 10-16)	Reading Drawing/painting Puzzles Audio-books Homeworks Internet searching	Playing Music Games Literature search Theater Education
Student	Reading Drawing/painting Audio-books Internet searching	Music Games Literature search Debates
Adult	Reading newspaper Audio-books Internet searching	Music Games Literature search Debates
Staff	Desk work/administration Organising books	Meetings Organising books Servicing the users Connecting with colleagues

Design Manifestations



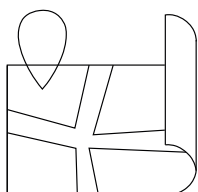
User group

- The library is targeted at children, therefore, spaces must be designed for both play and immersion
- Easy access and view from the interior spaces to nature, but also from one interior space to another
- The library must contain several different and clear function spaces that accommodate the 7 different intelligences



Sustainability

- Design for chosen UN Global Goals (p. 13)
- Design for chosen DGNB-criteria (p. 14- 15)
- Design for chosen passive and active strategies (p. 16- 17)
- Building should reach Low Energy Class 2020



Site

- The library will be designed according to Albertslund municipality's visions and plans for Hyldagerkvarteret (p. 25)

Process Introduction

This section presents the process of compiling the library in various sub-sections, including; Location of Functions, Tectonic Principles, Indoor Climate, and Materiality. In the process, use has been made of literature from the program, 3D programs for visualization and simulation of the library and its indoor climate, and calculation tools for LCA and Reverberation Time. The process is depicted in diagrams and text that explain and illustrate the ideas behind the various design initiatives. The different studies are divided into preparation and iteration sections, to emphasize which principles support a gesture and how different designs have been studied followed up by conclusions.

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Functions of the Library

Introduction

As the initial part of the sketching process, some choices have been made in terms of the library's location and surrounding outdoor functions and the placement of indoor functions/rooms. In addition, a volume study has also been made based on contextual parameters so that the project is narrowed down and a concept is developing. The location of the functions is constantly evaluated and fine-tuned during the process, along with new knowledge, simulations, visualizations, and section cuts.

Functions of the Library, Design Criteria



Accessibility

Easy and clear accessibility for pedestrians, as well as people by bike and car



Pathways

Preparation of new pathways that ensure greater traffic and activity on site



Site utilization

Maximum utilization of the site, without cutting down trees and destroying existing paths



Social & private zones

Social and private zones must be adapted to the site's character and the local plan's future plans for the site

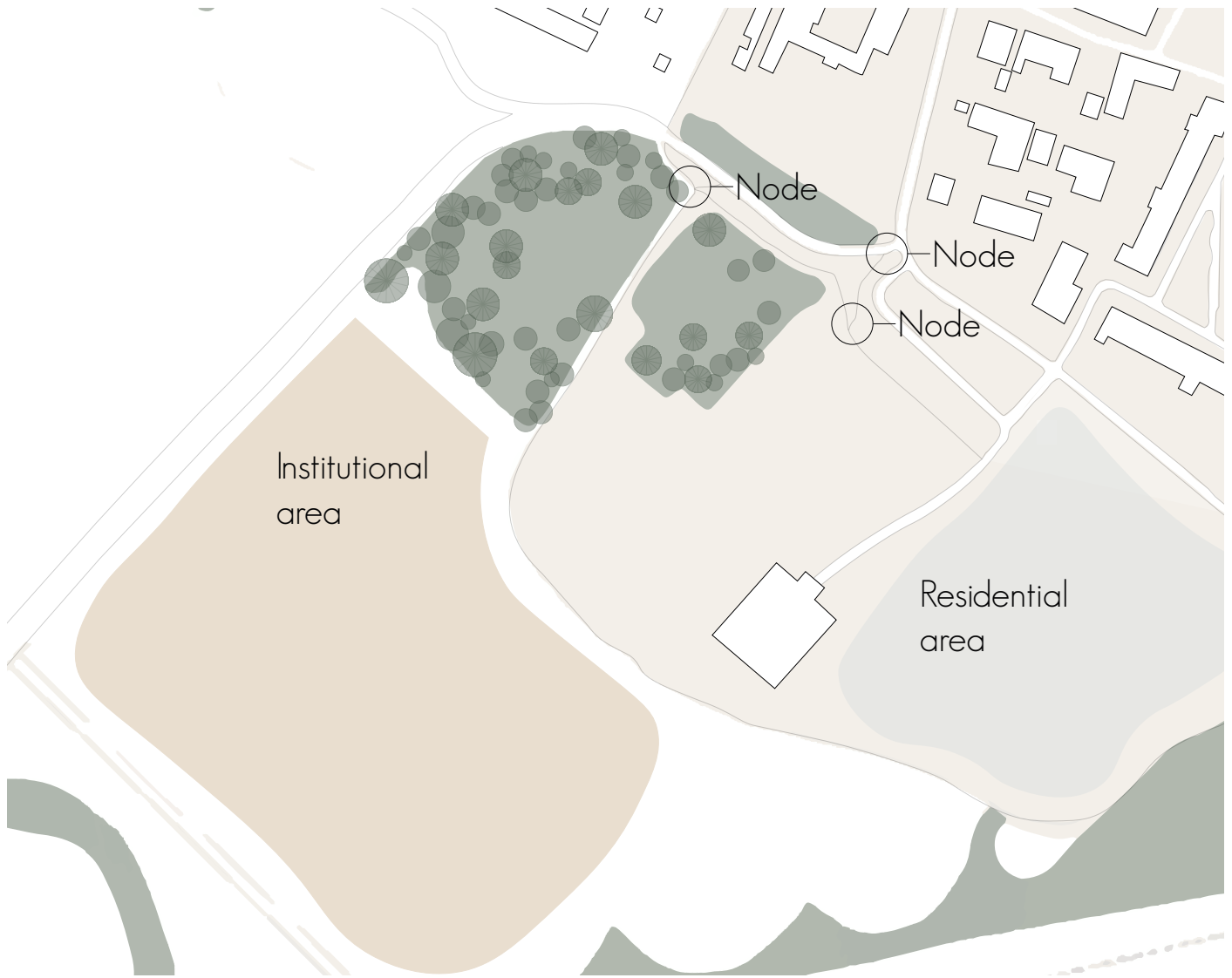


Fig. 28: Site studies

Site Studies

Iterations

To understand the zoning of the site by the degree of privacy, it is relevant to look at previous analyses about accessibility and infrastructure around the site. In the northern part of the site, several nodes are seen contributing to greater activity and infrastructure from both “soft” and “hard” road users. One path is running through the site, which is worthy of preservation and should contribute to the overall plan layout of the library. In the northern part of the site, there is also a tree line worthy of preservation, which shields from road and traffic noise. Therefore this part is perceived as being more private. For that reason, it would be evident to have a more social zone centrally on the site, where more

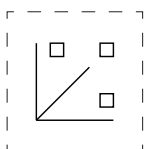
private zones are placed towards the tree groups. However, the future visions of the local plan must also be taken into account, where more institutions and residential buildings will be constructed in the southern part of the area, as seen in the fig. 28.

Diagrams have been made on conceptual zoning respectively gradients of social and private zones and a clear division on private versus social zoning, all of which take into account the existing trees on the site.

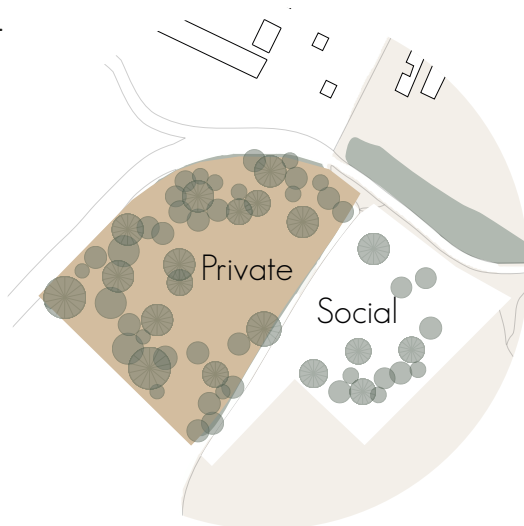
Conclusion

It is concluded that the social zone is located more centrally and south of the site, whereas the private zone or zones are kept to the outer parts of

the site, where rows of trees surround them. These iterations do not provide an unambiguous answer as to whether one iteration will work better over another, as all three iterations can each have their advantages and disadvantages. Therefore, it needs to be detailed further as soon as a volume is set up and functions are divided into the building.

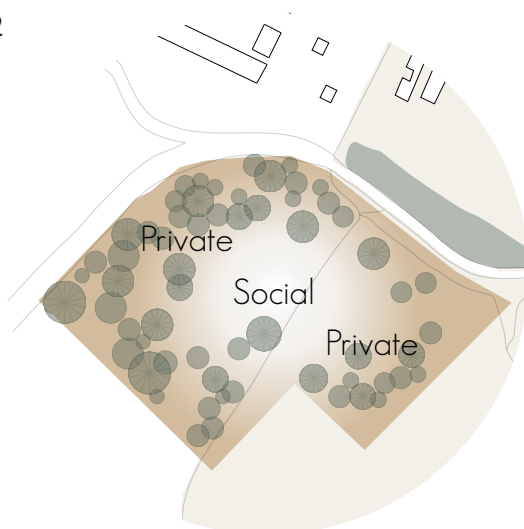


Iteration 1



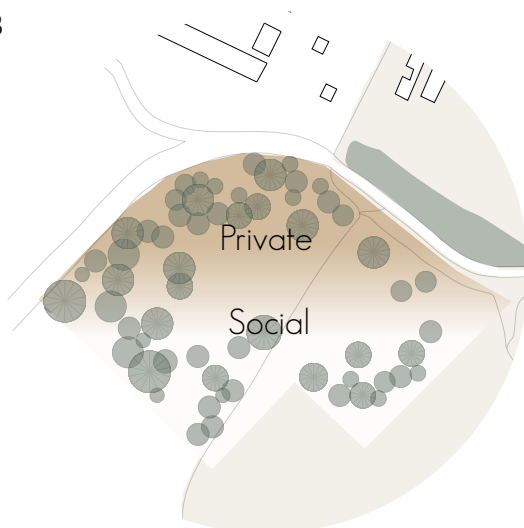
Clear division of private and public zones

Iteration 2



Centralized public zone

Iteration 3



Soft division between private and public zones

Fig. 29: Private and social zoning of site

Volume Studies

Iterations

To accommodate the character and flow of the site, a workshop was done to investigate the volume and new pathways. The volumes were evaluated based on the overall expression, whether it should be a library that stood out from the surroundings or be more "incorporated" into the landscape. The path that runs through the site and the trees were included in the assessment, as it was some important parameters that the trees and the existing pathway should be preserved. In that sense, it was the existing context that dictated volume.

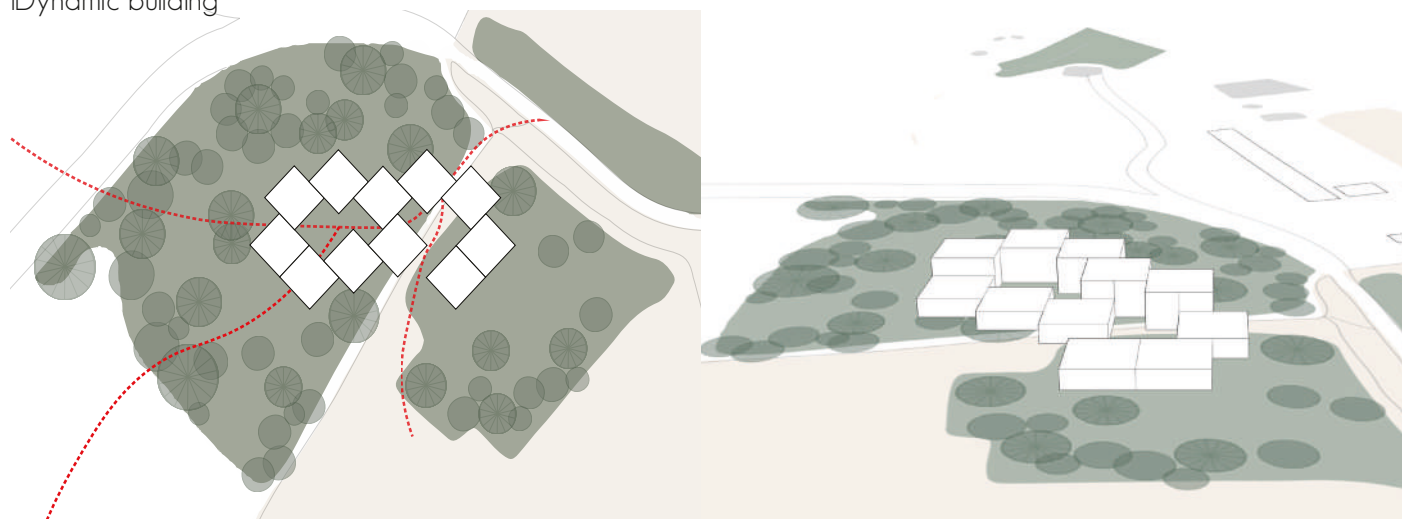
To simplify the task, a "grid format" of squared boxes made it easier to work with different compositions of the building. The preparation of the volumes could be made

without having to take into account surrounding typologies, shapes and textures, since the surrounding area from the local plan is almost empty. However, it some existing "lines" in the context made from the northern, surrounding road helped to shape the library. The "crack" illustrated in the iterations was thus followed both by the course of the road and the preserved trees.

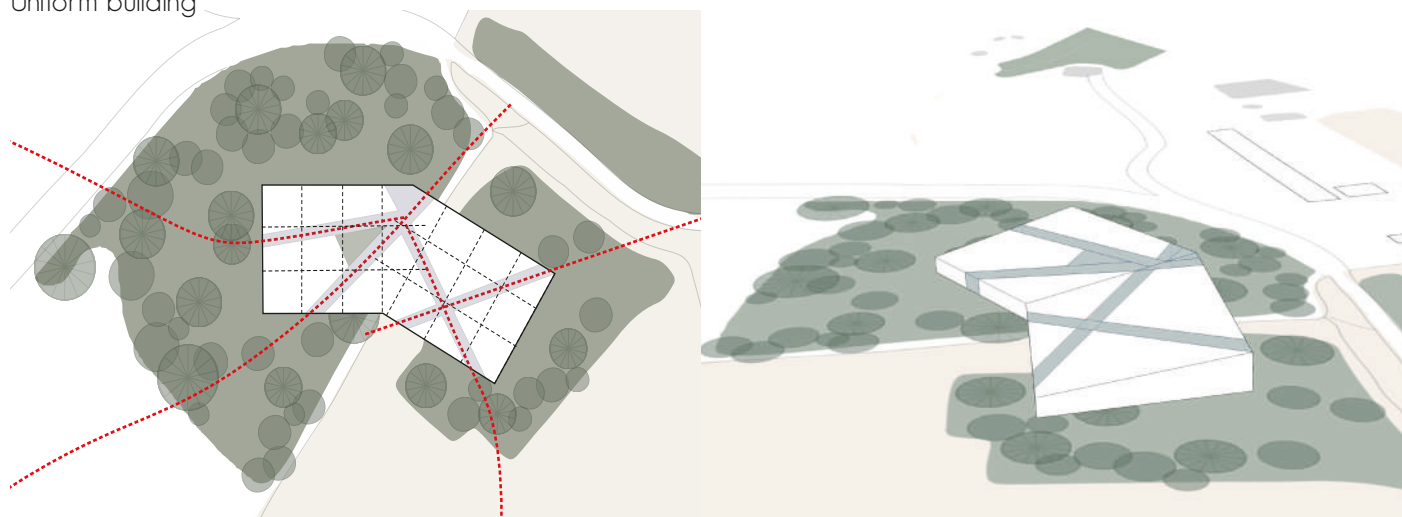
Conclusion

The surrounding nature allowed for public and open niches around the library, but it was decided to also provide a more private outdoor space, by creating a block-like structure to emphasize both private and public zones as seen in iteration 3.

Iteration 1 Dynamic building



Iteration 2 Uniform building



Iteration 3 Block building with courtyard

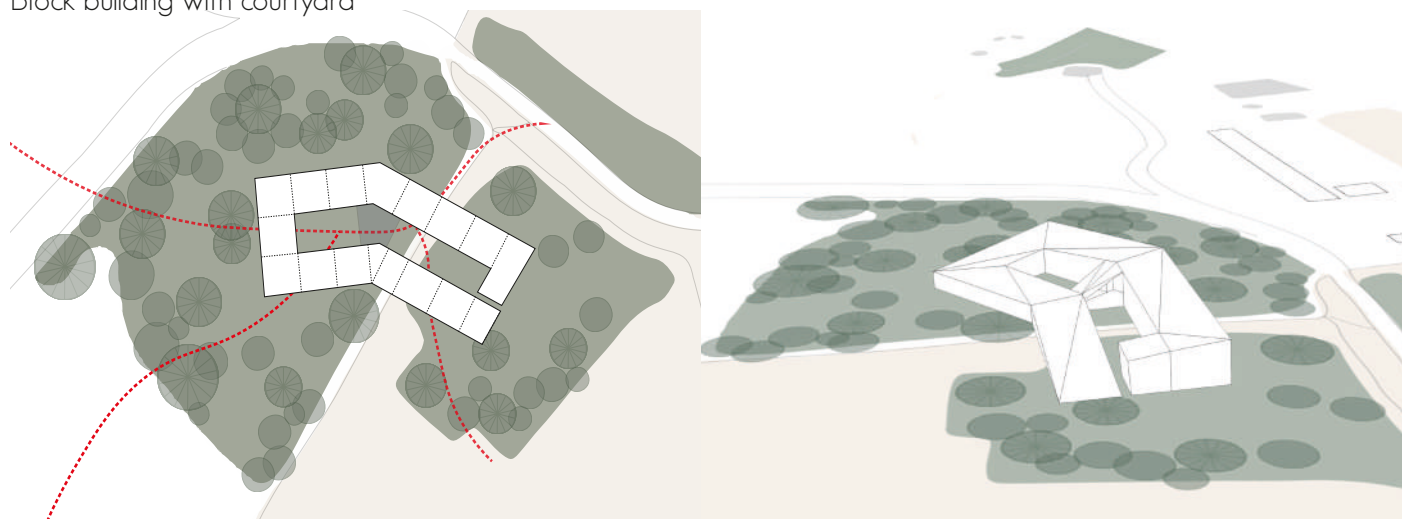


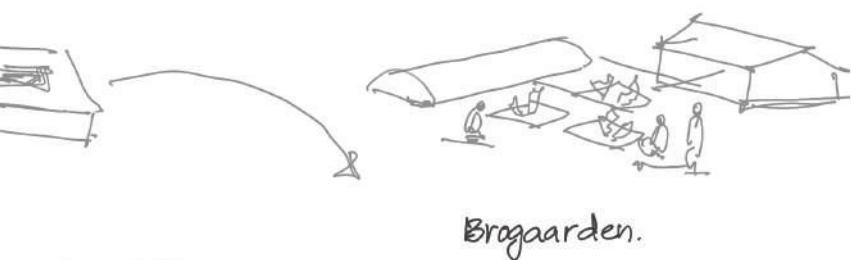
Fig. 30: Iterations on different building volumes on site

Outdoor Spatial Studies Preperation

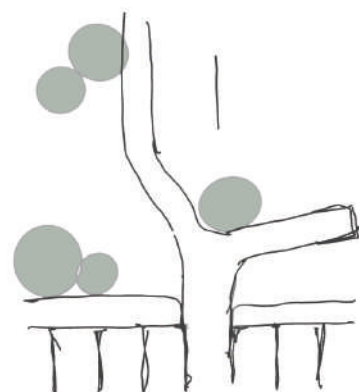
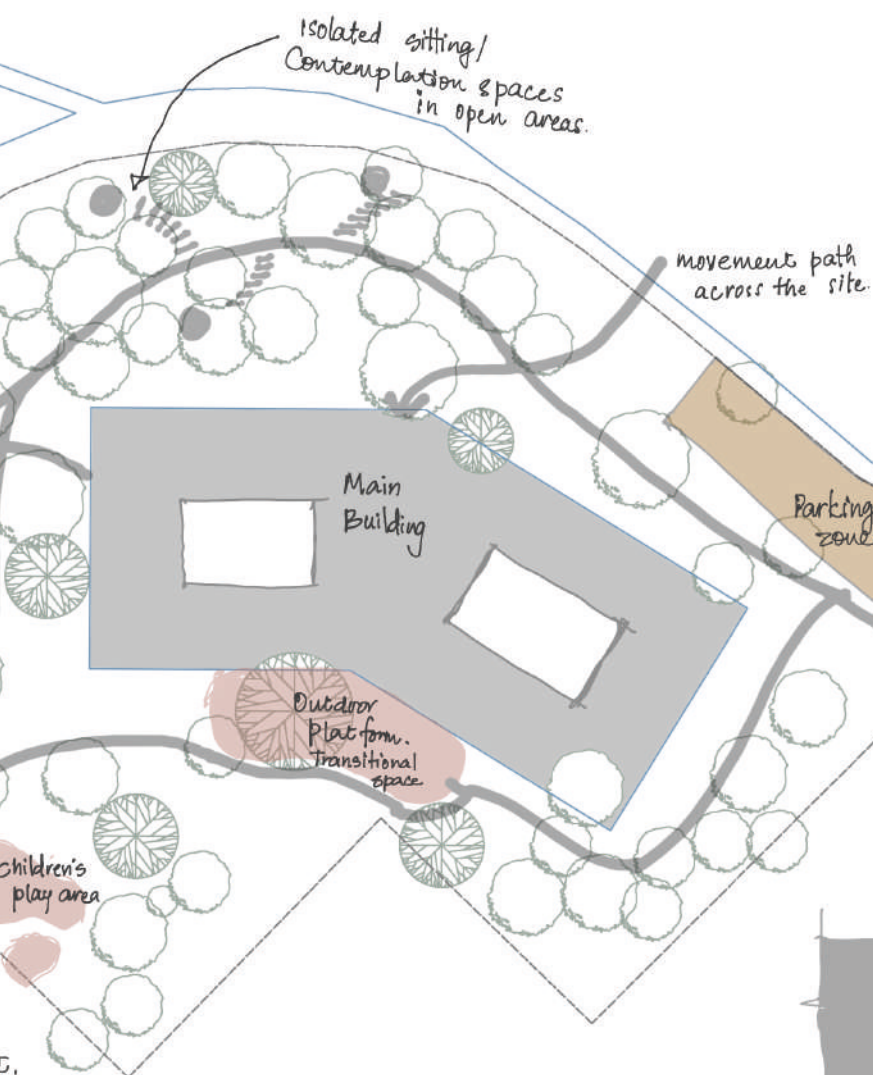
It is imperative that for youth to come together and integration to happen, various activities and people in and around public spaces are permitted to function alongside each other, to allow people to come together and inspire and stimulate one another. (Jan Gehl, 2001). The site layout and placement for the building are based on the initial zoning and enhance the opportunity for interaction. A parking area is provided closer to the road, which pushes visitors to walk through the site and slow down the pace. It makes the whole area pedestrian-friendly, and a slower pace increases the potential of interactions taking place.

Flexible boundaries in transitional zones such as outdoor platforms and extended entry zones are provided, which attracts more visitors to the library. Based on the literature studies, it is established that children prefer to be in a learning environment with easy access to the outdoor areas or visual connection to the surroundings. The existing pedestrian movements are used and incorporated into the design. The northern border of the site is demarcated by a dominant curving road and dense trees. It provides an opportunity to have quiet areas such as reading space which would also receive ideal northern light. With pathways running across the site, it also offers ample opportunity for outdoor contemplation spaces in the open area and extends further into the west towards the New Hyldegard Bakke. The building layout needs to be more open and inviting with the help of different functions since it faces the housing area development that aims to provide spaces for outdoor activity.





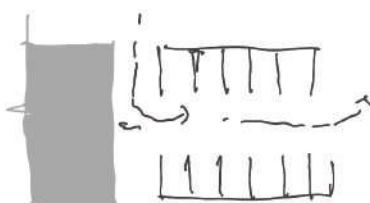
connects different
creating space for
the city.



ROAD

- Parking space right next to road leaving whole site pedestrian walkways only.
- more potential for interaction.

TRANSITIONAL ZONES.



Building

- Parking right next to building that provides quick access but less opportunity for interaction.

Fig. 31: Sketch on outdoor spacial studies

Indoor Spacial Studies Iterations

During this phase, it was desired to achieve harmony between the spaces and maintain a balance between the public, open areas, and the private, quiet areas. Spatial studies were carried out where different functions were put together, keeping in mind the sizes of each space, accessibility, orientation, and character. Different iterations were made to connect the spaces and evaluate on the general room flow connected to each of the iterations. Also the iterations showcased the relation between the spaces and the level of privacy.

Based on the literature, the case studies, the microclimatic analysis of the site, and the local plan, it

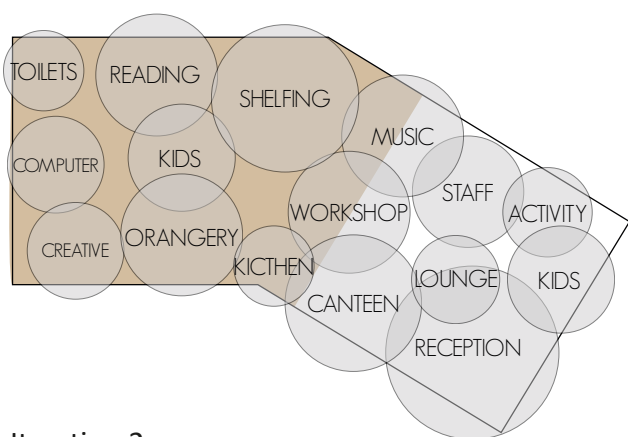
was evident that the central public space, namely the reception, was vital in the library design, which was the first space to be placed in the model layout. The reception area should act as a public and open transition zone, creating physical or visual connections to most of the other functions in the building. The placement of the other functions were also highly dependant on the nature of the activity in the various areas. The ground floor should have most of the public functions, whereas the first floor is more secluded and private. Here, the noise level will also not be so high, and therefore it will be obvious to have rooms shielded from "traffic" and external noise, such as a reading room and meeting rooms.

