Architecture and sustainability

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Supervisor: Associate Professor Mary-Ann Knudstrup
Technical Supervisor: Assistant Professor Tine Steen Larsen

By Mads Dines Petersen

Abstract

Present thesis is investigating how architects are affected by the ongoing discussion about sustainability in general, and investigates how they relate to the different approaches defined within the field of sustainable architectures. This will be elaborated through interviews with practicing architects.

Furthermore the aim is to study how architecture relates to the discussion in a more general way, where architectures relation to the world in which it is based is studied in order to find a more general relation between architecture and sustainability

These studies provides the basis for the design of an extension for Skive New Art Museum.

Summary

Present thesis is dealing with the discussion about architecture and sustainability.

Its starting point is the common discussion about sustainability seen in relation to the current climate changes, and through that a study of the common approaches within sustainable architecture is made.

Through interviews, it has been established that architects are very aware of the discussion, and they try to use it actively in the design process. Furthermore their work with it, is used as a branding of the office. It is seen that even though they brand themselves as being sustainable they are unaware of which direction they take within sustainable architecture, and the methods they use in the process differs from office to office dependent of the size of the office.

Following the study of the different approaches is a study a more general connection between the discussion about sustainability and architecture. Here it is found that the nature of architecture is to represent a common ideal image for the world in which it is based, linking the present concerns about being sustainable with architecture.

These studies ends out in a design proposal for an extension for Skive New Art Museum, where the approaches discussed earlier are used in the design phase.

Through the design phase it is seen that working with the different parameters used by the different approaches to sustainable architecture a positive effect can be achieved, but it is also seen that it requires an awareness of how it is used, and a concept to guide the use of the tools.

Contents

Preface

This report is the result of the study for my master thesis. It has evolved from a polemical thought about sustainability's position in architecture and an interest for the discussion about sustainability, to a combination of a brief study of the common discussion, mainly in the media as well as in books presenting the scientific research for common people, and a specific study of sustainable architecture. The report consists of three parts. The first part about the theoretical studies of sustainability. The second part being the design proposal for a new art museum in Skive and finally the appendixes consisting of all technical data used in the research phase as well as the design phase.

The theoretical part consists of four chapters evolving from the study of the omnipresent discussion about climate changes and sustainability, through a study of the approaches to sustainability in architecture and how architects work with it today and ending up in a study of how ethics affects architecture

In connection with the theoretical part of the project I owe a great thanks to the architects who has been willing to participate in the process through interviews, where they have shared their view on sustainable issues in architecture with me.

The design part is focused on the design of an extension for Skive museum. This part consists of five chapters evolving from the architectural and environmental brief, over site analysis, spatial demands, design development to a perspectivation over the design.

Following the design part is the appendixes where the interview guides used in the theoretical studies can be seen as well as the different technical considerations which have been used in the design process.

The technical appendixes consists of one dealing with ventilation in relation to the demands for comfort (appendix B), one concerning structural considerations in relation to u-values (appendix C) and finally one concerning building simulations (appendix D)

Through out the report the term sustainable architecture has