Conclusion

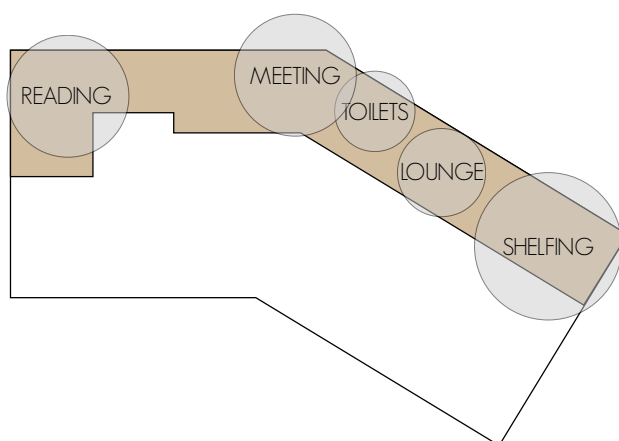
It was decided to work further with iteration 3, as the principle of a southern public facade and a centralized reception corresponded well to the visions from the local plan. By working with this iteration, it was possible to create transitioning and dynamic spatial processes to distribute the various functions. The selection was also based on the space diagram, where all spaces are in some way connected, either physically or visually, to promote the ideology behind learning spaces, where a more fluid and harmonious transition is seen between the spaces.

Iteration 1

Ground floor

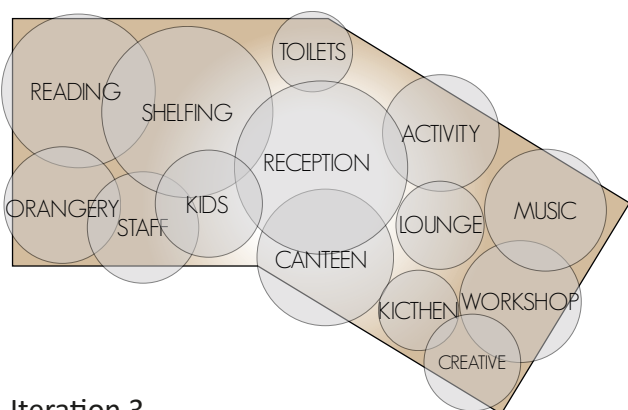


1st floor

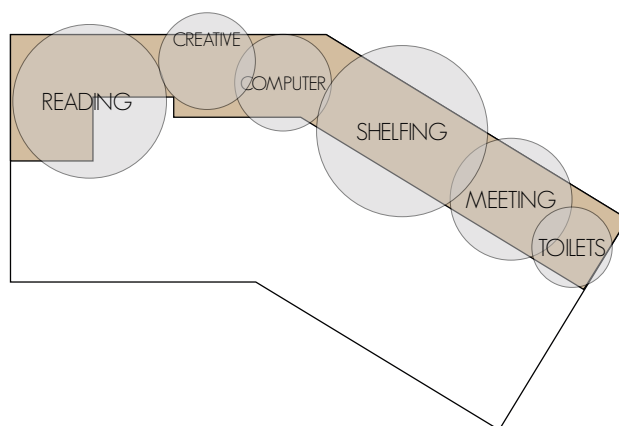


Iteration 2

Ground floor

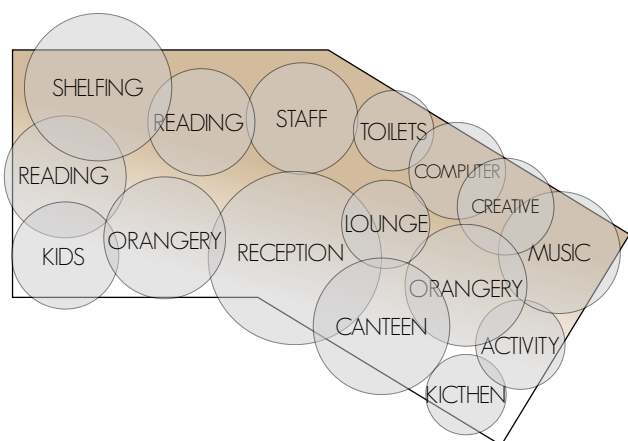


1st floor

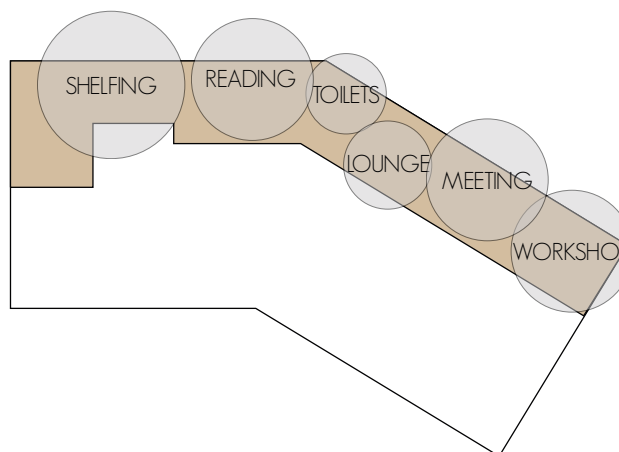


Iteration 3

Ground floor



1st floor



Level of privacy



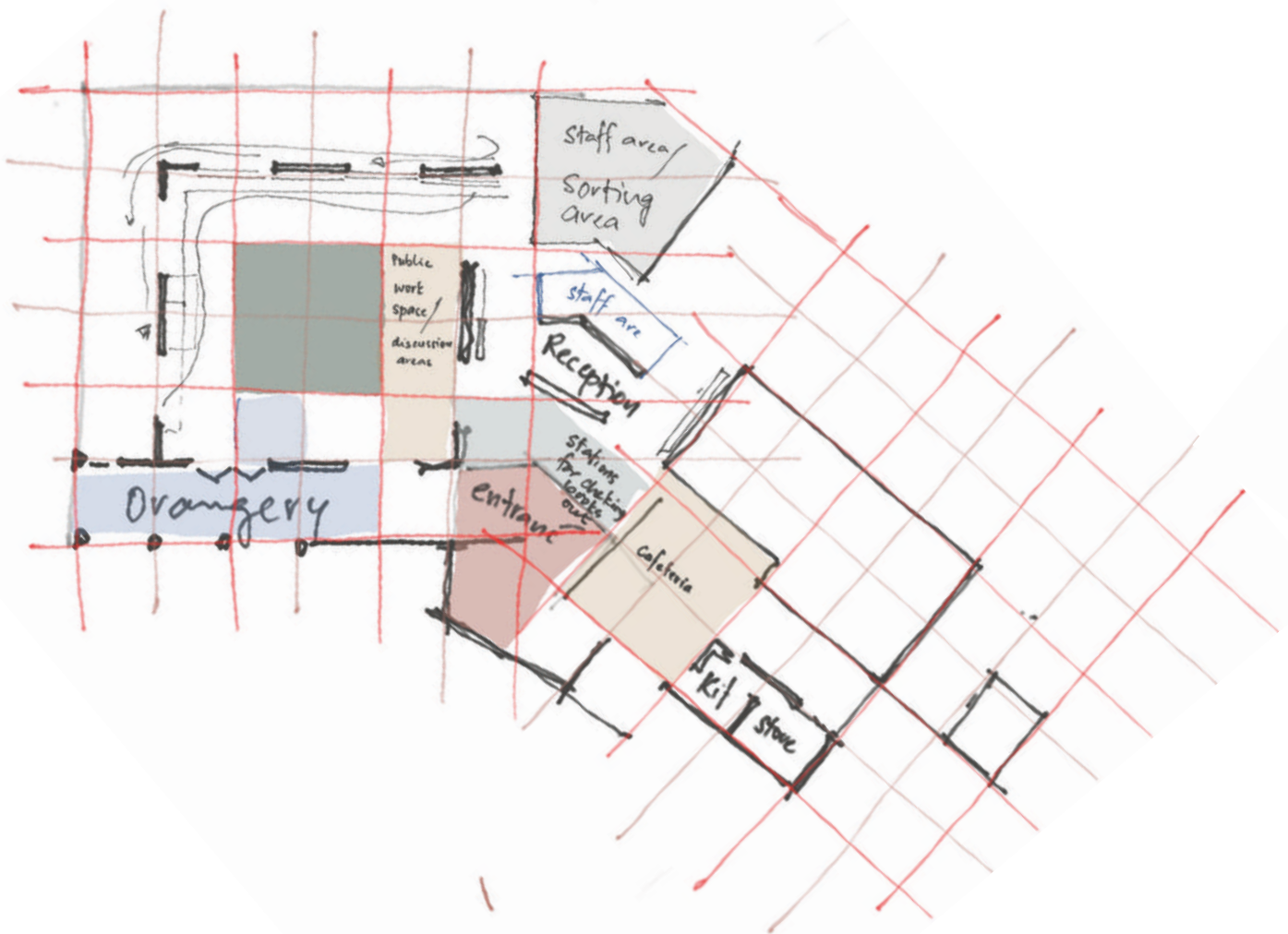
Public

Private

Fig. 32: Iterations on different spatial layouts

Stage 1, sketch

Very open plan layout, for further development



Plan Iteration Development

Preparation

Once the volume was in place, and the functions were located corresponding to the room program, a floor plan and more accurate distribution of the various functions were detailed. An estimate was made on how many people would be in the same zone at the same time, which constituted the areas for the different zones. This was further updated and evaluated in the room program (annex 08). In the room program it is possible to calculate CO₂ levels and atmospheric indoor climate, based on known data about room size, activity level, number of people, building pollution, etc. In this

way, the rooms could be fine-tuned based on keeping the ventilation rates down to save energy and prevent long ventilation pipelines. Since the building was divided into a grid system, it was also essential to organize the functions so they fit with the grid and comply with a modular design, which would ensure more systematic and flexible interior designs.

The plans were first outlined by hand, after which they got digitized in Revit. Building sections were also looked made alongside the plan layouts, to get an understanding of the room

heights and the human scale.

The library's identity lies in creating spaces for play and social/ interpersonal development in children for better integration conditions. Therefore, spaces promoting play, should be included in the plan solution, where several activity spaces and the kid's area are intended for more dynamic and creative activities. Thus, they should be placed so that they do not disturb the other rooms, as noise and playful children can act as a disturbing element for the other functions, where you would otherwise have to sit and immerse yourself in the library's reading material.

Stage 2, sketch

More detailed plan layout, with most of the spaces settled

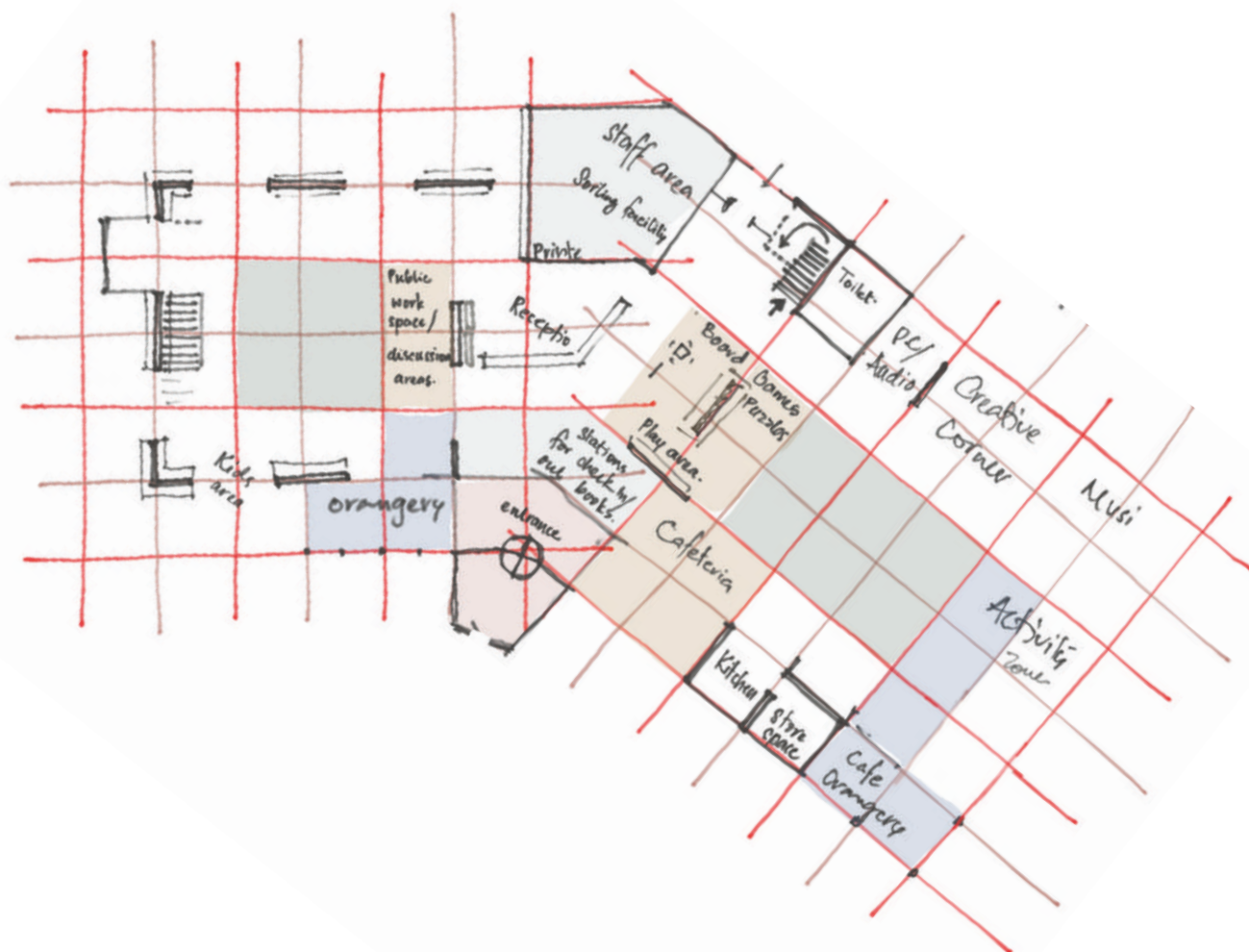


Fig. 33: Sketches of different stages of plan layout

By having separate activity rooms, it is possible to create a dynamic environment with different activities happening. A kid's area was located at the southwestern end of the library. Here the children have the opportunity to immerse themselves at a calmer level, where their parents or the library staff can supervise them. The largest kid's activity room was located on the right side of the plan, where children have the opportunity to play more freely, without disturbing the library's other spaces, as it is a more secluded area. The activity room in the middle is reserved both for people in all ages.

Here you can sit and solve puzzles, either alone or together with others, you can read alone or out loud for a small audience, or you can play at a slower pace, since a lot of activity is going on here. The reception area and the central activity area are the two main spaces you see when entering the main entrance. Here it was obvious to create an atmosphere and feeling of belonging and social cohesion, so you get the feeling of entering a community library.

Tectonic Principles Introduction

Acquired knowledge from the program has culminated in how principles can support different gestures. In this section, visualizations, diagrams, and sketches have been made that show how gestures and principles are expressed in different ways in the library. This section evaluates established principles and how they are implemented in the library's floor plan and sections and in the structural system.

Tectonic Principles Design Criteria





Figure 1
Window and seating



Figure 2
Load-bearing columns providing shelves

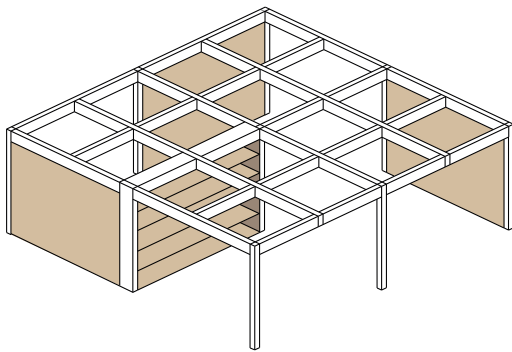


Figure 3
Grid-system for flexible space division

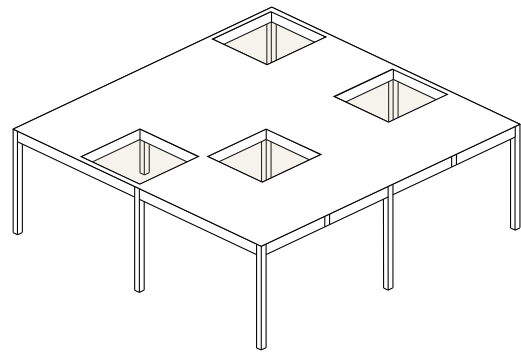


Figure 4
Waffle-system for skylights

Tectonic Construction Preperation

In the library, great focus is on the tectonic grip in the construction so that the construction more or less dictates the use or execution of the activities that will take place in the different spaces to emphasize gestures from a principle.

The diagrams above are showing different ways in how tectonic thinking have been implemented in the design of the library. Figure 1 illustrates how the window can be utilized as a seat. Hereby you add value to an element by giving it more features, and you are promoting a gesture from a principle by creating an action based on a design. Figure 2 and 4 are showing examples on load-bearing columns, that also

act as shelves and space-creating/space-dividing elements. There is a transparency in the shelving systems, as they are not completely shielding, as you can follow the activities taking place on the other side of the shelves. This visual connection is important to emphasize the ideology behind creative learning environments.

By having a grid structure it is possible to be flexible in the design of the interior rooms, where it is easy to set up walls so that spaces are created in accordance with the library's internal functions and the activities performed in the various spaces. Furthermore, the grid structure can contribute to a division of more private and public zones, depending

on how dense the system is and what initiatives have been taken to make the design more functional.

The wooden waffle construction (figure 4) will also contribute to a division of spaces, as one can be very versatile in the use of openings for skylights. Here you can make the room brighter and darker as desired, in a way to dictate the use of the room. An intimate atmosphere typically occurs in darker rooms, where light spots in the ceiling of the library's private areas, can serve the reading spaces. In brighter rooms with many skylights, greater transparency is created, better suited for the public spaces to indicate openness and overview.

Fig. 34: Diagrams on tectonic principles on construction

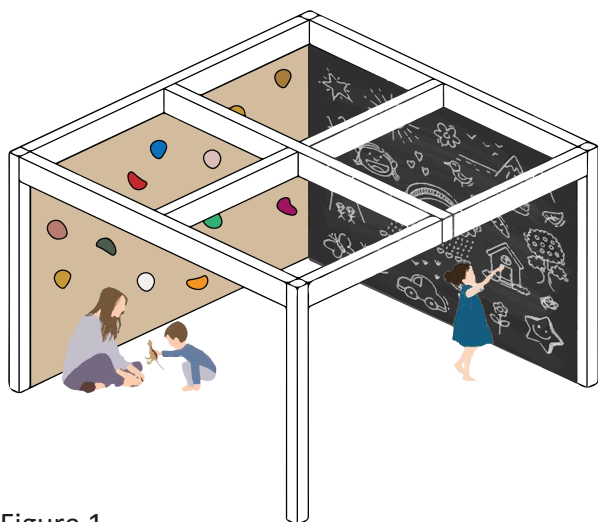


Figure 1
Flexible construction for blackboard and
climbing wall

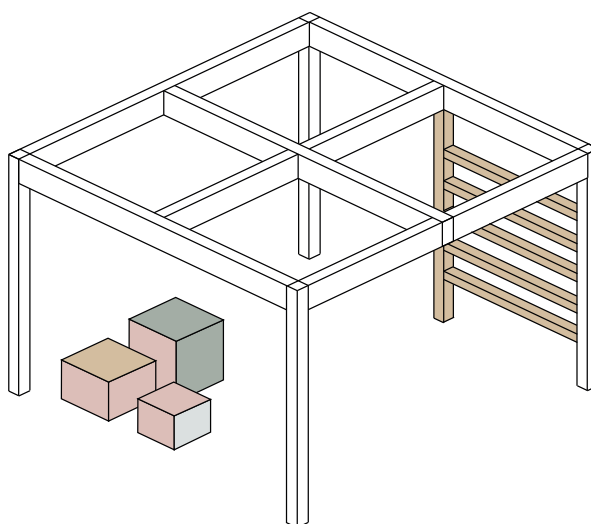


Figure 2
Utilization of construction for wallbar & moveable
elements for play

Elements of Play Preperation

As mentioned in the section; "Library - a Playground for Kids", play must be an integral part of the child's upbringing, to promote different learning processes. Therefore, an evaluation has been made of how play can be brought into the library by forming parts of the construction in the various activity areas. By utilizing the structural system of the building to act as an element to promote an action or a behavior, one emphasizes the tectonic aspect.

The load-bearing columns become important, in addition to acting as room dividers and helping to create shelves, they can also be used, if dimensioned correctly, for wallbars, climbing walls, black boards, etc.

Figure 1 and 2 illustrate the ways in which the columns can be utilized to promote play and activities. Play can also be implemented in other ways. Here you work with movable elements, so that the children themselves can create their activity space and thus be the "creator" of their own play.

Fig. 35: Diagrams on tectonic principles for play

Central Space Iterations

The first area you meet when entering the library is the central area. It is the heart of the library, which functions as a gathering place, orientation place, service- and activity area. It is a large common room with different functions and expressions, which stimulates the senses and causes informal encounters to occur. It is these informal encounters that make integration occur across age groups, ethnicities, and cultures. It is thus a question of what principles to apply to enable integration as a gesture.

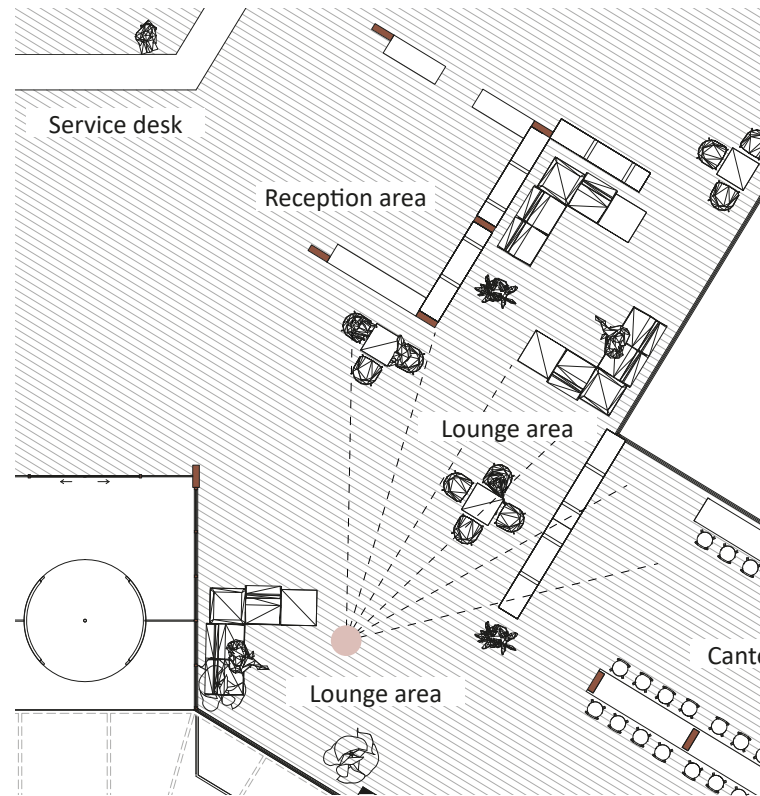
Various iterations have been made to support these occasional meetings. The visualizations illustrate how meetings can arise when organizing furniture, thus creating an environment for deliberation, collection, and contemplation. In addition, there is also a change in the number of shelves, the so-called transparent "room dividers." To achieve an exciting area with a lot of activity, one will have to make open and closed niches of different nature for people. In this way, the architecture becomes a catalyst for meetings to arise where the visitors can choose the forum and degree of privacy or publicity themselves.

Conclusion

The central area was determined to have a more open environment, as it provides greater flexibility and overview. With the systematic placement of furniture, informal meetings can still occur. At the same time, it was assessed that if you as a visitor need to retreat a bit, there are other areas in the library that better meet this need, as the central area functions more as a transit zone.

Iteration 1

Render with plan showing a more dense central area with more shelves and furnitures.



Iteration 2

Render with plan showing a more open central area with less shelves and furnitures.

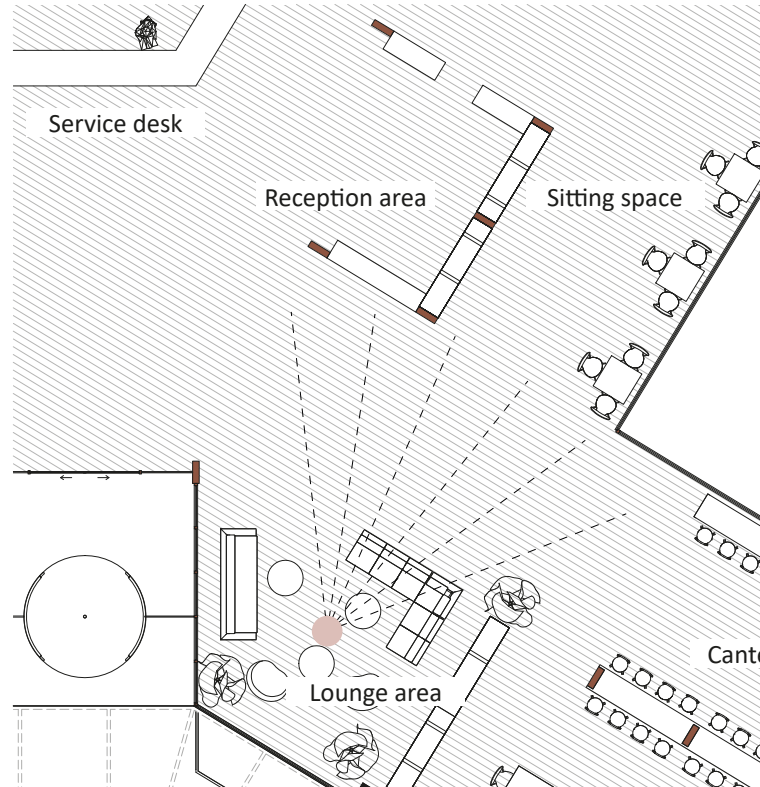




Fig. 36: Render with plan , central space 1st iteration



Fig. 37: Render with plan, central space 2nd iteration

Kid's Activity Area

Iterations

The children's area is an important place in the library and serves as a gathering place for children and their parents. In this place, it should be an opportunity for them to play either alone or with other kids to unfold in different ways. Social integration is then supported, and the children's different intelligences are developed. When preparing the children's area, various iterations of spaces of varying nature have been made. It is a conscious choice that the area should be open and have visual contact with nature outside, as it provides the best conditions for the children to be visually stimulated and have space to run, play and jump. However, the tectonics lies in how the furniture is organized and thus which niches arise.

The first iteration shows a very open environment where there are not so many disturbing elements that can stand in the way of the children's play. However, this solution may have the opposite effect, that the children are not stimulated enough and where play may become too forced.

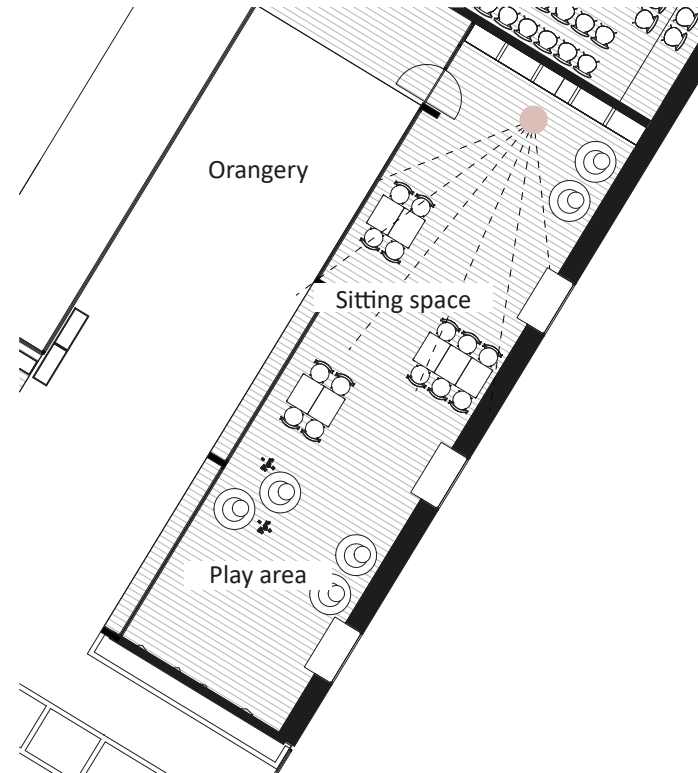
A transparent wall and a wallbar, dividing the room, have been added in the second iteration, challenging the kids more spatially, thus arousing their curiosity. With this solution, it can be an obstacle for the children to play more sporadically.

Conclusion

Iteration 2 was chosen as the best solution, as the elements for space divisions create a more exciting room flow and expression. If the children feel hindered in their play, they can bring out their play outside to the playground, where they have greater mobility and can play more freely.

Iteration 1

Render with plan showing an open activity area with provided seating and few shelves creating a linear flow.



Iteration 2

Render with plan showing a more dense activity area with more shelves creating a dynamic flow.

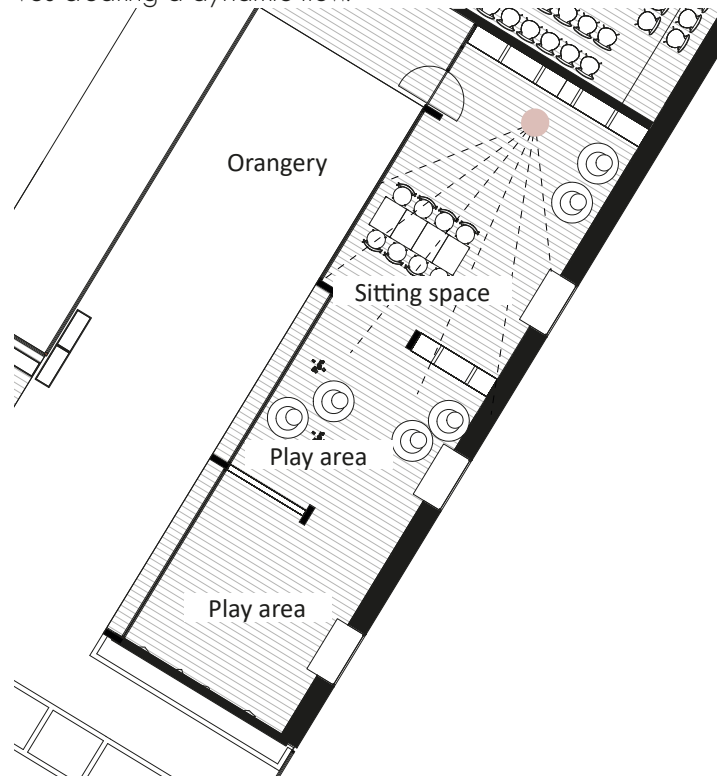




Fig.38: Kid's activity area open space



Fig. 39: Kid's activity area with niches

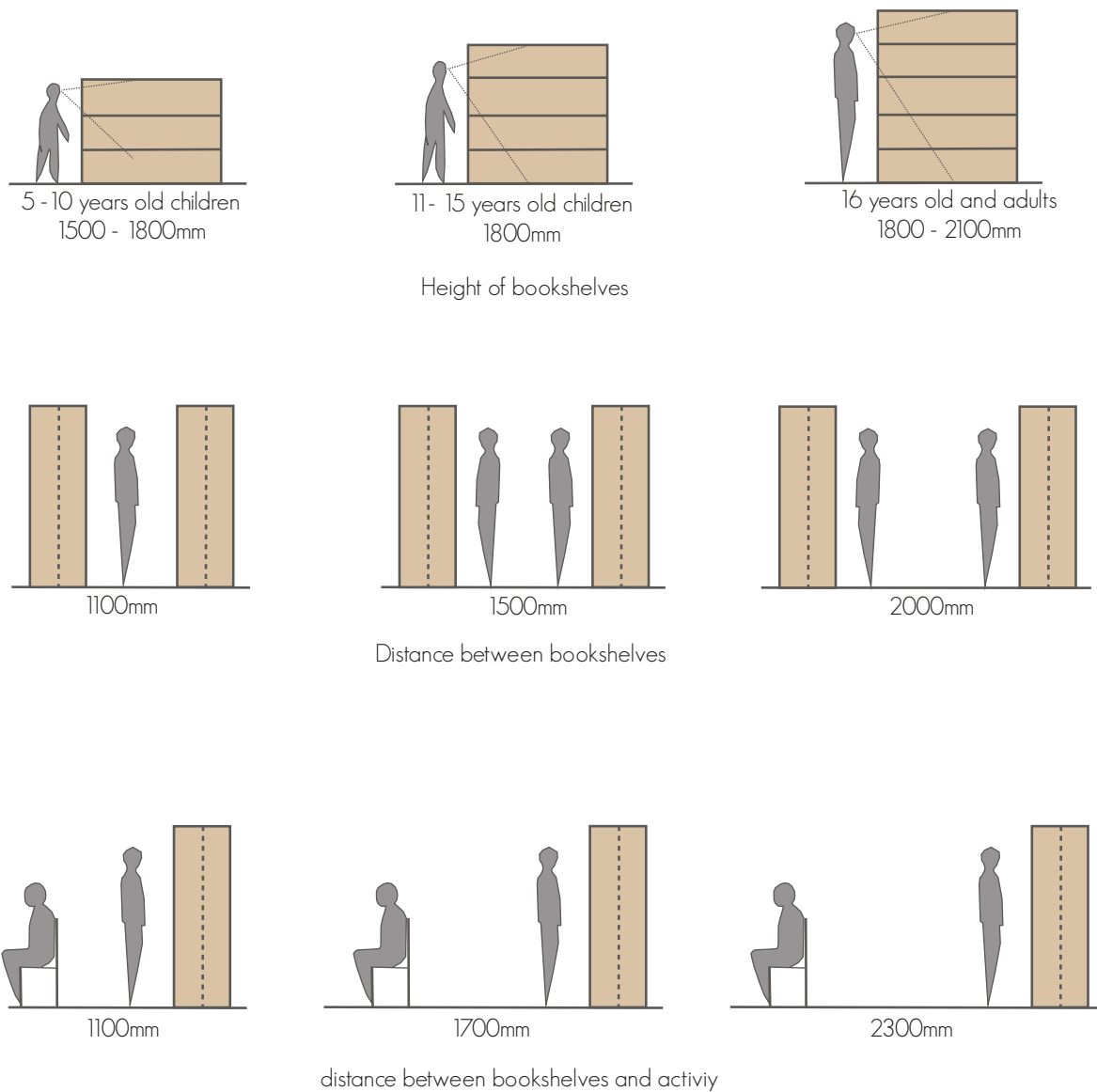


Fig. 40: Human scale studies on distances between bookshelves

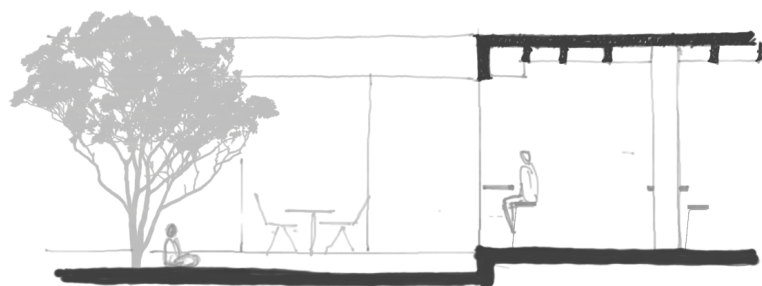
Human Scale Studies

Preparation

Being an institution for knowledge, the arrangement of bookshelves is important in the library's design. The study of the bookshelves was carried out to understand the required dimension of the shelves for kids and adults. Firstly, the height of the shelves for children and adults was determined, and later dimensions required between the shelves and other potential activities were determined to achieve "enough" space for moving alongside the

shelves and other activities. As shown in fig. 40 the height of the shelves required for the elementary school kids aged 5-10 is 1,5 m to 1,8 m, for junior high children aged 11 - 15 is up to 1,8 m and for children above 16 years and adults is 1,8 m to 2,1 m (Time saver standards, fourth edition). It is also important to establish the distance between the shelves to move between them comfortably. A distance of 1 m is enough for one person to move

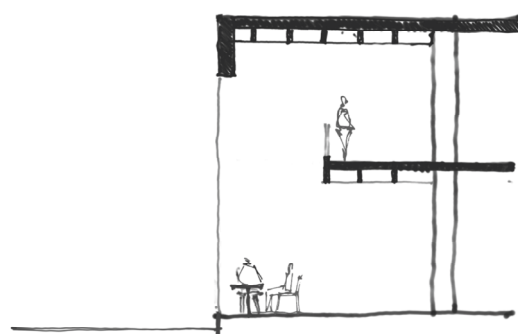
freely, but a minimum of 1,5 m of distance is determined for two users to use the space simultaneously. More distance can be provided based on the traffic and activity taking place around the shelves. While 1,1 m is a comfortable distance, it is still very close and identified as "a personal distance" by Jan Gehl. A minimum distance of 2,3 m needs to be provided for more physical activities next to the shelves.



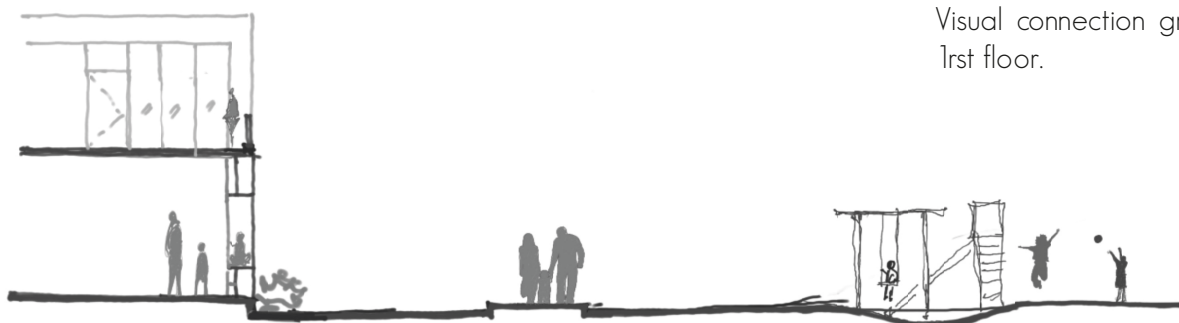
Visual connection between canteen area and courtyard.



Visual connection between reading areas at different levels, courtyard and shelving area.



Visual connection ground floor and 1st floor.



Visual connection between children's area, terraced space, pathway and playground.

Fig. 41: Sketches on visual connections in various areas

Visual Connections

Preparation

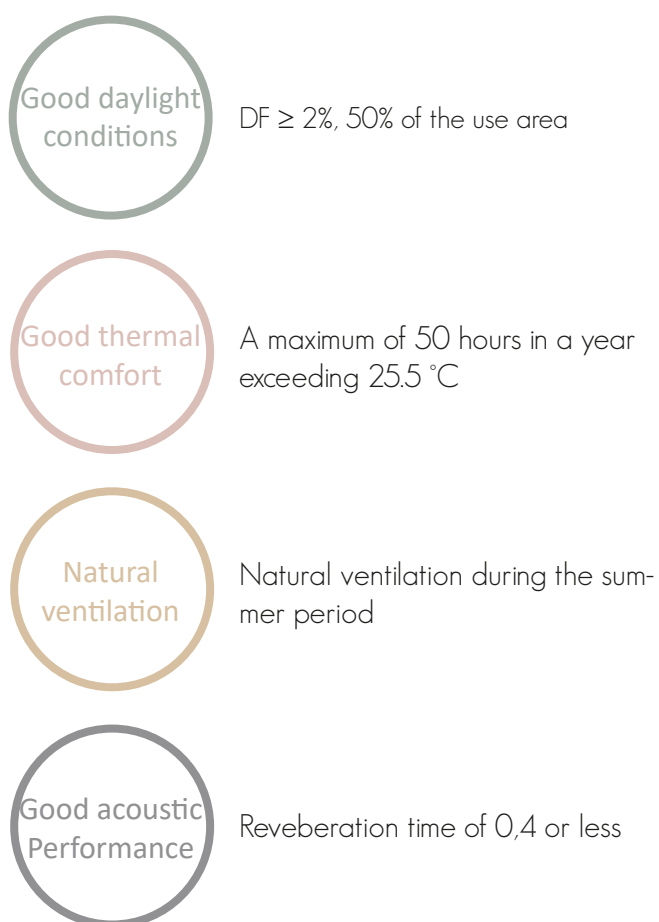
Some spaces/functions have been selected where different sections are outlined to support the idea of creative learning environments and visual stimuli from diverse activities. The sections above illustrate visual connections from the indoor to outdoor areas and from the ground to the 1st floor. At the same time, the sections give an indication of the human scale in the library.

Drawn sections continuously inspired further development of the plan layout. The sketches were made early in the design process, to illustrate desired spatial experiences and how to implement the visual contact for different spaces.

Indoor Environment Introduction

A good indoor climate is essential for the overall experience of the library. Therefore, different iterations have been made on daylight, atmospheric indoor environment, reverberation time, and ventilation principles. Various simulation tools have been used, which have been a tool for achieving an optimal indoor climate, where at the same time, it has been possible to evaluate the architectural expression in parallel with the simulations.

Indoor Environment Design Criteria





Iteration 1

Full window size, no coverage



Iteration 2

50% coverage with lamellas



Iteration 3

50% coverage with lamellas
Recessed windows

Fig. 42: Living-room atmospheric iteration process

Canteen, Excessive Heat Iterations

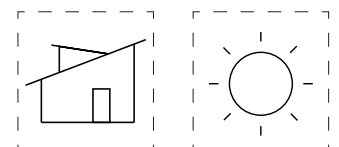
The canteen, which is located on the library's ground floor, is particularly exposed to a lot of daylight and thus the possibility of overheating. In the canteen area, many people will be present during the canteen's opening hours, and as large glass sections are facing both north and south, there is a risk of overheating if you do not take some action in the form of designing windows and shadow elements. BSim simulations have been made based

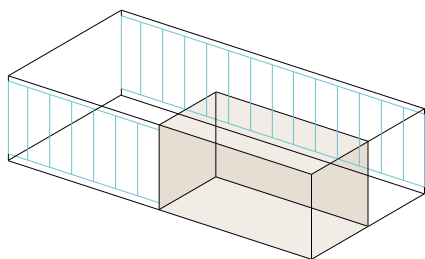
on different scenarios, where various initiatives have been constructed into the model. It has been equated with the visual expression, thus achieving an iterative process on a more in-depth evaluation basis.

Conclusion

Iteration 3 is chosen based on the simulations, where the number of hours above 25.5 remains below the maximum number of hours of 50

hours/year. Based on the visualization associated with this iteration, it has also been assessed that the shading panels contribute with a dynamic impression that fits well with the library's other construction, where the visual contact has still been maintained.





BSim model and window section iterations

Iteration 1

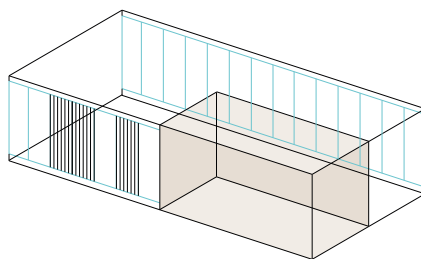
- Window area: 36 m²
- Natural ventilation

Results

*Hours a year

Hours above 27 °C: 255

Hours above 28 °C: 95

**Iteration 2**

- Window area: 36 m²
- Natural ventilation (automatic)
- 50% window covering (south)

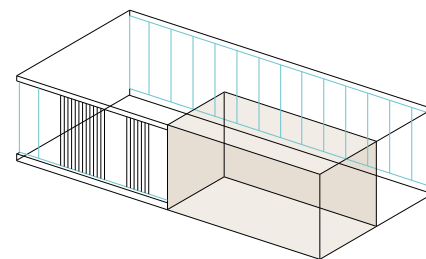
Results

*Hours a year

Hours above 25,5 °C: 62

Hours above 27 °C: 87

Hours above 28 °C: 43

**Iteration 3**

- Window area: 36 m²
- Natural ventilation
- 50% window covering (south)
- Exterior shading, south (recessed windows)

Results

*Hours a year

Hours above 25,5 °C: 47

Hours above 27 °C: 35

Hours above 28 °C: 4

Fig. 43: Bsim model iterations on excessive heat in canteen

Activity level: 1,2
 Clothing level: 0,5
 Operative temp 23-25,5 °C

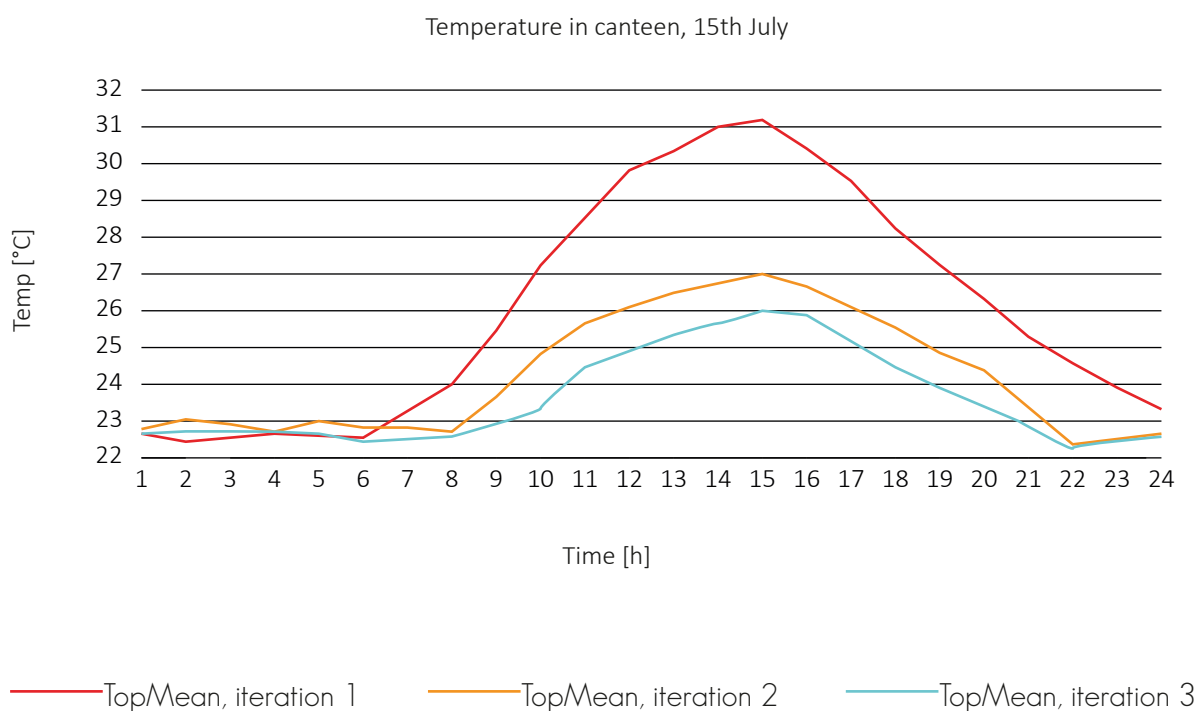


Fig. 42: BSim model iterations on excessive heat in canteen

Lighting Analysis

Standard Day - 46% Passing

33% below threshold
20% above threshold w/o
shades



Fig. 45: Render with slit on north facade

Lighting Analysis

Standard Day - 53% Passing

27% below threshold
20% above threshold w/o
shades



Fig. 46: Render with skylight in roof

Windows (DF %)

Iterations

Two different iterations are made for evaluating the atmospheric quality due to different window solutions and the indoor daylight factor ($\geq 2\%$, 50% of the use area.). The visualisations are based on the Revit model, showing the whole first and second floor of the library whereas a plug-in (InSight) for Revit has been used to simulate on the DF%. It has been a desire to have a harmonious expression, from the inside as well as from the outside. In the first iteration a slit window was

added to provide an inward looking, private space, where people can immerse themselves, without any external distractions, yet it was imperative to provide ample amount of daylight for visual comfort.

Conclusion

In the first iteration, the layout did not pass the requirement for daylight factor. Therefore an alternative solution to the slit window of the northern facade had to be

implemented. Therefore, skylights were added to the roof, which also represented the character of the grid system. In the simulation, it was evaluated that it was not necessary to have the slit window but only skylights.

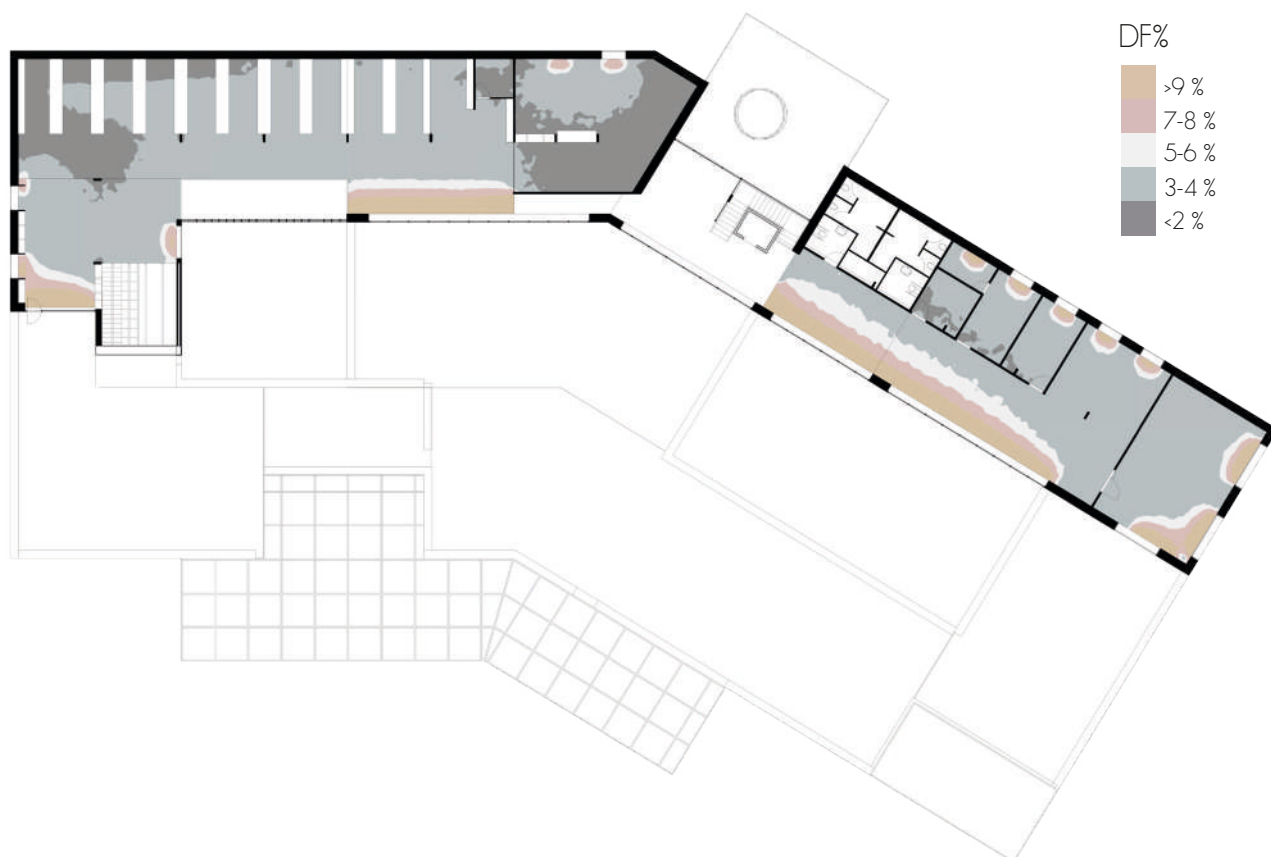


Fig. 47 Plan with slit on north facade

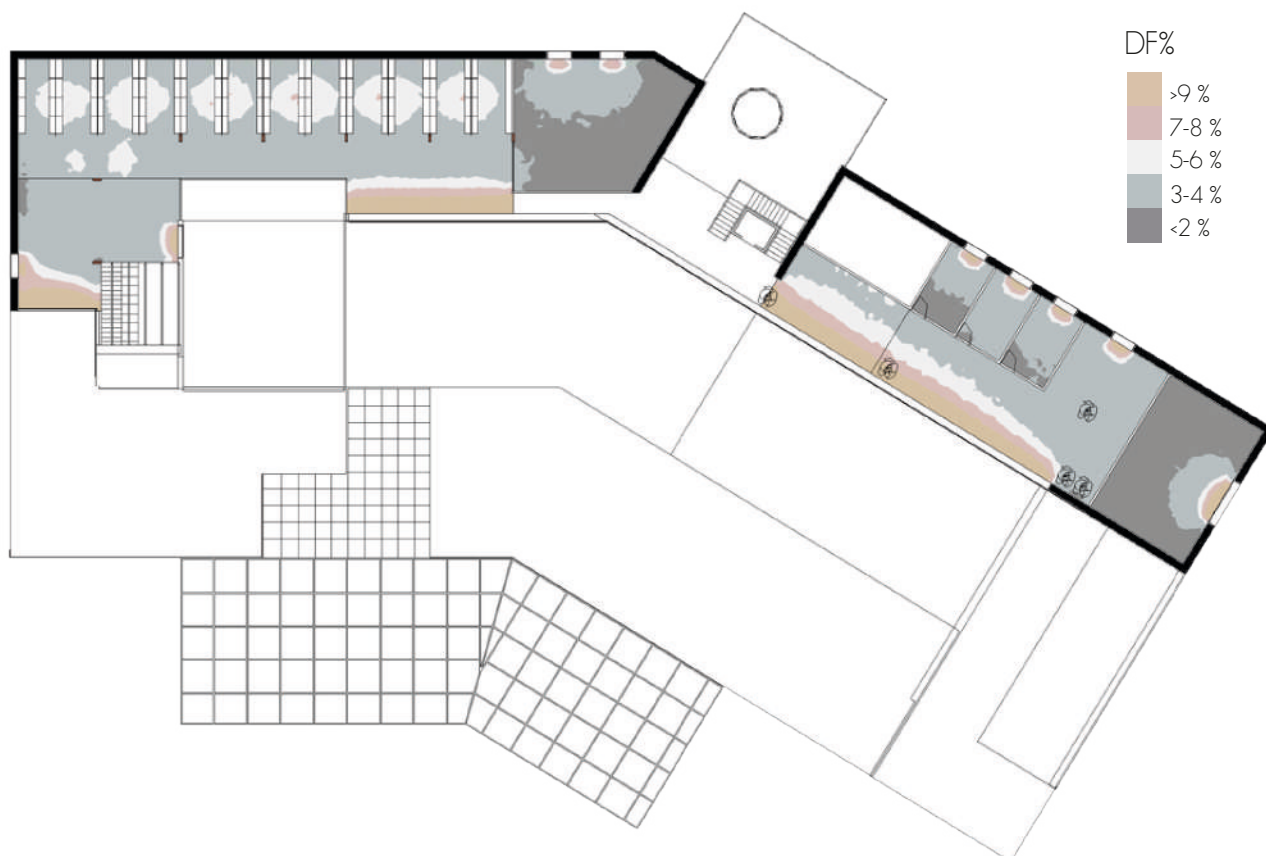
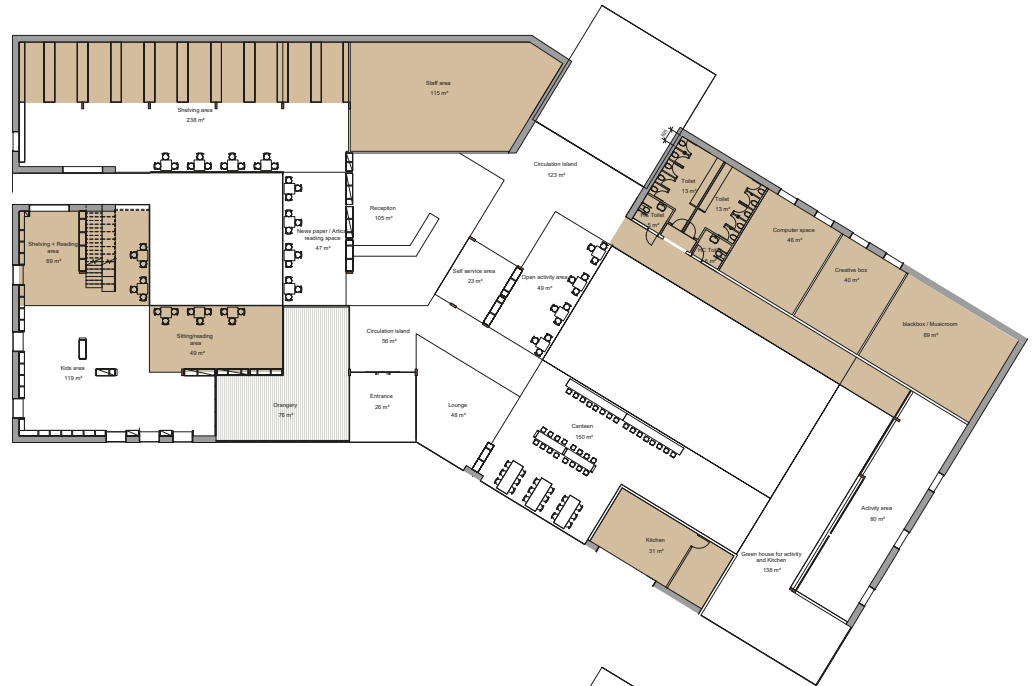


Fig. 48: Plan with skylight in roof

1st step

Sketch suspended ceiling where needed at private/intimate areas



2nd step

Place aggregates and draw ventilation ducts according to the ventilation rates in each area



Ventilation Strategies

Iterations

A good indoor climate depends a lot on how much and what type of ventilation you use. It is important to prevent overheating in (primarily) summertime and immerse odor nuisances and CO₂ in the building to achieve atmospheric and thermal comfort. Ventilation should therefore not be overlooked, as it has a great impact on user behavior and well-being. Natural ventilation will be used in the summer to lower the energy demand for the building. Unfortunately, the climate in Denmark does not allow you to make use of

natural ventilation all year round, as you may thus experience drafts. Mechanical ventilation will then be used during the cold months. The ventilation depends on the materials inside the building and how the occupancy changes during the library's opening hours, i.e., what type of activity is performed and how many people are estimated to be in the different zones. The schedule for the library's opening hours on weekdays and weekends has been a helpful tool for calculating the ventilation rates for each hour in the

different zones, so you get an idea of how ventilation changes during the day (see ill.). From the calculations (see room program, appendix p.), it can be seen that there is a varied need for ventilation in the library; therefore, it has been chosen to use a VAV system (variable air volume) to accommodate this variation in airflow. A VAV system with heat recovery can also be advantageous in winter, thus lowering the energy requirement by using the energy/heat that is drawn out of the building and reusing it in the air that is blown back in by the

3rd step

Add suspended ceiling to areas to hide running ventilation on ducts.

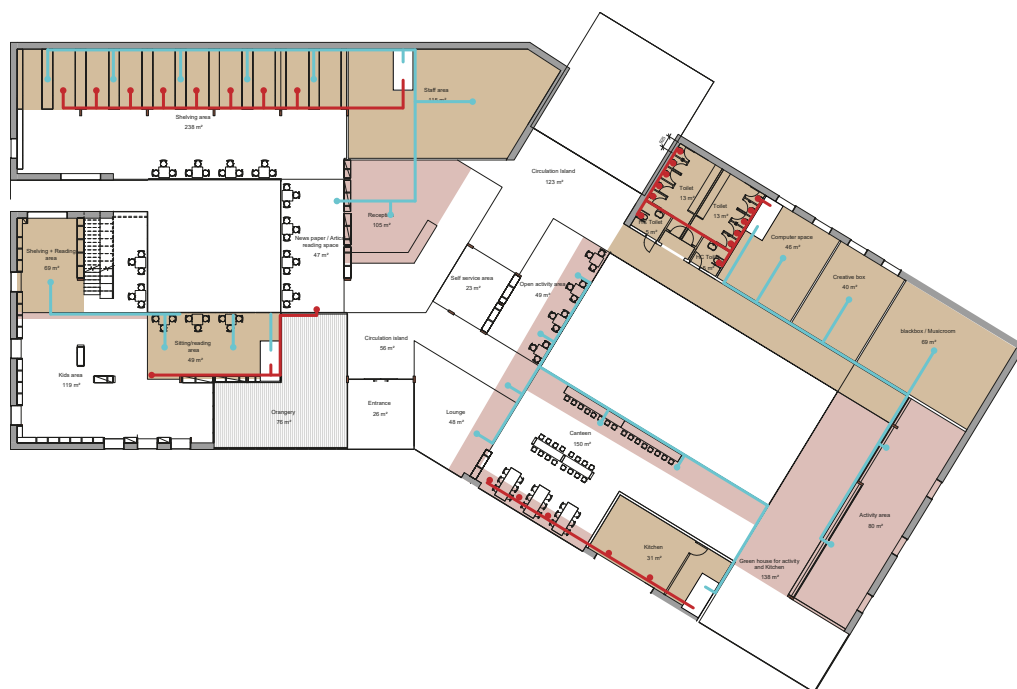


Fig. 49: Ventilation strategy process



Fig. 50: Render of false ceiling in reception area

ventilation system. In the library, it is more advantageous to use the principle of mixed ventilation to accommodate heat recovery. The principle is incorporated in our design, where it is strived to hide as much as possible the shafts and pipes, as this would disturb the level of detail in the library's wall and ceiling construction. Ventilation pipes are hidden behind a suspended ceiling made out of plywood sheets and with covering clay cladding. The mechanical ventilation system is divided into four units. All four

aggregates are placed on the ground floor. These systems are VAV and have a varying ventilation rate based on Br18 criteria of a minimum of 0,35 l/s pr. m² of each living area and the standards of 20 l/s for kitchen and 15 l/s for toilets. The colored areas indicate where the ceiling is suspended to make room for and hide the ventilation.

Conclusion

The placement of the ventilation ducts was made following the desired atmosphere written in the room

program (see p. 57). A suspended ceiling gives you the experience of a more private and intimate zone and should therefore be placed over spaces that should possess this spatial quality. In this way, both the construction and the architectural aspect are taken into account.

Cross-ventilation Principle

Preperation

In the summer, natural ventilation will be used to lower the overall energy consumption in the building. The canteen is used as an example to depict the principle behind cross-ventilation. The canteen is also well located in relation to the wind direction, as during the program phase, a wind analysis was carried out, which shows that most wind

comes from the southern part of the site. There will thus be openings in the canteen's windows to the south (the windward side) in the lower part, after which the wind will cool the air, and based on the displacement principle, will ventilate the polluted air towards the courtyard (the leeward side) as seen in fig. 51.





Fig. 51: Diagram of natural ventilation strategy in canteen area

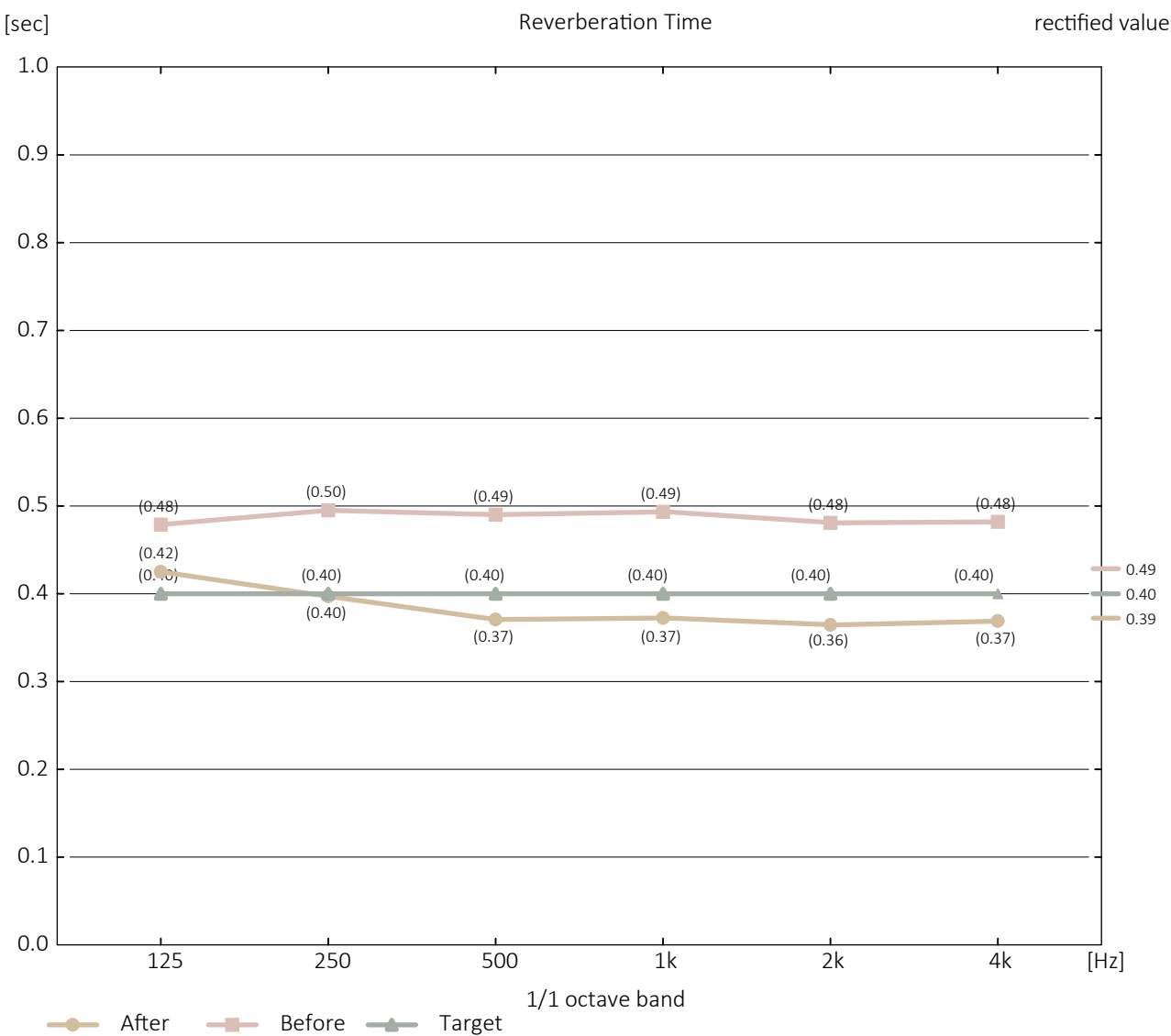


Fig. 52: Table showing reading area before and after sound-insulating materials

Reverberation Time in Reading Area Iterations

A library consists of many different rooms, each of which must comply with the acoustic requirements for reverberation time. The acoustic comfort is important for the experience of space and is of great importance for children's development and learning, including developing language skills. Daycare institutions often have high noise levels, so strict requirements are set for the acoustic indoor climate in this particular type of building. Playing children are usually noisy, and an increased noise level often means that the children automatically will raise their voices more and more. Hearing is still developing in children, making them particularly susceptible to hearing damage, and noise can have a wide range of other

negative consequences, such as stress, dissatisfaction, desocialization, and learning problems in the long run. With chronic noise exposure, children can also have problems with mental development due to reduced ability to concentrate, motivation, and communication difficulties. In the library, some measures must be taken that can help to lower the noise level. The design and materials of a room are the two most important factors that make up the acoustic indoor climate, as the acoustics of a room are determined by the ability of the surfaces to "throw" the sound back into the room. Thus, the reverberation time is the time it takes from a transmitted sound source to the sound level in a

room having dropped by 60 dB. The reverberation time is thus the most important concept for determining and characterizing the acoustics of a room. To calculate the reverberation time, one must know the volume of space and absorption materials, including the number/amount of materials.

Planning of reverberation time is usually done based on a Sabine calculation, but as it is considered inaccurate, 3D simulations are made instead of documenting that the building complies with the projected requirements for reverberation times in furnished condition. The reverberation time is calculated in different frequency ranges, which



Fig. 53: Render of reading area with sound-insulating materials

says something about the oscillations of the sound waves per second and has the unit Hertz (Hz). One analyzes sound in various frequency bands, including 125 Hz (deep tones), 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz (high tones). (Alpha-akustik.dk, 2019). Based on this knowledge, a reverberation curve is made to assess the acoustic quality of the room.

According to Br18, the reverberation time for a daycare institution should be $T \leq 0.4$ s in the frequency range 125-400 Hz. (Br18, Sound conditions, §368-§376).

Acoustic quality is also related to visual quality. These two things must go hand in hand, as you can make enough measures on sound without contributing to the visual perception or, in the worst case, interfering with the architectural expression. It is taken into account when working with the reading area. The reading areas aim

for a deficient noise level, and even if it meets the reverberation time requirement, several interventions must be made to lower the noise level even further so that you achieve complete silence, i.e., a dB of 30 or less. This allows you to start and work with sound-absorbing panels in the ceiling, as well as carpets or other textile surfaces/materials. (See diagram). Using barriers to absorb sound is an easy way to control acoustically. Shielding between areas for different uses provides both acoustic and visual division of different zones. Screens with solid cores and acoustic absorbing surfaces are the most effective for this purpose.

As the reading room is the room that requires the most silence and thus the most absorbent materials, reverberation time has been calculated here. However, the calculation also indicates the reverberation time in the rest of the

library's rooms, as the rooms are built of the same materials.

The reverberation time is calculated from the room without furniture and sound-insulating materials to determine how much "extra" material or fabric to put into the room.

Conclusion

The room's reverberation time slightly exceeds the target of $T \leq 0.4$ s, but it is considered permissible. If you put in materials equal to 20 chairs, and some acoustic panels on the walls (total amount: 20 m²), the result will be below $T \leq 0.4$ s. (See tables in annex 03).

Materiality Introduction

Different materials have been examined in relation to the site's character, plan layout, and desired expression to accommodate the sustainable development in the building sector and up-cycling and state-of-the-art materials. On the following pages, outdoor wall claddings are presented, where an LCA analysis is used to justify the choices of the various materials alongside an evaluation table. Furthermore, the construction of the wall have been assessed to meet the requirement for the wall's U-value.

Materiality Design Criteria



Exterior Cladding, Architectural Expression Iterations

In this section, three different exteriors claddings have been evaluated for each of their environmental profile and performances, as well as for their visual expressions. In the end, a comparison has been made to justify the selection of the material for the facades of the library.



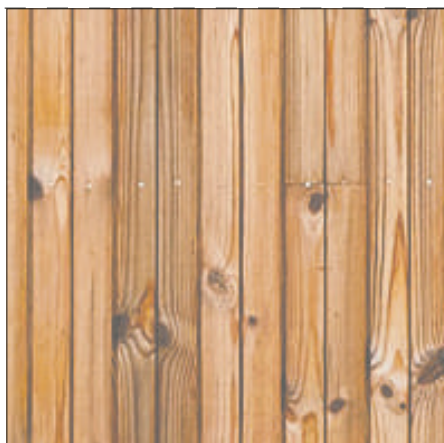
SuperWood

SuperWood is spruce wood that is extracted only from FSC forests in Norway, Sweden, and Finland. It is treated with a new technique where one uses carbon dioxide to kill biocides in the wood extending the lifespan to 60 years. The wood is treated under high pressure, where the small particles in the wood protection penetrate completely into the core of the wood and thus protect against rot and fungus.



Burnt wood

SuperWood is spruce wood that is extracted only from FSC forests in Norway, Sweden, and Finland. It is treated with a new technique where one uses carbon dioxide to kill biocides in the wood extending the lifespan to 60 years. The wood is treated under high pressure, where the small particles in the wood protection penetrate completely into the core of the wood and thus protect against rot and fungus.



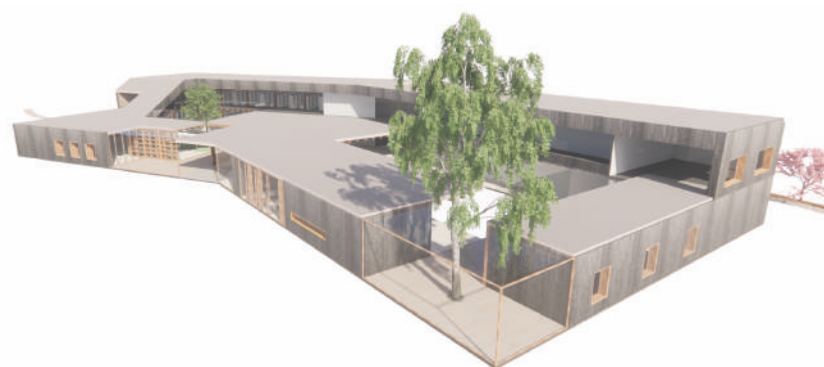
ThermoWood

ThermoWood is heat-treated wood, which makes it more resistant to rot and fungus. It is a relatively new technique, where with the help of a carefully controlled oven treatment, you "dehumidify" the wood and reduce the wood's water content and make the wood more brittle. After installation, ThermoWood has a dark color which patinas over time to a silver color if it does not receive oil treatment.



SuperWood

This type of facade cladding is slowly beginning to gain ground due to its robustness and Nordic expression. Over time, the exterior cladding gets a more gray shade, which does not take too much attention from the surroundings. With this type of cladding, the library will look modern, Nordic, and blend well into the surroundings.



Burnt wood

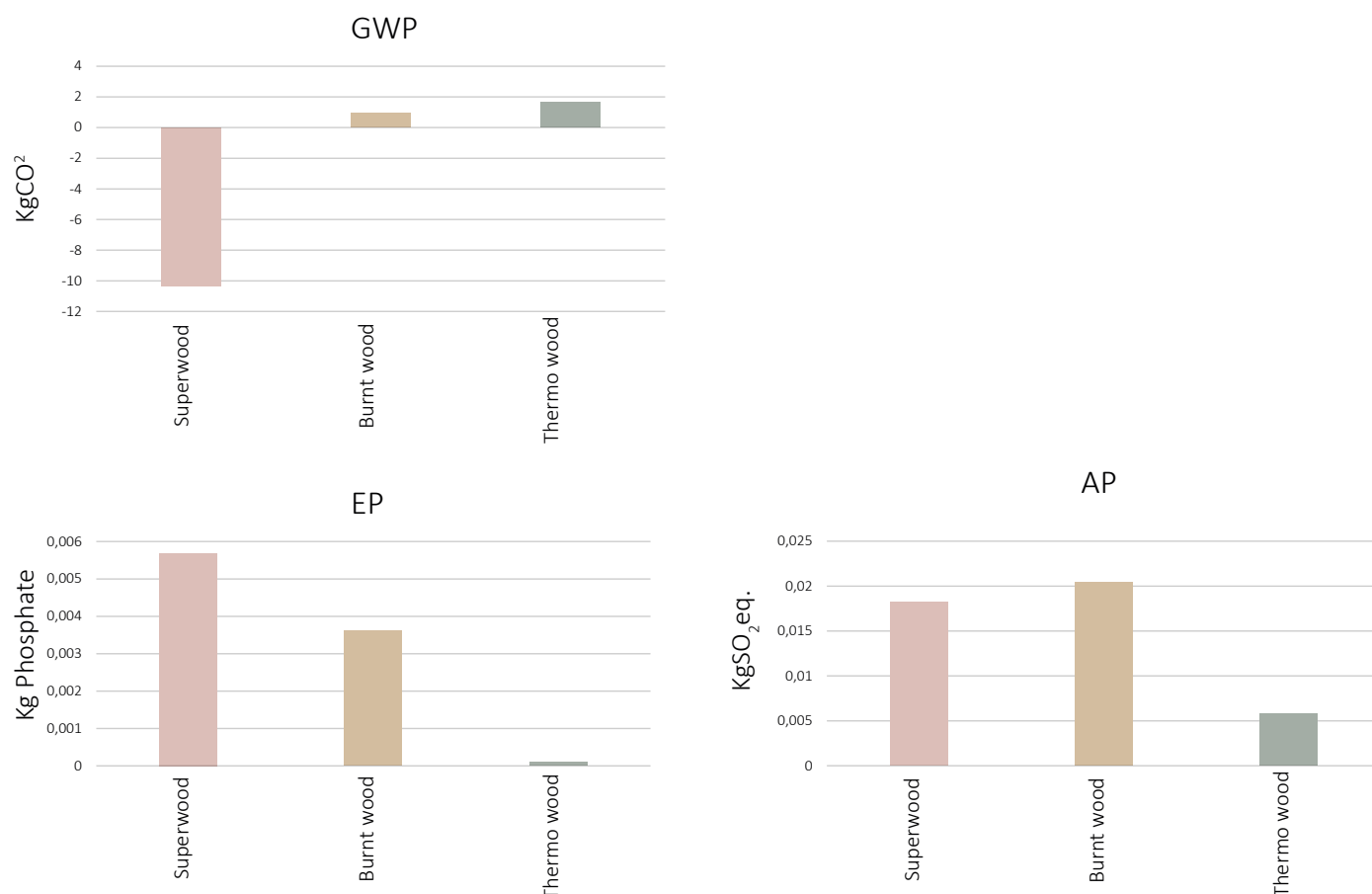
Burnt wood is a dark wood cladding that appears very rustic and dominant. With this facade cladding, the library will stand out a lot from the surroundings and may not seem so inviting to outsiders.



ThermoWood

ThermoWood is a slightly darker type of wood cladding that patinates over time to a greyish tone if not given an oil surface treatment. It fits in well with the Nordic context, where you'd get the sense of a "real" wooden house. The cladding is well suited for smaller buildings but may seem a little too dark for a larger institution.

Fig. 54 : Renders of different sustainable wooden facade claddings



Exterior Cladding, LCA Iterations

Life cycle analysis

Different LCA diagrams have been made to see the environmental profile of different facade claddings for the various parameters, GWP, AP, EP, ODP, and POCP. Furthermore, they are set up against each other to evaluate which material performs the best.

Global warming impact (GWP)

GWP is the parameter that weighs the most in DGNB (40%). Here we see that Superwood performs better than the other two materials. It is because it is an untreated material that is good at storing CO₂. The other two materials, Burnt Wood and ThermoWood, generally perform well and are almost equally good; however, they both require a bit

more processing as Burnt wood is an upcycled material, and ThermoWood is a heat-treated material. All three materials are natural materials, which means that they are carbon-negative. They store CO₂ while they grow and release it only when they are incinerated at the end-of-life phase.

Acidification potential of soil and water (AP)

ThermoWood performs best in this parameter, as it is only heat-treated, and thus there is no great risk of acidification of soil and water. Burnt wood and Superwood perform almost equally well but score higher than ThermoWood because their surface treatment increases the risk of acidification.

Eutrophication potential (EP)

EP is a parameter related to the use of fertilizer and the burning of fossil fuels. ThermoWood is the best performing material, whereas Superwood is the material that performs the worst. It is because Superwood is still a relatively new material under development. In its growing phase, the material is treated with fertilizer, which negatively impacts the ecosystem. In addition, when impregnating the material, the burning of fossil fuels results in nitrogen and phosphorus acidifying soil and water through the rain. It can result in unwanted algae growth, which increases the risk of oxygen depletion.

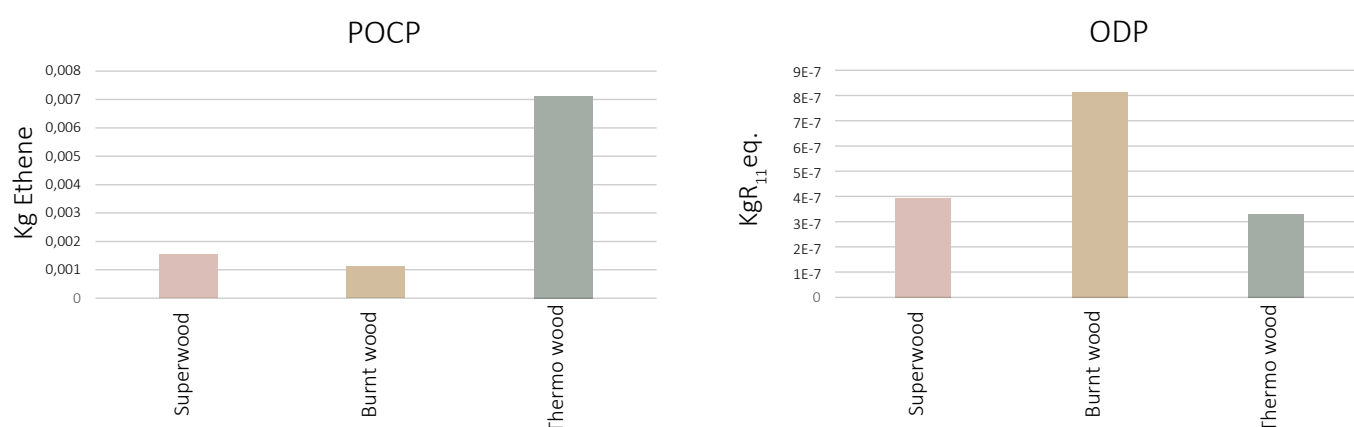


Fig. 55: LCA tables of different sustainable wooden facade claddings

Depletion potential of the stratospheric ozone layer (ODP)

Superwood and ThermoWood perform almost equally well in this parameter, whereas Burnt wood performs worst. This is due to the substances emitted into the atmosphere during the surface treatment, which increases the depletion of the ozone layer.

Formation potential of tropospheric ozone (POCP)

Superwood and Burnt wood perform almost equally well in this parameter; however, Burnt wood performs a little bit better as it is an up-cycled material with minimum processing. However, ThermoWood is the material that scores the worst. This is because it is a new material

that gets a more comprehensive heat treatment than the other two materials, resulting in the emission of smog.

Conclusion

It is difficult to assess which material generally performs the best, but as Superwood performs best in GWP, it has been chosen to use this material for the library's facades. This decision is also based on the visual expression, where Superwood is a lighter wood compared to the other two materials, which works well for a larger institution so that the building does not appear to be dominant in the landscape.



Fig. 56 : Collage of windows from Genbyg.dk (Genbyg, 2021)

Upcycled Windows

Preperation

As mentioned in our section on upcycling, it has been an important prerequisite for sustainable construction to use the resources we already have and work with a circular life cycle for materials.

In this project, upcycling windows will be placed on the walls surrounding the courtyards. This should help to raise awareness about recycled materials among library visitors and create a unique expression.

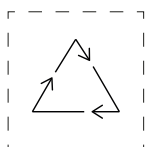




Fig. 57: Inspiration picture: Lendager Group, upcycled windows

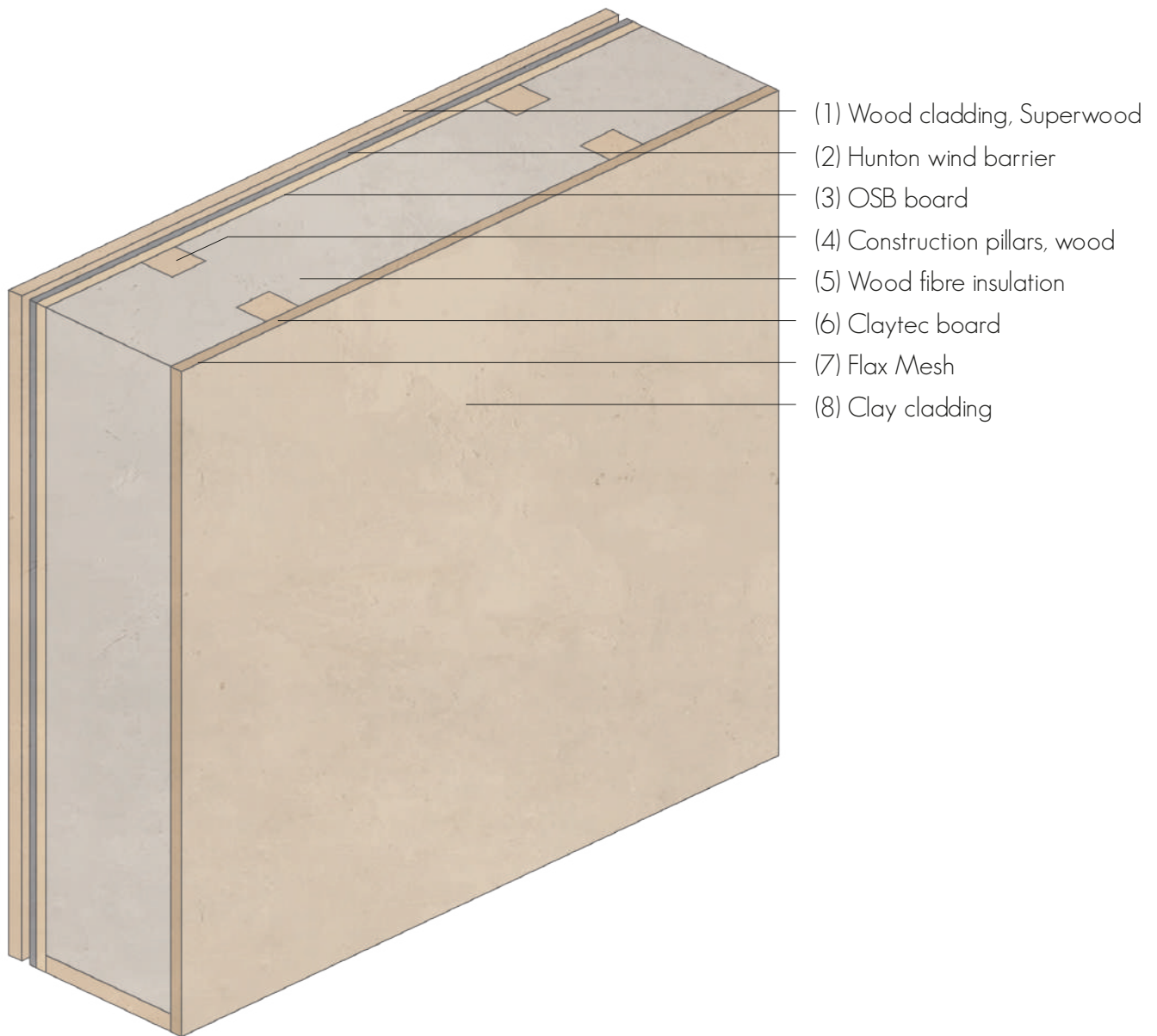


Fig. 58: Wall construction

Constructing the Wall Preperation

A lot focus has been put on the structure of the wall, as it has a great influence on the building's overall performance, both in terms of an LCA-score as well as the indoor climate, and contribution to the energy framework. The wall possesses a number of different specifications, including how it is structurally build-up and how it contributes to the indoor/outdoor environment and expressions. Therefore, research has been carried out for the wall's composition of different materials (see annex 07) so that it meets the global course for environmental sustainability and

the technical DGNB criteria on the building envelope and at the same time is a tectonic element in the library.

The wall is made of all natural materials throughout, bio-based materials. In this way, one operates in an iterative life cycle, where the materials are part of an ecosystem so that they minimize the environmental impact. Cradle to Cradle is an expression of the way in which the function and commissioning of a material is processed. In other words, these are materials that can be included in repetitive circuits where there is

no waste, as it is either recycled or becomes a new resource for new biological and technical circuits. The design principles behind Cradle to Cradle principle says that products must be able to be disassembled and either be degraded safely as a biological nutrient or recycled into new products. With this initiative, future generations can access the resources we already have today, which are also the basis for the circular economy (also mentioned under the section, Upcycling). With the voluntary building class of 2020, there are a number of

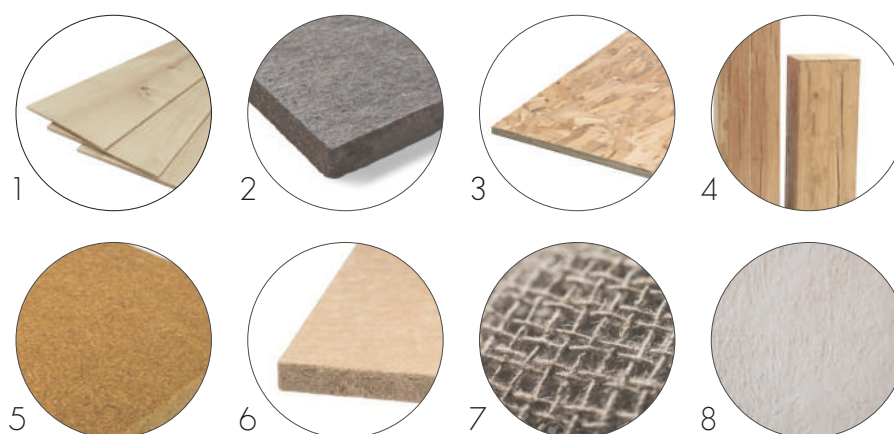


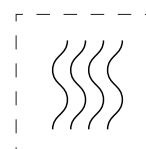
Fig. 59: Wall materials

	Material thickness	Thermal conductivity	Thermal resistance
	d	λ	R
Unit	[m]	[W/m°C]	[m ² °C/W]
Indoor thermal resistance	-	-	0,13
Clay plaster	0,005	0,8	0,013
Claytec board	0,025	0,13	0,192
OSB board	0,018	0,13	0,130
Wood fibre insulation	0,3	0,04	7,895
OSB board	0,018	0,13	0,130
Hunton wind barrier	0,012	0,049	0,245
Air gap	0,044	-	-
Wood cladding	0,025	0,192	0,13
Outdoor thermal resistance			0,04
Total	0,447		8,783

U-value: 0,117 W/m²°C

requirements for different building parts and components. If we look at the different building parts, including, ceiling and roof, terrain deck and exterior wall, there are some energy requirements that are worth looking at as they have a major impact on the composition and thickness of the various construction materials. Eg. for an outer wall, there must be a U-value of less than 0.12 W/m²°C, from which a number of bio-based materials have been investigated, where the insulation material and thickness are the ones that has the greatest influence on the wall's total

performance. Based on calculations, an insulation thickness has been determined which, together with the other materials, gives a U-value of less than 0.12. When the insulation material has been determined, one can examine for different exterior facade cladding and interior wall coverings, to evaluate any differences in the performance of different materials in an LCA study and the overall expressions.



Presentation



Albertslund New Youth Library

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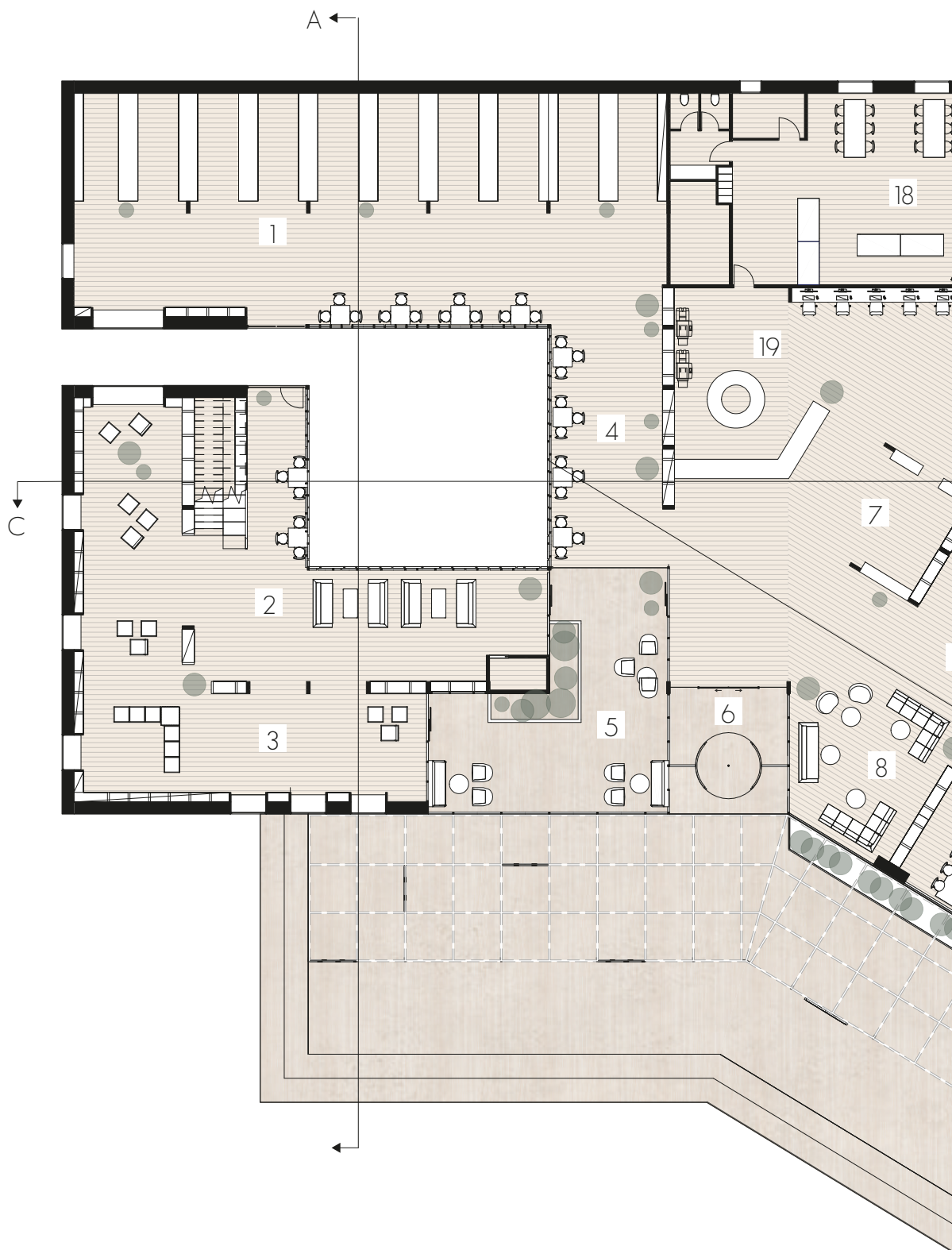
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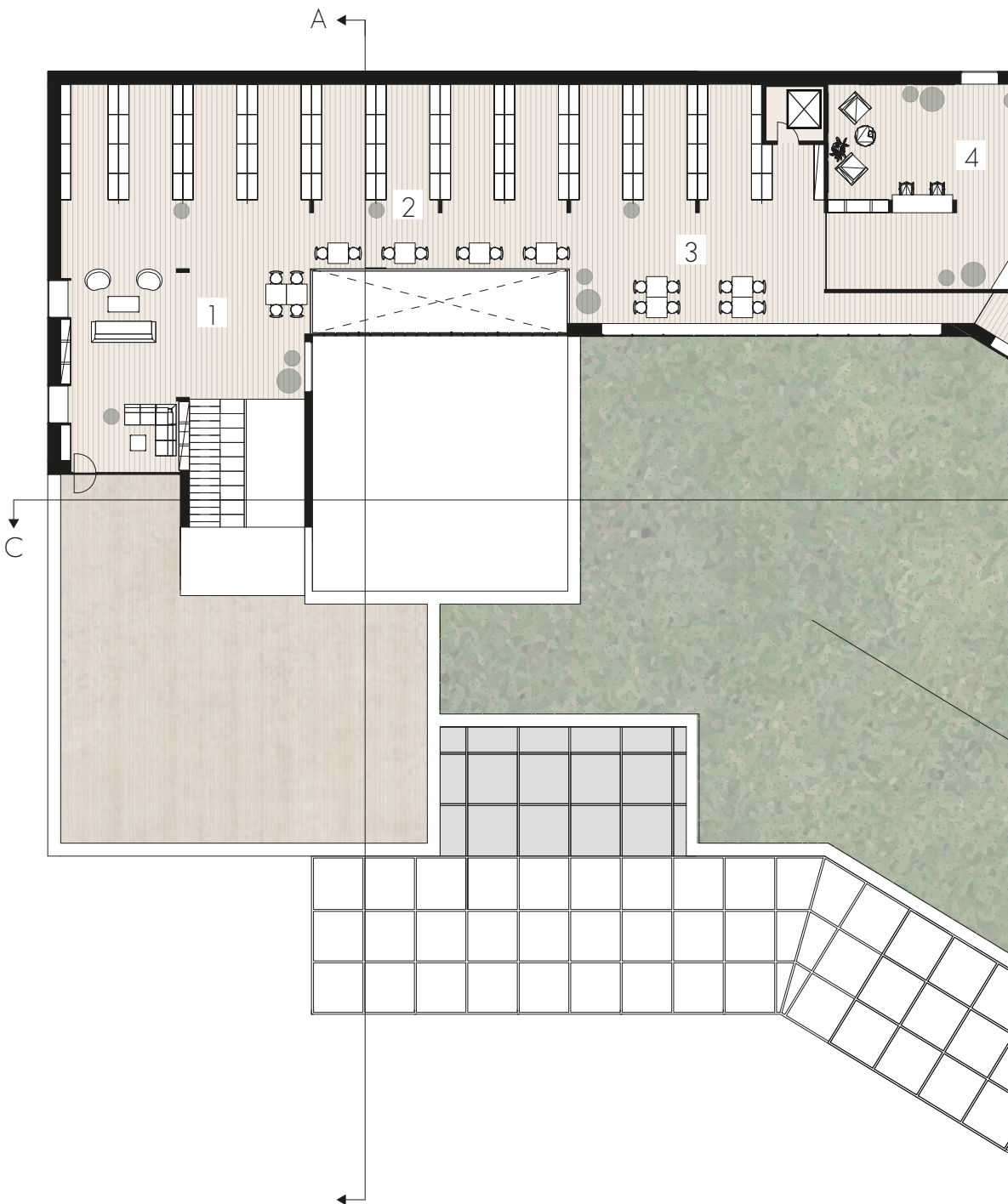
Fig. 60: Masterplan, 1:500



1. Shelving area
2. Sitting/reading area
3. Activity area
4. Newspaper area
5. Orangery
6. Entrance
7. Self-service area
8. Lounge area
9. Activity area
10. Canteen
11. Kitchen
12. Social green house
13. Kids area
14. Black box
15. Idea box
16. Computer space
17. Toilets
18. Staff area
19. Reception



Fig. 61: Floor plan, ground floor, 1:250



1. Lounge area
2. Shelving area
3. Shelving/reading area
4. Reading area (silent)
5. Waiting area
6. Toilets
7. Meeting room
8. Meeting room
9. Work station
10. Workshop



Fig. 62: Floor plan, 1st floor, 1:250



Section A 1:200



Section B 1:200



Fig. 63: Section A, 1:200



Fig. 64: Section B, 1:200





Fig. 65: Section C, 1:200



Fig. 66: Section D, 1:200

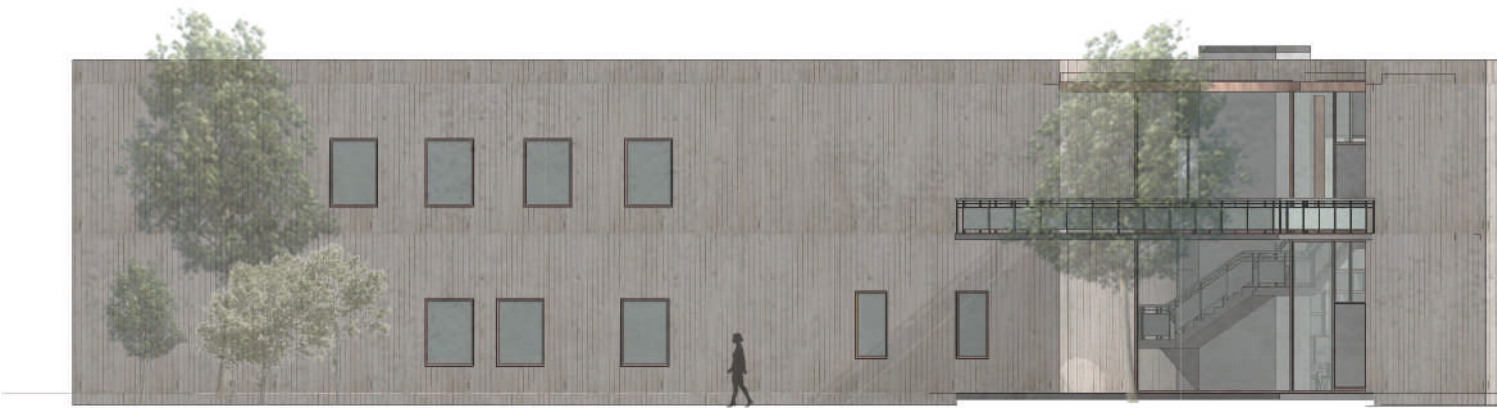




Fig. 67: East facade 1:200

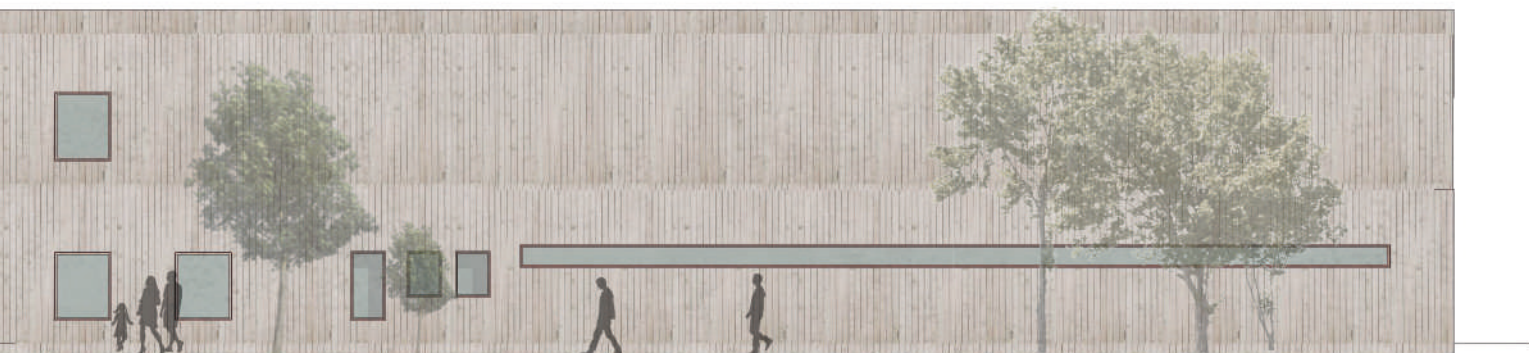


Fig. 68: North facade, 1:200





Fig. 69: South facade, 1:200

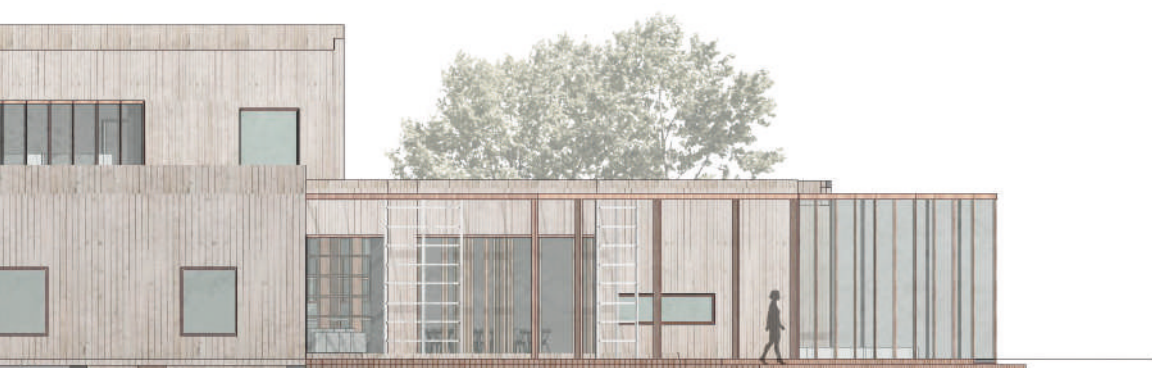


Fig. 70: West facade, 1:200

Creative Learning Environments Collection



"In the black box, a large event is about to be prepared. Many different people are gathered to presenting each their ideas to one another."

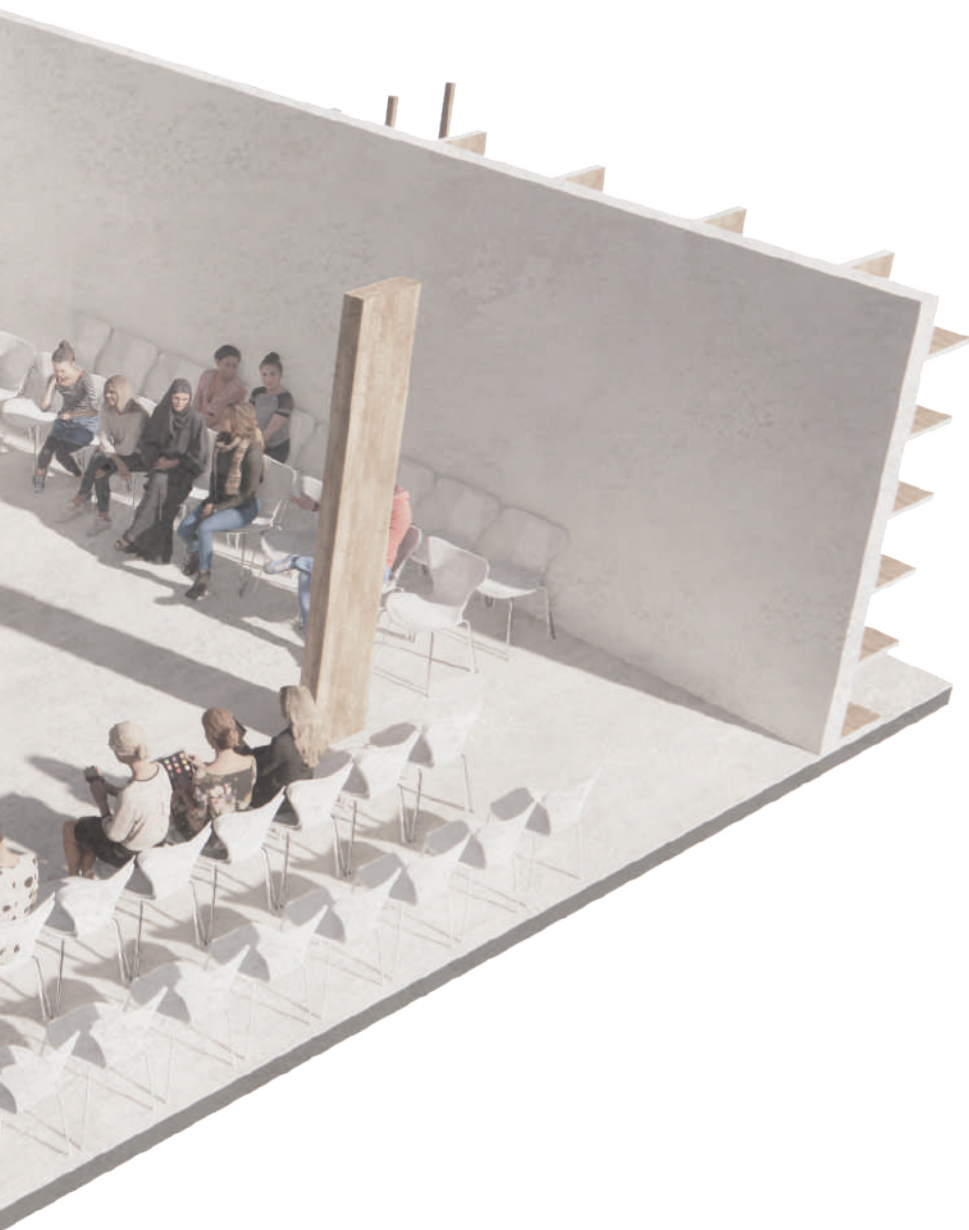
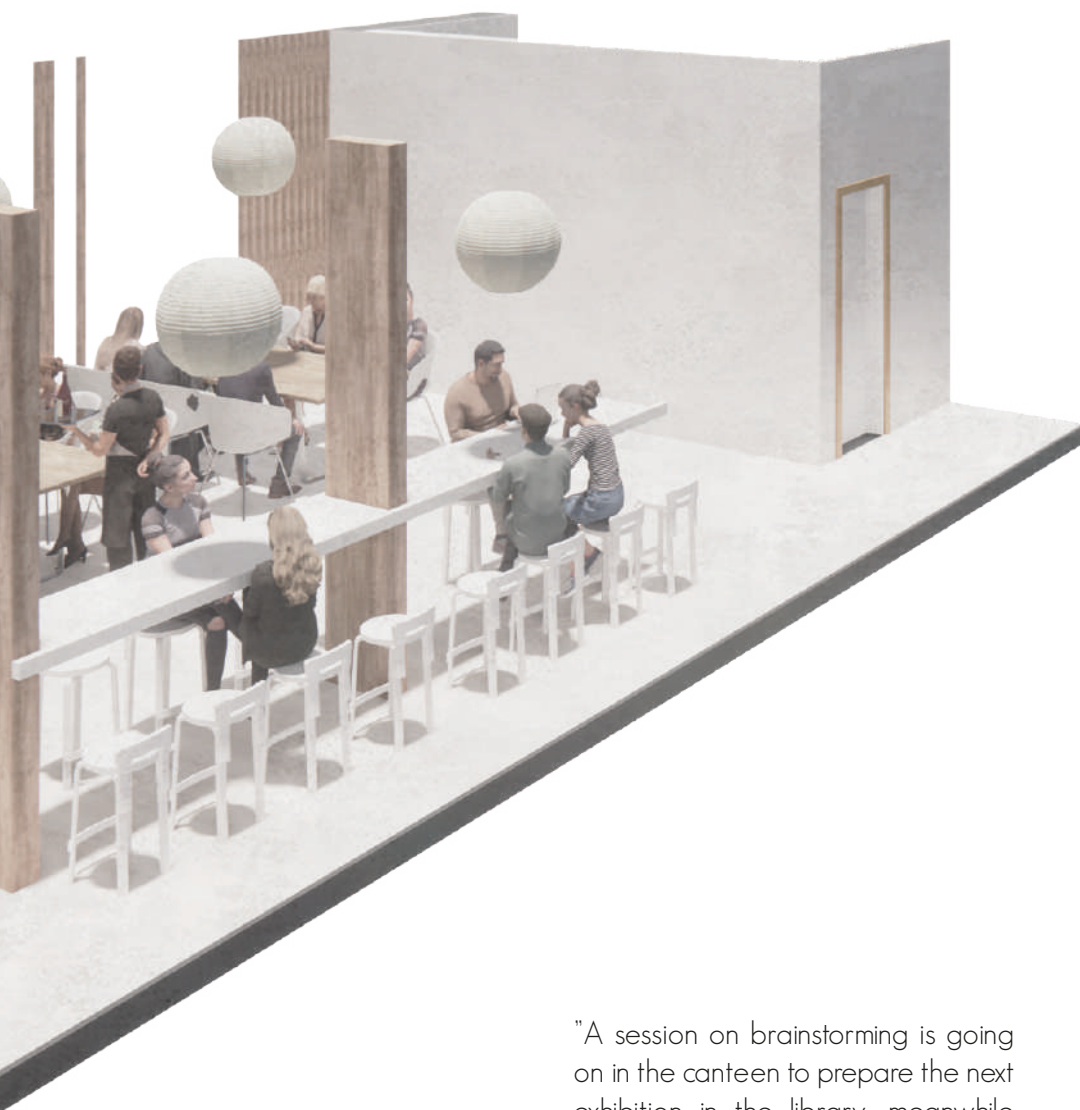


Fig. 71: Creative learning environments, collection model (black box)

Creative Learning Environments Deliberation

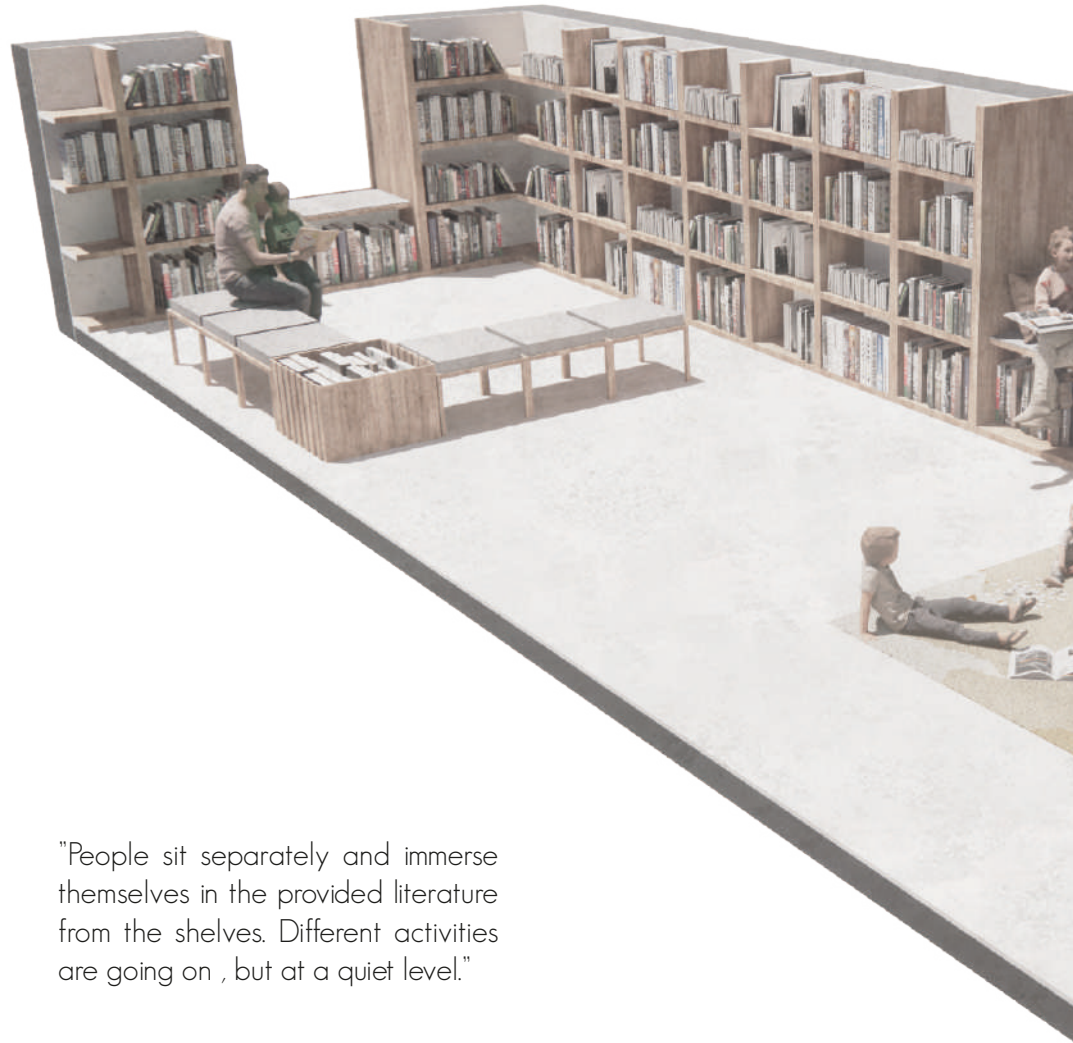




"A session on brainstorming is going on in the canteen to prepare the next exhibition in the library, meanwhile enjoying food and company."

Fig. 72: Creative learning environments, deliberation model (canteen)

Creative Learning Environments Contemplation



"People sit separately and immerse themselves in the provided literature from the shelves. Different activities are going on , but at a quiet level."



Fig. 73: Creative learning environments, contemplation model (activity area)

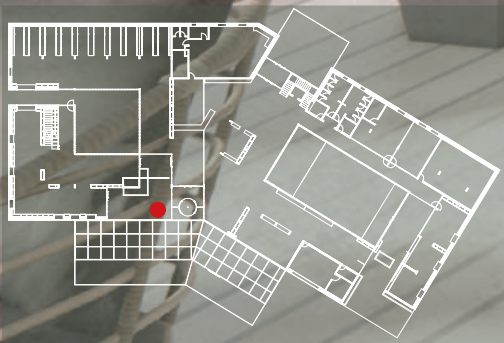
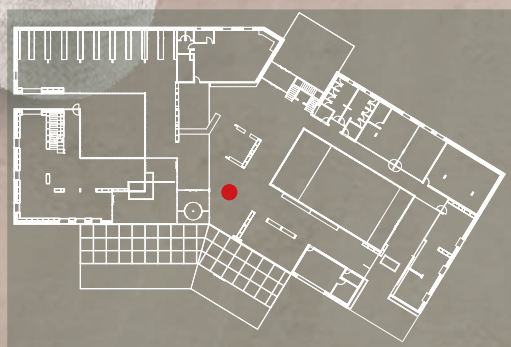




Fig. 74: Orangery





Presentation

Presentation

Fig. 75: Self service and lounge area





Fig. 76: Kids and reading area

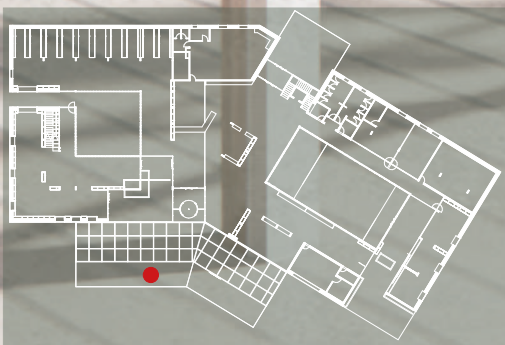




Fig. 77: Outdoor area with pergola





Construction Detail

Wall construction with window (top view)
1:5

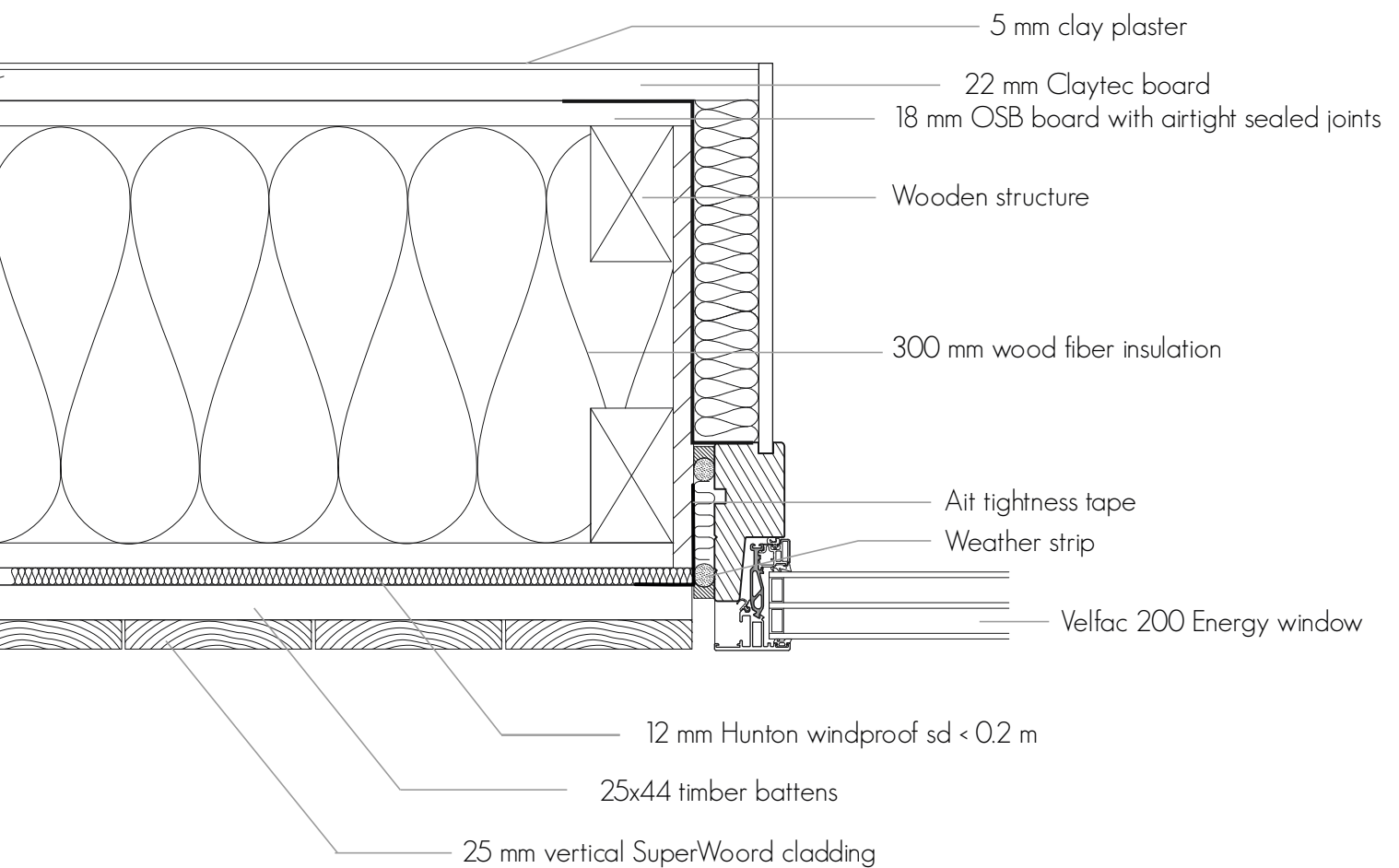


Fig. 79: Construction detail, wall with window

Section detail with window 1:20

1. 12 mm asphalt roofing
2. 18 mm OSB board
3. 450 mm wood fiber insulation
4. Wood joist
5. 5 mm clay
6. 22 mm claytec board
7. Air gab (installation)
8. 22 mm wood fiber board
9. Shelf beneath window sill
10. 25 mm parket flooring
11. 150 mm wood joist with polystyrene
12. 300 mm polystyrene
13. 200 mm stone
14. 18 mm footing cladding
15. 300 mm lecattherm block

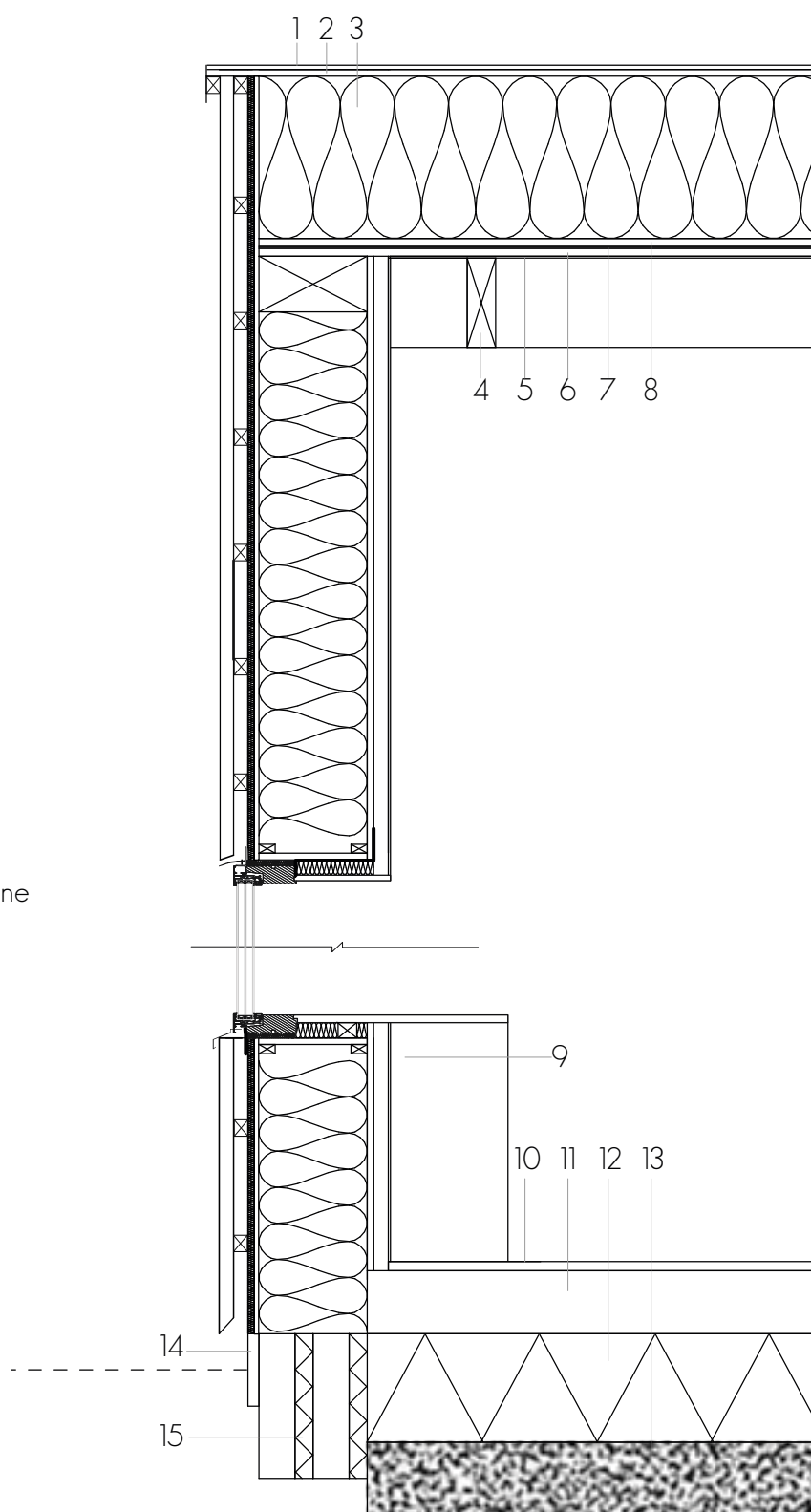


Fig. 80: Construction detail, wall, roof, and deck

Materials

The materials in the library are of great importance for the experience of space and the architectural expression inside and outside the building.

Great emphasis has been placed on the structure consisting of climate-friendly materials, which give the indoor spaces a pleasant look and contribute to a good atmosphere.

Clay has been used on walls and ceilings and is a material that is very widespread and available in Denmark. In addition, the clay also contributes to a good indoor climate, in connection with air quality, and with its rough surface, also to the acoustic comfort.

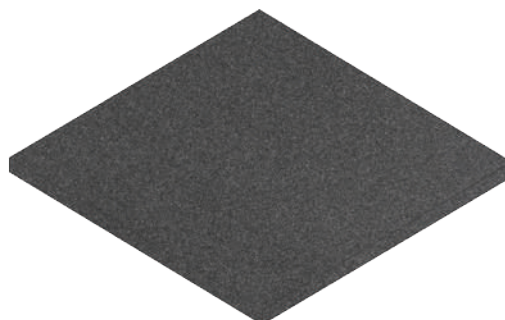
Wood has been used in many places

in the library, including flooring, construction elements, and insulation. It must support the sustainable choice within the environmental parameter, to use natural materials that store CO₂ and have a good score in an LCA evaluation. The wood also contributes warmth and makes the library more homely. However, linoleum floors have been used in the library's wet room as a better alternative to wood, as it is more resistant to moisture and rot.

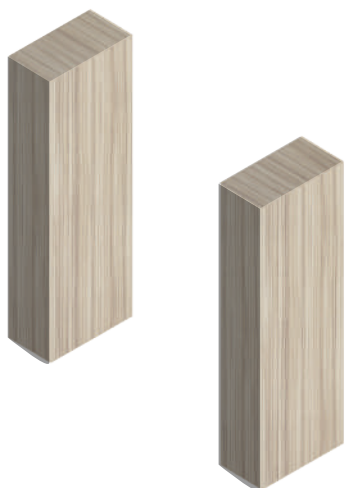
Asphalt roofs have been used on the roof, as the dark color and texture stand in good contrast to the sound wood facade cladding. Here, solar panels will also blend in well with the roof construction.



Clay plaster



Asphalt roofing



CLT construction



Parket flooring



Wood fiber insulation



Linoleum flooring

Ventilation

The mechanical ventilation is divided into four units to reduce long pipe lengths. On the first floor, the pipes are connected to two of the units on the ground floor. Since there is a varying need for ventilation, a VAV system is used, which meets the requirement in DGNB of a volume flow of min. 0.35 l/s pr. m² in each living area and the standards of 20 l/s for kitchen and 15 l/s for toilets. The pipes are hidden away under a false ceiling, where use has been made of mixed ventilation.

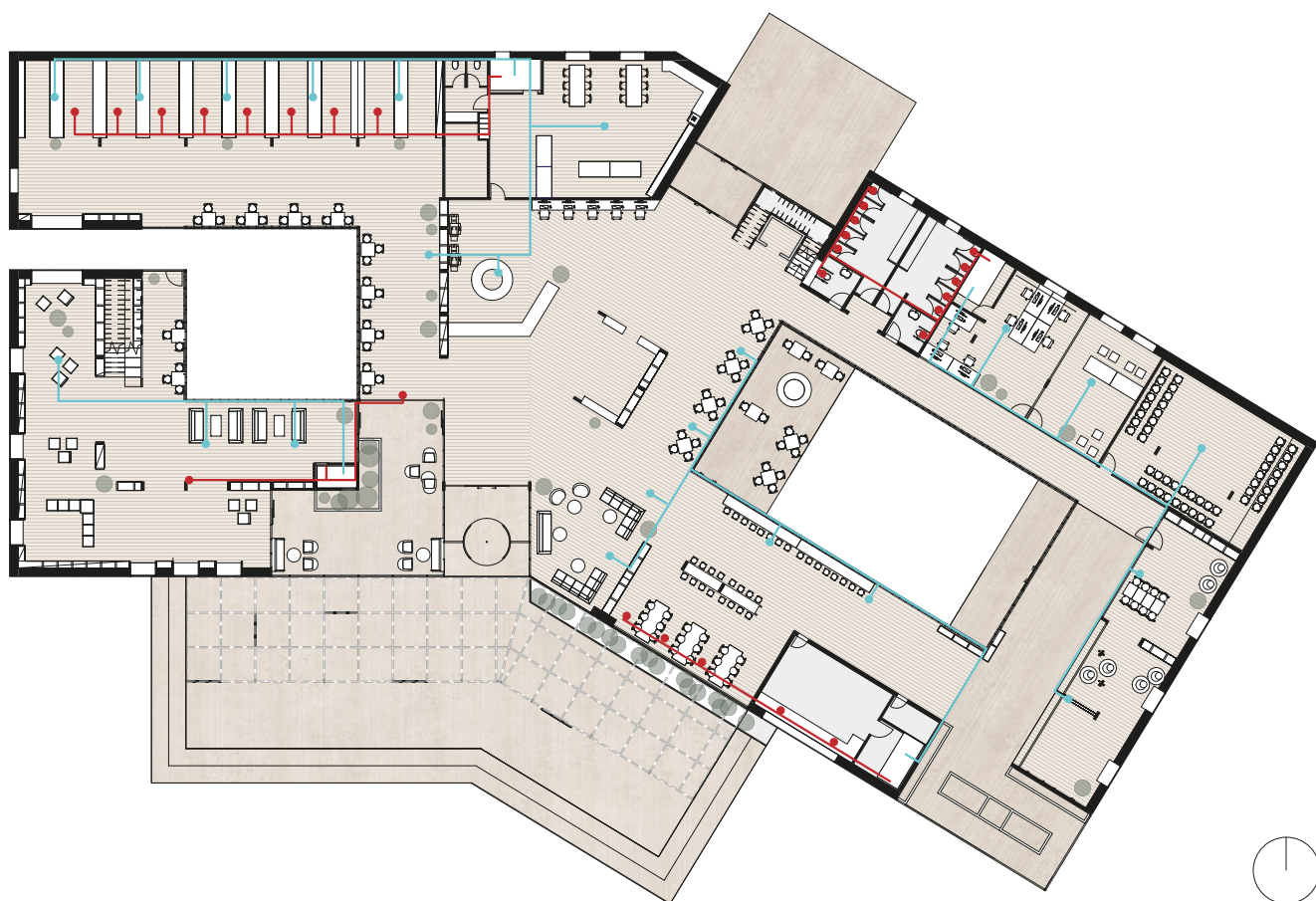


Fig. 82: Ventilation plan, ground floor

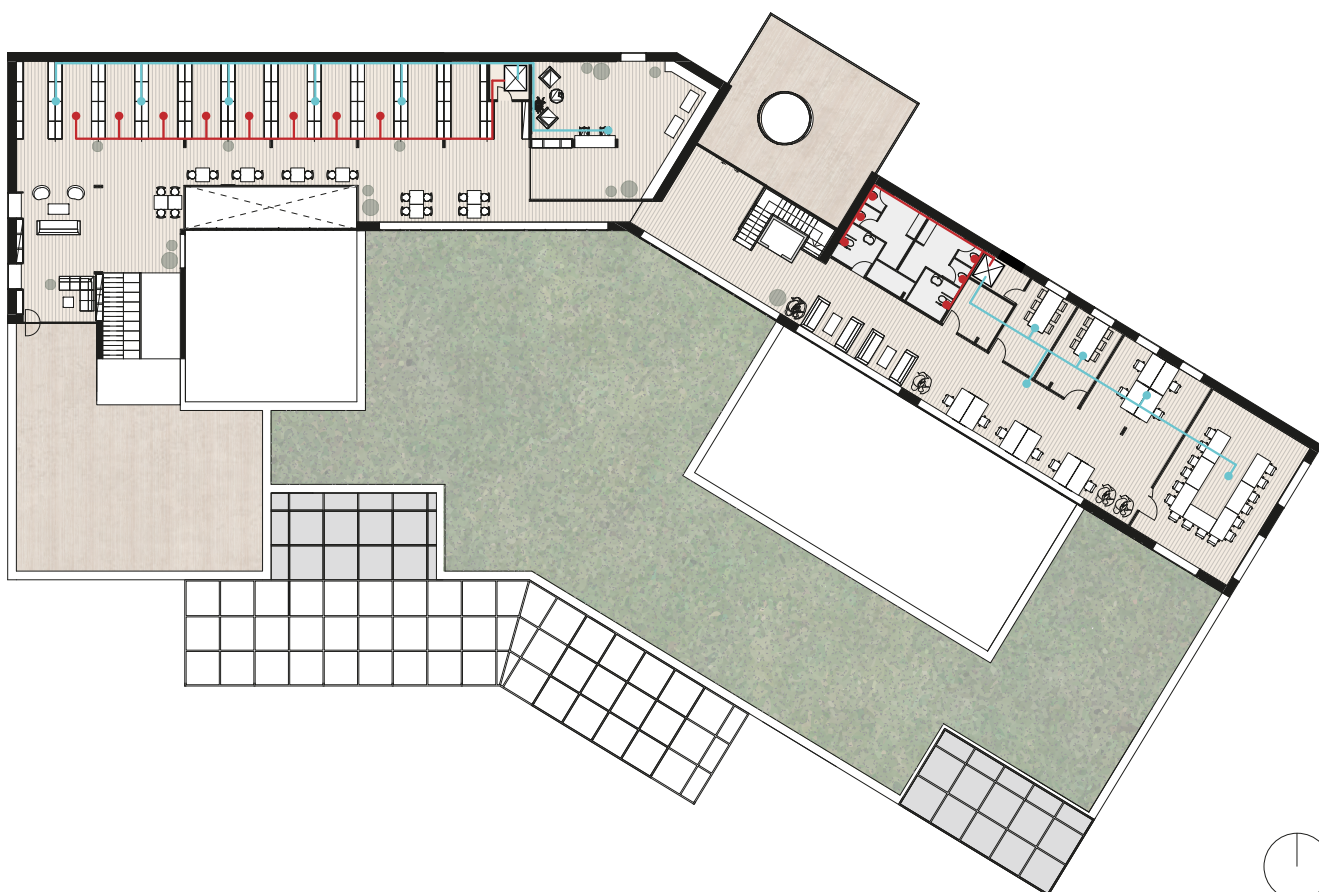


Fig. 83: Ventilation plan, 1st floor



Fig. 84: Albertslund New Library

Transmission loss	12,3 W/m ²
Ventilation loss	7,6 W/m ²
Total heat loss	20 W/m ²
Internal supply	33,7 kWh/m ² /year
services from special sources (solar cells)	4,1 kWh/m ² /year
Low Energy Frame 2020 with district heating	33 kWh/m ² /year
Total Energy requirement	31,6 kWh/m ² /year

Fig. 85: Results from Bel8

Energy Performance

Today, there is a strong focus on lowering the environmental impact of new buildings. Energy consumption must be kept to a minimum so that they do not require unnecessary energy during the period of use. It was a motivating factor that the library in Albertslund should stay during the Low Energy Class 2020 to accommodate a building that generates its energy by implementing active strategies and reducing heat supplementation

and ventilation through intelligent use of passive strategies. The building envelope has been optimized, where different materials and material thicknesses have been evaluated to achieve a low U-value. All these measures are made in parallel with evaluations of the overall expression of the library so that the architectural expression is not lost by adhering to a lot of calculations.

Conclusion

The proposal for a library in Albertslund is made to fulfill Albertslund's local plan's vision for Hyldagerkvarteret and contribute to an institution that will provide a municipality with books and other literary articles while being a meeting place to gather people in a multicultural city, irrespective of gender, age, and ethnicity. In addition, the library must create better conditions for the children's upbringing by activating them and enriching them with diverse learning. The library has been developed based on the three different sustainability parameters, where criteria have been presented, to reduce the institution's overall carbon footprint and be part of more sustainable development in the building sector. The sustainable measures have shaped the building in terms of materiality, indoor environment, and energy consumption, contributing to the library's overall expression. In the process, literature studies about tectonic thinking have been used to operate in gestures and principles. The principles aim to bring people together and create diverse learning environments, which will create an optimal framework for integration and knowledge sharing. The gestures result in different behavior

patterns organized based on the principles behind creative learning spaces, including contemplation, deliberation, and collection. In addition, it has been studied what measures are needed to activate different types of intelligences. The library thus aims to contribute a lot of indoor stimuli as a catalyst for greater social contact and improved cognitive abilities.

The library's visual and physical spatial connections have been the focal point, as great flexibility and diversity in space and spatial characters provide the best framework for dynamic learning and promote informal encounters in emergence. Therefore, most spaces are located in an extension of each other to create an open and manageable knowledge center. However, great emphasis has been placed on the library having a distinctive identity reflected in the structural system with a grid structure, transparent and load-bearing shelves, and the ceiling's waffle system. With these design initiatives, one moves away from the traditional institutional expression and supports the library as a modern building with its very own character.

Reflection

The library as an institution is recently undergoing a radical development. It is now considered in many respects, not only as an institution that aims to house literature but more as a gathering place for many different people, where you can play, debate, give lectures, etc. For this project, a question was raised of what a library should accommodate and what functions should be available. But one thing was clear to us: the importance of all actors involved in new construction must follow the course of more sustainable development. Since sustainability is depicted in three different parameters, namely economic, environmental, and social sustainability, it is a delicate balance to unite these three parameters into a higher entity. To a large extent, it is an interdisciplinary evaluation process, where measures should promote the whole spectra of sustainability and their intersections without them diminishing each other. For that reason, many iterations and evaluations need to be made to assess the overall picture of a new construction. The requirements included in a DGNB certification do not necessarily ensure that the library will be used accordingly, as we can't predict the user's behavior. However, criteria can act as catalysts for better behavior as you optimize the indoor climate and ensure that the rooms are comfortable to thrive in.

Throughout the preparation of this project,

it has been a recurring question of how to work with knowledge and how it should be implemented in the library. Knowledge must not only be linked to professional literature, as one can increase one's knowledge in many different areas, including the different intelligences. Being a human is a lifelong learning process. Reading, studying, and learning with and from other people will strengthen the community, especially in a multicultural society where diversity can act as a barrier to social union. We believe that if we become wiser about each other's differences, integration will improve and result in a good welfare society. The library is largely designed for the children in Albertslund, as children are in the development phase and can better receive external stimuli. Therefore some design initiatives have been made to make it fun and exciting for them to go to the library. Here they should have the opportunity to cultivate different areas of interest through play. Great emphasis has been placed on gestures and principles to support these design initiatives. We have studied the tectonic approach to architecture, where user behavior, the gestures, is supported by principles. The principles of this project are largely attributed to the various creative learning environments, as it has been proven that if you are in a versatile environment where you have the opportunity to both retire or participate in social gatherings,

then learning is strengthened. In this way, the library does not try to dictate the use of the various functions. Still, the user can choose his or her forum in the hope that this can create a dynamic environment and promote informal meetings. In addition, it has also been important for us to point out that architecture in a building shouldn't only be regarded as being randomly composed materials but that materials by systematic composition can have several functions. A pillar is not just a pillar but can be utilized as a space-creating element, can be dimensioned as a shelf for books or a wall bar for playful children.

The project spans a very wide range, and there have been many good goals and visions for the library, but precisely this scale and type of building has made it difficult for us to get it all involved. Perhaps we wanted to do more than what our knowledge and resources could provide, which has resulted in us not being so detail-oriented and where several initiatives have been presented on a more conceptual level. There was also a desire to simulate more of the library's zones and thus develop a more thorough validation of comfort and the indoor climate. In contrast, only a few rooms have been pointed out in our project to present the principles behind comfort measures, including reverberation time, daylight factor, and ventilation.

As the focus has largely been set on social

sustainability, it has been unclear how the sustainable parameters influence each other. The active and passive strategies have been secondary solutions, where we had a desire for it to be clearer in our design, and there should be a deeper meaning in implementing them. It would have benefited us design-wise if we had made more iterations and made more evaluation tables to support the iterative process. But we also recognized the importance of presenting preparatory texts and studies in the process phase to clarify our concept. We have been very fixated on the architectural grip of a modular grid system, which resulted in us not being so exploratory on alternative layouts and expressions. However, this is not necessarily seen as a disadvantage. We found it important to create an exciting design that matched our style and preferences and ensured that we had enough time to fulfill a whole design layout. With the proposal for Albertslund New Youth Library, we believe that it can contribute to greater social cohesion and integration among the inhabitants in Albertslund Municipality and activate children through play and social/individual development. The project proposal also aims to shed light on the importance of considering sustainable initiatives before and during the design process to meet the worldwide agenda on sustainability.

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Annex 01

Brainstorm

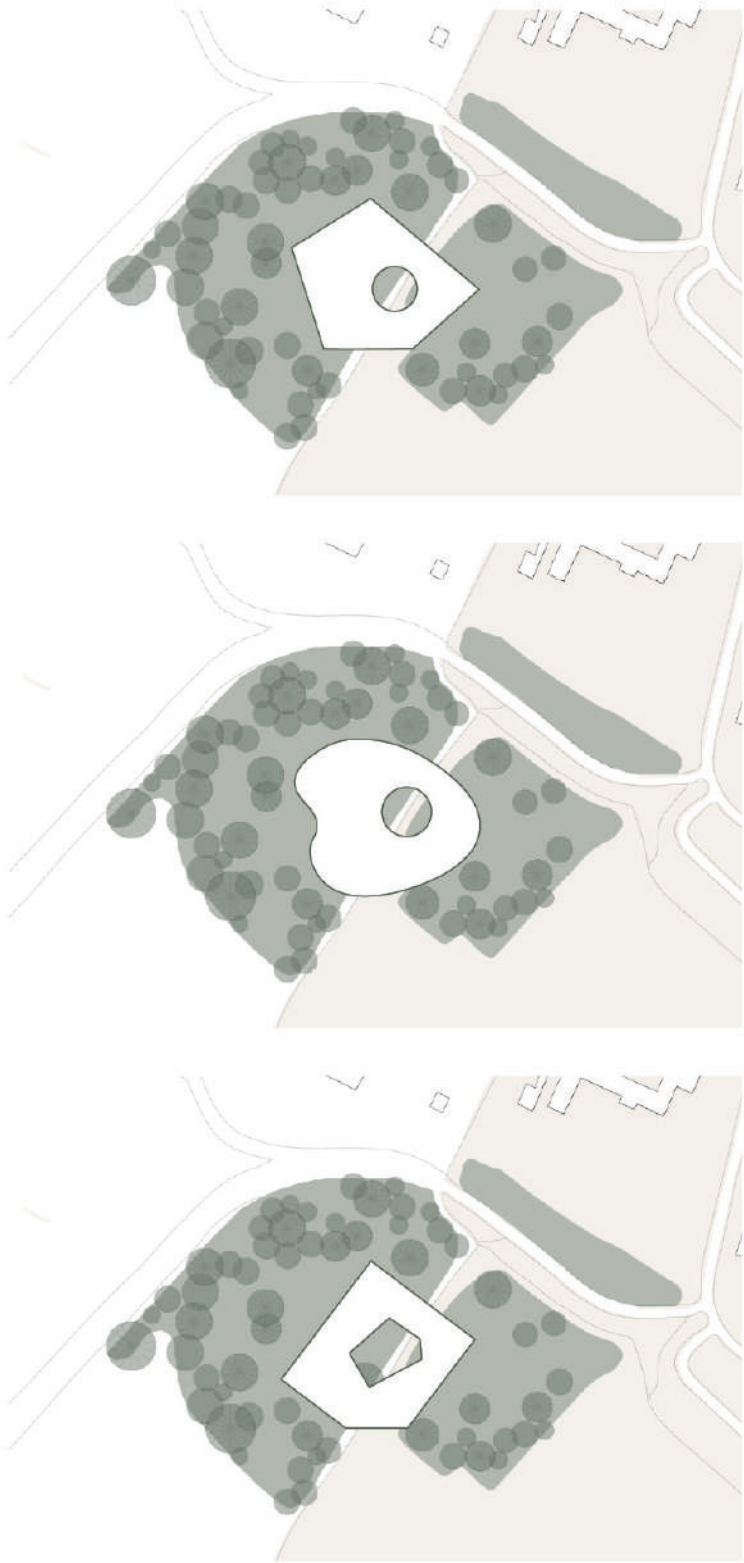
After the analysis phase, a collage was prepared as a kind of brainstorm before the process. The collage consists of different images with encircling words that describe different moods, expressions, or functions. The library's design has thus been based on the collage and the acquired knowledge from various literature studies.

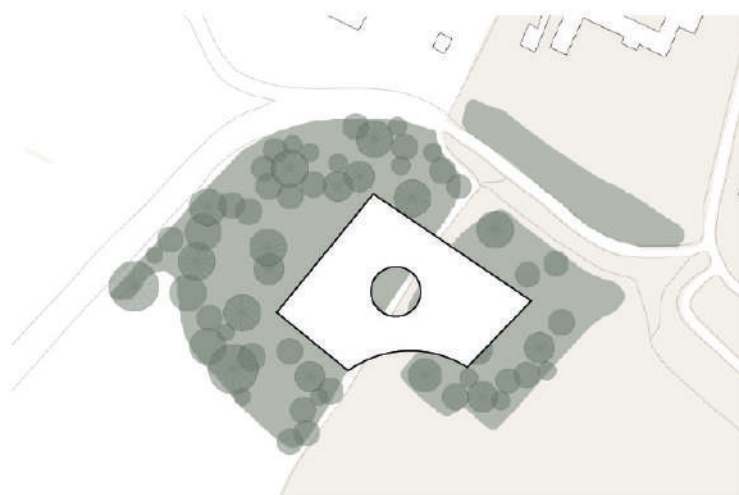
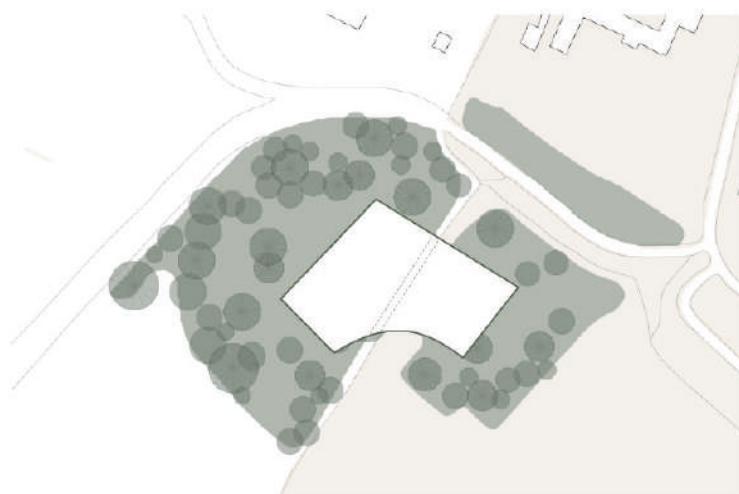




Annex 02

Studies on Conceptial Plan layout





Annex 03

Reverberation Time

Reading room (1st floor)

Room dimensions:

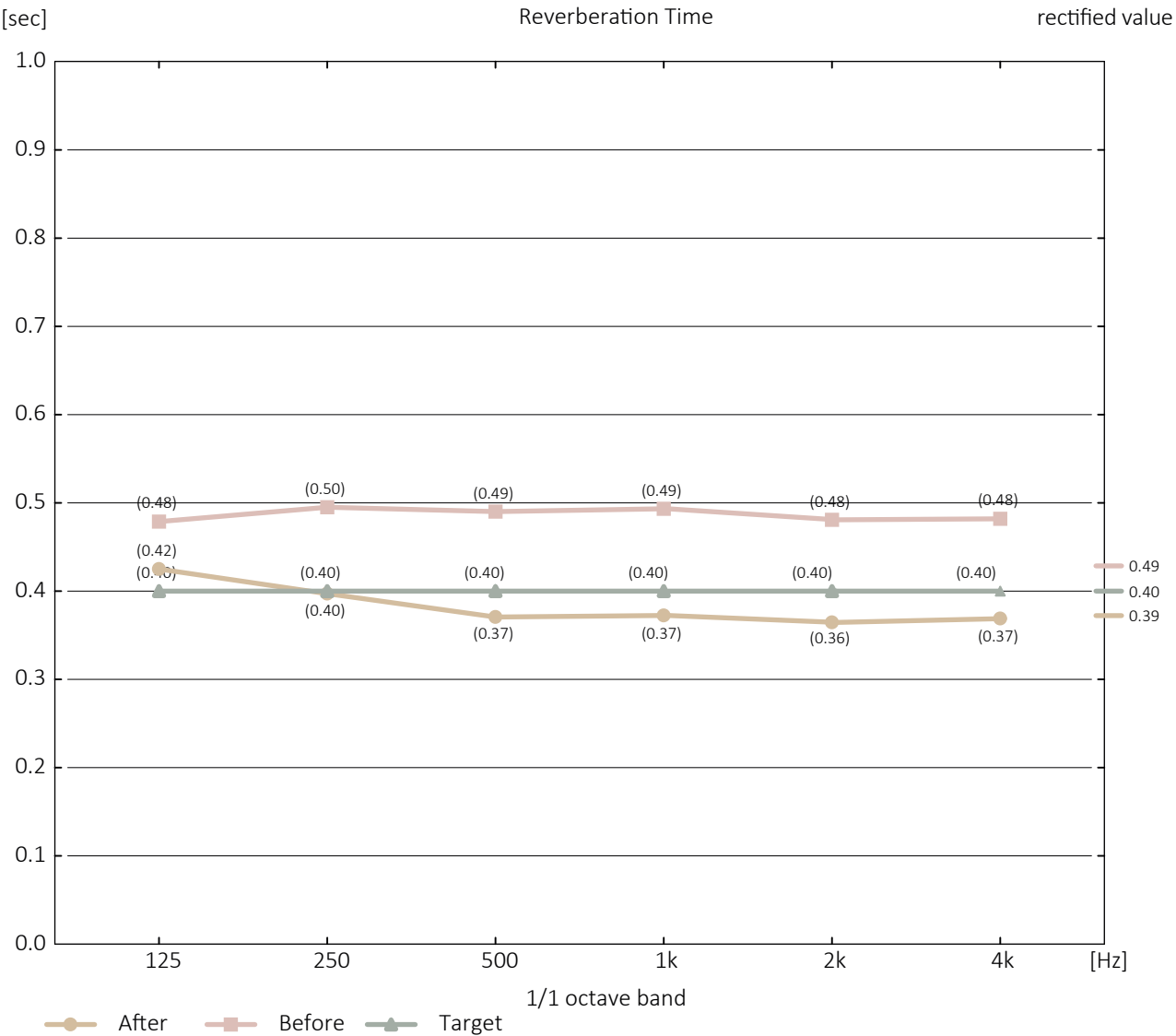
Height: 3,7 m
Length: 8 m
Width: 9,25 m

Surface dimensions:

Ceiling: 74 m²
Wall: 121,87 m²
Floor: 74 m²
Window: 2 m²
Door: 3,78 m²

Room materials	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ceiling: Waffle-systen	0,24	0,19	0,14	0,08	0,13	0,1
Wall: Clay, rough surface	0,02	0,02	0,03	0,04	0,05	0,06
Door: Wooden door, light	0,2	0,15	0,10	0,08	0,09	0,10
Windows: Double-glazed windows	0,1	0,07	0,05	0,05	0,02	0,02
Floor: Wooden floor on joists	0,15	0,11	0,10	0,07	0,06	0,04
Chair	0,45	0,46	0,47	0,48	0,5	0,45
Acoustic panels	0,15	0,65	1	1	1	1

*Chairs 20 pcs.
*Acoustic panels, total surface = 20 m²



Annex 04

U-value calculations

Wall

Building element	Material thickness	Thermal conductivity	Thermal resistance
	[m]	[W/m°C]	[m ² °C/W]
Indoor thermal resistance			0,1300
Clay plaster	0,005	0,8	0,0063
Claytec board	0,022	0,13	0,1692
OSB board	0,018	0,13	0,1385
Wood fiber insulation	0,3	0,04	7,5000
OSB board	0,018	0,13	0,1385
Hunton wind barrier	0,012	0,049	0,2449
Air gap	0,044	0	0
Superwood cladding	0,025	0,192	0,1302
Outdoor thermal resistance			0,0400
Total	0,624		8,5206

$$U = 0,1177 \text{ W/m}^2\text{°C}$$

Deck

Building element	Material thickness	Thermal conductivity	Thermal resistance
	[m]	[W/m°C]	[m ² °C/W]
Indoor thermal resistance			0,1700
Wood flooring	0,025	0,12	0,2083
Polystyren	0,15	0,04	3,7500
Polystyren	0,3	0,04	7,5000
Stone	0,2	1,6	0,1250
Outdoor thermal resistance			0,0400
Total	0,624		8,5206

$$U = 0,0848 \text{ W/m}^2\text{°C}$$

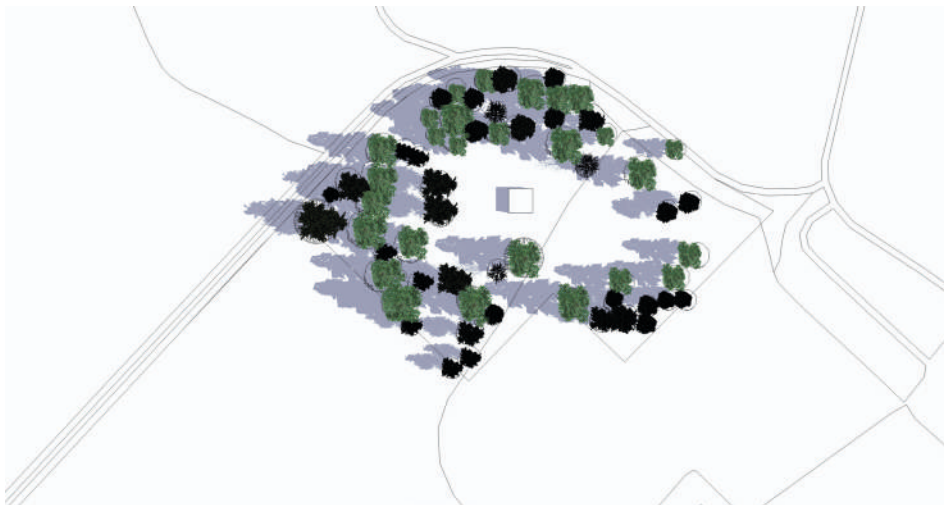
Roof

Building element	Material thickness	Thermal conductivity	Thermal resistance
	[m]	[W/m°C]	[m ² °C/W]
Indoor thermal resistance			0,1000
Clay plaster	0,005	0,8	0,0063
Claytec board	0,022	0,13	0,1923
Air gap (installation)	0,05	0	0
Wood fiber board	0,022	0,04	0,5500
Wood fiber insulation	0,45	0,04	11,2500
OSB board	0,018	0,13	0,1385
Asphalt roofing	0,012	0,7	0,1386
Air gap	0,044	0	0
Superwood cladding	0,025	0,192	0,0171
Outdoor thermal resistance			0,0400
Total	0,624		8,5206

$$U = 0,0815 \text{ W/m}^2\text{°C}$$

Annex 05

Shadow Analysis on Site



21 June, 8:00 am



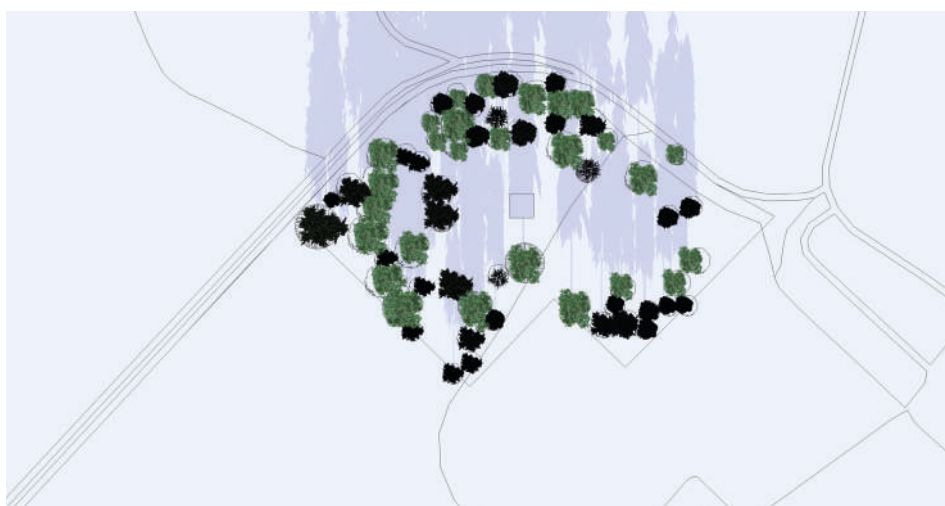
21 June, 12:00 pm



21 June, 16:00 pm



21 December, 8:00 am



21 December, 12:00 pm

Annex 06

Case Study, Garaget

Case Study, Garaget - a meeting point in Malmö

Location: Malmö, Sweden

Size: 500 m²

Built: Inaugurated in 2008

No. of employees: Staff of 7

Annual visit: from 16.872 in 2008 to 68.457 in 2011

To understand the internal functions of a library with the same vision of promoting social sustainability and cultural exchange in an area with sociocultural differences, Garaget in Malmö, Sweden, has been chosen as a source of evaluation. The Garaget library appears as an extension of Malmö City's overall strategy for "Diversity, Meetings, and Opportunities." They were inaugurated in 2008 and are located in an old industrial hall, where there has been a significant focus on user involvement. It has formed the framework for the library - or as an extra living space, as they like to call it. It is characterized as a "district library," as it is located in the division

between three districts outside Malmö's center, in a social and ethnic border country. The unique thing about this particular library is the user involvement, where it is the users and not the staff who make their mark on the character of the interior spaces. The decor is based on flexibility and the development of "room-in-a-room," where a homely atmosphere has been sought through many recycled furniture, lots of floral wallpaper, and plants, which give the impression of a living room. With recycled furniture and flea, these interior design initiatives also signal ecological sustainability, which is an important theme for the place. The activities are shaped after a continuous dialogue and media involvement process with the visitors. When in 2012, they chose to furnish three large rooms with large glass sections, resp. a quiet reading room, a PC room, and a meeting room, and

also made room for shared space functions, the number of visitors increased by 50% (Schaumburg, n.d.). In addition to these rooms, there is also a creative workshop, library, café, stage, and dialogue lab. (Garaget i Malmö - Modelprogram for folkebiblioteker, 2017).

The creative workshop

Here children and adults can sew, knit, draw, and more. It is also possible to move out to the kitchen region, where you can cook and bake.

The library

Here you can borrow, order material, and seek out new knowledge. You can also borrow PCs and iPads. At the library's opening, the shelves were almost empty, after which all purchases of material were made based on the users' needs and wishes. The library's selection of books is still relatively small today,



Picture 2: Garaget - a meeting point in Malmö

so the room with shelves looks more like a private book collection than a systematic library

The café

Here you can buy homemade organic cakes and baby food. Guests have the opportunity to settle down and read newspapers.

The stage

This function forms the framework for the many activities that take place at all times of the day. Users come up with ideas and a workforce, where Garaget provides premises, tips, and advice for marketing.

Dialoglab

This is a knowledge center for dialogue techniques and citizen discussions and is explicitly aimed at officials in the municipality who want to develop their competencies in this area.

Conclusion

Based on this case study, knowledge has been acquired about possible functions in a library that can help to promote social sustainability in a society where there are also integration difficulties. As the place today appears as an attractive meeting place for people of all ages and with mixed cultural backgrounds, it is worth noting what measures the municipality has taken to give the place character and promote the number of visitors - namely by user involvement. It has its relevance to the project in that we can "adopt" some of their initiatives and include some of the same spaces in Garaget, and find inspiration in the homelike atmosphere and so-called "living space."

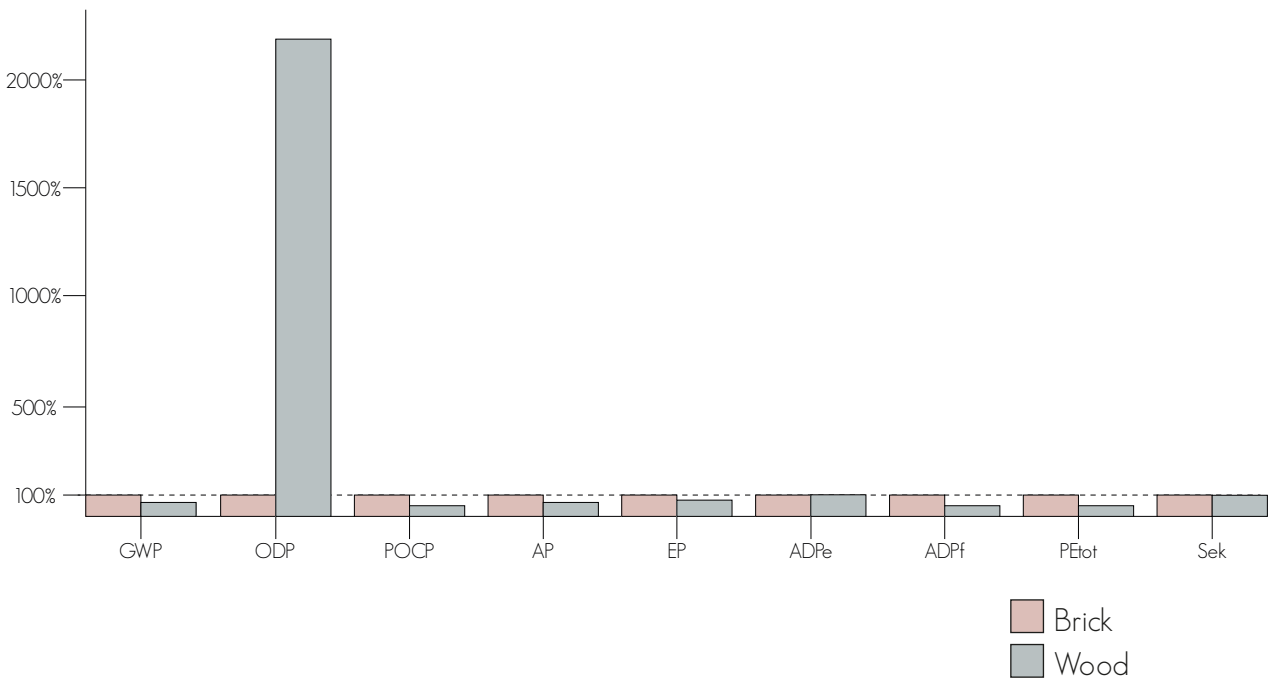
Annex 07

LCA Construction Compositions

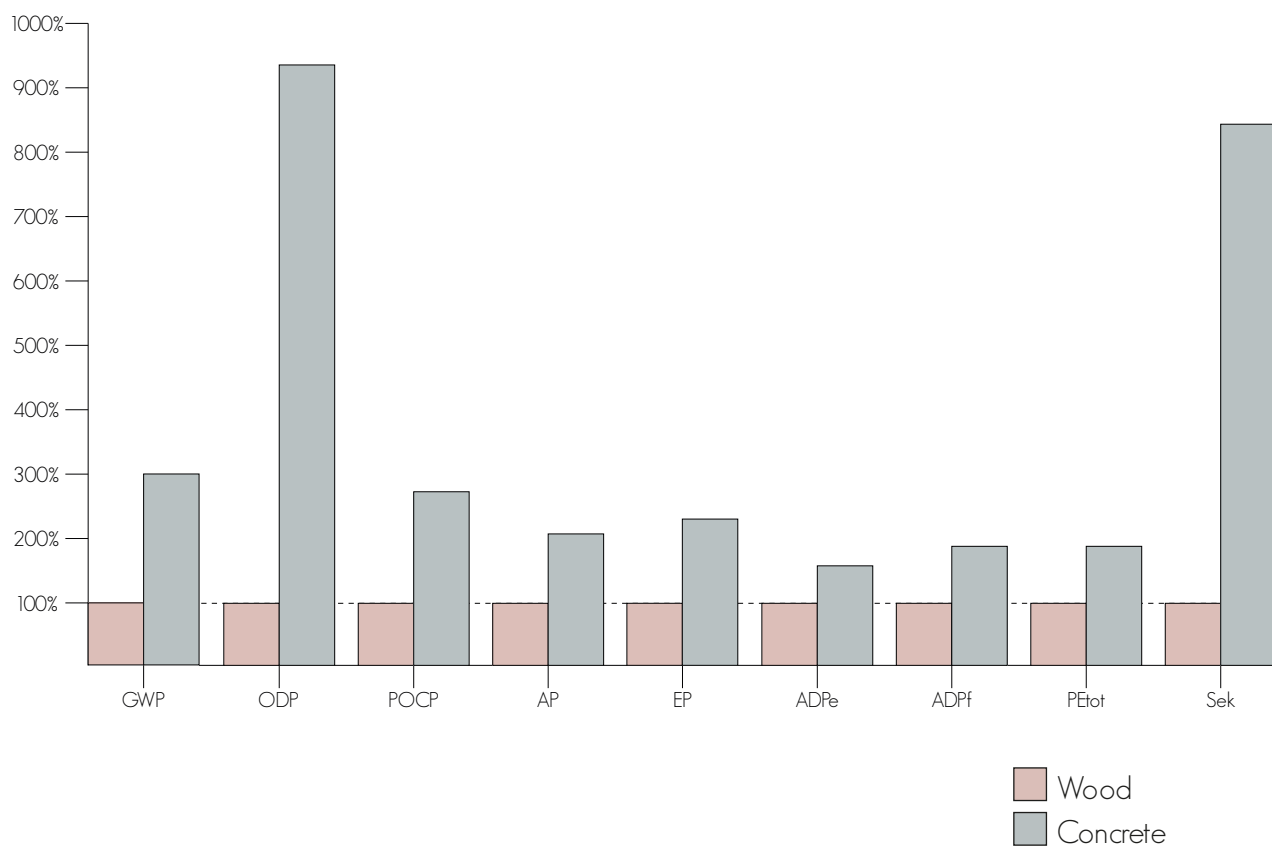
Outer wall

Brick wall	120 kg CO ₂ pr. m ²	Evaluation Generally the wooden exterior wall performs better in the parameters than with the brick and concrete exterior wall. This lays the foundation for the choice of a facade primarily consisting of wood.
110 mm bricks 250 mm mineral wool 100 mm aerated concrete		
Concrete wall	190 kg CO ₂ pr. m ²	
70 mm concrete cladding 250 mm mineral wool 100 mm aerated concrete		
Wood wall	76 kg CO ₂ pr. m ²	
25 mm ThermoWood 25 mm ventilated cavity 10 mm wind barrier 250 mm timber subframe 250 mm mineral wool 100 mm aerated concrete		

Brick vs wood outer wall



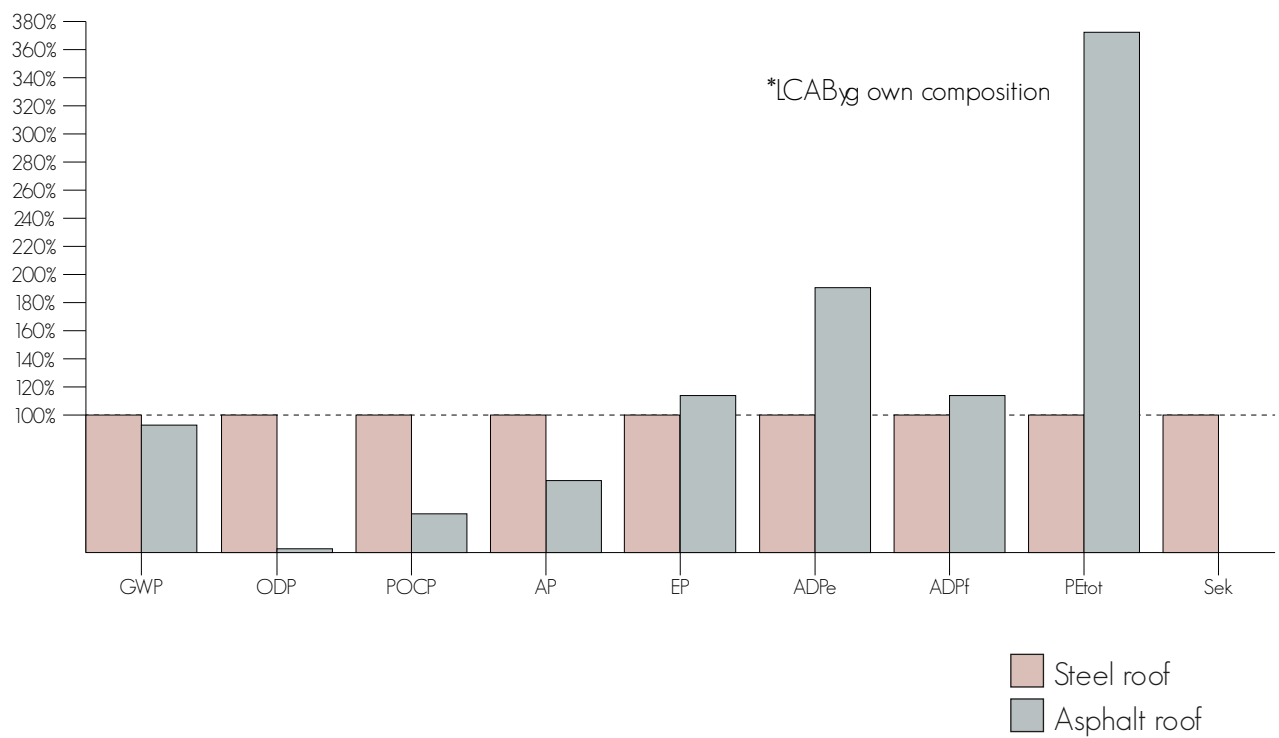
Wood vs concrete outer wall



Roof

Asphalt roof	16 kg CO ₂ pr. m ²	Evaluation The asphalt roof generally performs better than the steel roof. This supports the choice to use asphalt roofing in the construction.
12 layer of Asphalt roofing 18 mm cross laminated timber		
Steel roof	18 kg CO ₂ pr. m ²	
Steel roofing sheet Roof battens Board lathing Roof foil		

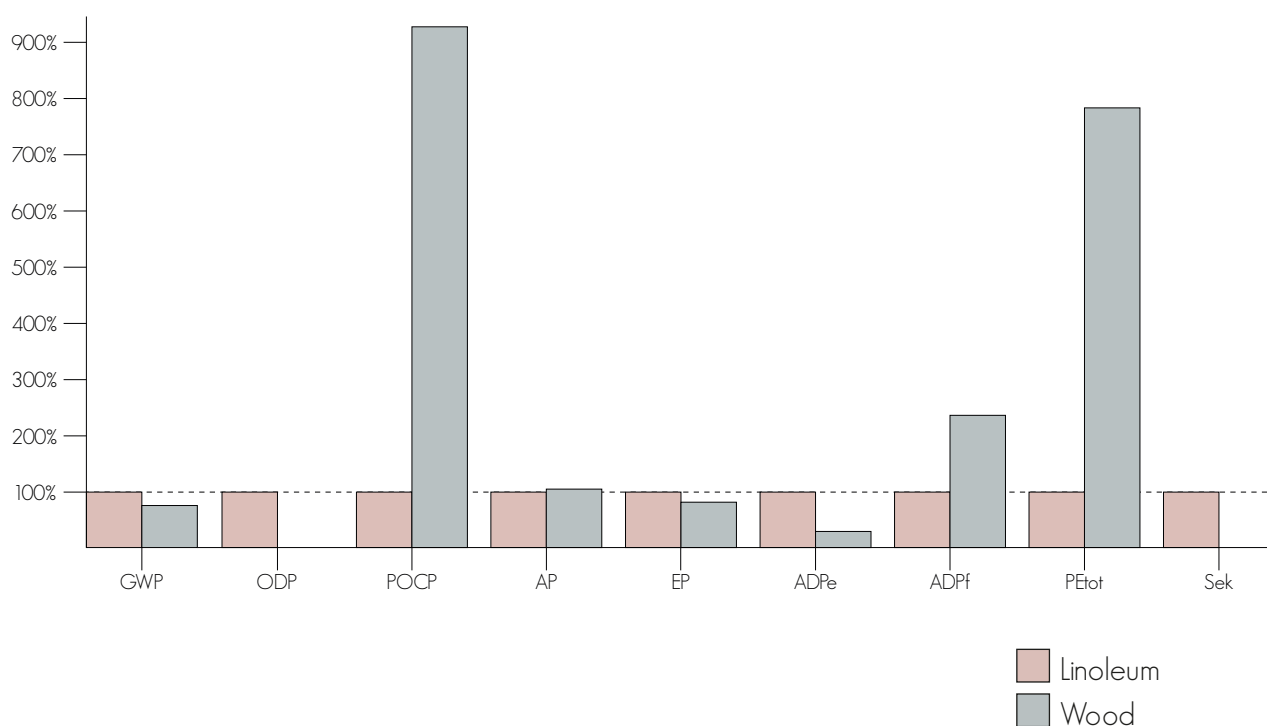
Asphalt vs steel roof



Floor

Linoleum floor	8 kg CO ₂ pr. m ²	Evaluation The wood flooring performs better generally but is high in POCP, which could lead to a further investigation of different types of wood flooring.
*LCAByg own composition		
Wood floor	6 kg CO ₂ pr. m ²	
*LCAByg own composition		

Linoleum vs wood floor



Annex 08

Full Room Program

	People	Area m ²	rooms n	Room total area m ²	Height m	Volume m ³	Operative temp. summer/winter (°C)	Clothing level summer/winter (clo)	Activity level met	olf*person
Social Exploration										
Meeting room 1	5	14	4	56	3,8	53	<24,5 / 22-25	0,5 / 1	1,4	5
Meeting room 2	5	13	1	13	3,8	800	<24,5 / 22-25	0,5 / 1	1,4	5
Workshop/multi-purpose	15	64	1	64	3,8	243	<24,5 / 22-25	0,5 / 1	1,4	15
Work stations	15	69	1	69	3,8	262	<24,5 / 22-25	0,5 / 1	1,4	15
Lounge area 1	10	51	1	51	3,8	194	<24,5 / 22-25	0,5 / 1	1,4	10
Lounge area 2	10	48	1	48	3,8	182	<24,5 / 22-25	0,5 / 1	1,4	10
Activity area 1	5	49	1	49	3,8	186	<24,5 / 22-25	0,5 / 1	1,4	5
Activity area 2	10	80	1	80	3,8	304	<24,5 / 22-25	0,5 / 1	1,4	10
Sitting/reading area	10	49	1	49	3,8	186	<24,5 / 22-25	0,5 / 1	1,4	10
Black box/ music	10	69	1	69	3,8	262	<24,5 / 22-25	0,5 / 1	1,4	10
Green house 1	10	138	1	138	3,8	524	<24,5 / 22-25	0,5 / 1	1,4	10
Cafeteria	20	150	1	150	3,8	570	<24,5 / 22-25	0,5 / 1	1,4	20
Kids area	20	119	1	119	3,8	452	<24,5 / 22-25	0,5 / 1	1,4	20
Knowledge search										
Shelving area (1st floor)	30	239	1	239	3,8	908	<24,5 / 22-25	0,5 / 1	1,4	30
Newspaper reading area	10	47	1	47	3,8	179	<24,5 / 22-25	0,5 / 1	1,4	10
Shelving area (ground floor)	30	241	1	241	3,8	916	<24,5 / 22-25	0,5 / 1	1,4	30
Shelving + reading	20	72	1	72	3,8	274	<24,5 / 22-25	0,5 / 1	1,4	20
Individual Exploration										
Reading area	20	74	1	74	3,8	281	<24,5 / 22-25	0,5 / 1	1,4	20
Creative box	5	40	1	40	3,8	152	<24,5 / 22-25	0,5 / 1	1,4	5
Orangery	10	76	1	76	3,8	289	<24,5 / 22-25	0,5 / 1	1,4	10
Self service area	5	23	1	23	2,5	58	<24,5 / 22-25	0,5 / 1	1,4	5
Computer space	15	46	1	46	2,5	115	<24,5 / 22-25	0,5 / 1	1,4	15
Staff										
Reception	5	105	1	30	2,5	263	<24,5 / 22-25	0,5 / 1	1,4	5
Staff area	10	115	1	115	3,8	437	<24,5 / 22-25	0,5 / 1	1,4	10
Other										
Waiting area	5	35	1	35	3,8	133	<24,5 / 22-25	0,5 / 1	1,4	5
Entrance	5	26	1	26	3,8	99	<24,5 / 22-25	0,5 / 1	1,4	5
Circulation island	5	56	1	56	3,8	213	<24,5 / 22-25	0,5 / 1	1,4	5
Circulation island	5	123	1	123	3,8	467	<24,5 / 22-25	0,5 / 1	1,4	5
kitchen	3	31	1	31	3,8	118	<24,5 / 22-25	0,5 / 1	1,4	3
Toilet	5	13	2	26	2,5	33	<24,5 / 22-25	0,5 / 1	1,4	5
				2255						

olf (building)	Persons	CO ₂ -production m ³ /h	Air flow rate, CO ₂ m ³ /h	Air change h ⁻¹	Pollution load olf	Air flow rate, sensory m ³ /h	Air change h ⁻¹	Air flow rate l/s	m ³ /h
5	1,4	0,1	158,7	3,0	6,4	153,6	2,9	4,9	17,6
5	1,3	0,1	158,7	0,2	6,3	151,2	0,2	4,6	16,4
5	6,4	0,4	476,0	2,0	21,4	513,6	2,1	22,4	80,6
5	6,9	0,4	476,0	1,8	21,9	525,6	2,0	24,2	86,9
0	5,1	0,2	317,3	1,6	15,1	362,4	1,9	17,9	64,3
0	4,8	0,2	317,3	1,7	14,8	355,2	1,9	16,8	60,5
5	4,9	0,1	158,7	0,9	9,9	237,6	1,3	17,2	61,7
0	8,0	0,2	317,3	1,0	18,0	432,0	1,4	28,0	100,8
0	4,9	0,2	317,3	1,7	14,9	357,6	1,9	17,2	61,7
0	6,9	0,2	317,3	1,2	16,9	405,6	1,5	24,2	86,9
0	13,8	0,2	317,3	0,6	23,8	571,2	1,1	48,3	173,9
0	15,0	0,5	634,7	1,1	35,0	840,0	1,5	52,5	189,0
0	11,9	0,5	634,7	1,4	31,9	765,6	1,7	41,7	149,9
0	23,9	0,7	952,0	1,0	53,9	1293,6	1,4	83,7	301,1
0	4,7	0,2	317,3	1,8	14,7	352,8	2,0	16,5	59,2
0	24,1	0,7	952,0	1,0	54,1	1298,4	1,4	84,4	303,7
0	7,2	0,5	634,7	2,3	27,2	652,8	2,4	25,2	90,7
0	7,4	0,5	634,7	2,3	27,4	657,6	2,3	25,9	93,2
5	4,0	0,1	158,7	1,0	9,0	216,0	1,4	14,0	50,4
0	7,6	0,2	317,3	1,1	17,6	422,4	1,5	26,6	95,8
5	2,3	0,1	158,7	2,8	7,3	175,2	3,0	8,1	29,0
5	4,6	0,4	476,0	4,1	19,6	470,4	4,1	16,1	58,0
5	10,5	0,1	158,7	0,6	15,5	372,0	1,4	36,8	132,3
0	11,5	0,2	317,3	0,7	21,5	516,0	1,2	40,3	144,9
5	3,5	0,1	158,7	1,2	8,5	204,0	1,5	12,3	44,1
5	2,6	0,1	158,7	1,6	7,6	182,4	1,8	9,1	32,8
5	5,6	0,1	158,7	0,7	10,6	254,4	1,2	19,6	70,6
5	12,3	0,1	158,7	0,3	17,3	415,2	0,9	43,1	155,0
8	3,1	0,1	95,2	0,8	6,1	146,4	1,2	10,9	39,1
5	1,3	0,1	158,7	4,9	6,3	151,2	4,7	4,6	16,4

Annex 09

Microclimate Study on Rain

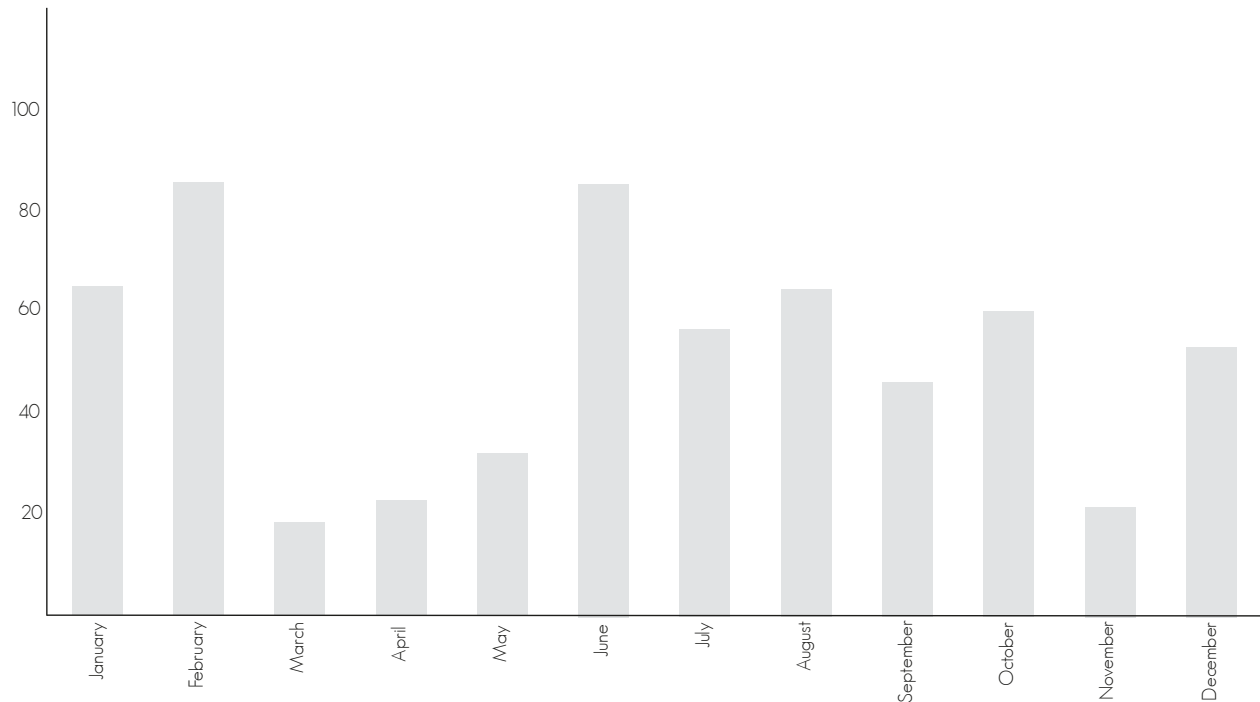


Fig. 16: monthly average rain for the year 2020 (Based on: DMI; 2020)

Rain

Fig. 16 shows the average rainfall in Albertslund throughout the year 2020. It is evident that February and July have a maximum amount of rain 86mm and 82mm respectively. due to raised temperature weather patterns are changing. According to The Ministry of Environment and food. Denmark, the amount of precipitation in winter will fall as rain due to high temperature and summers will have rain in the form of heavy showers.

However, this presents us the possibility to provide a rainwater harvesting system as well as due to minimal snowfall, it is possible to provide a flat roof. This also helps us identify the need for outdoor sheltered spaces.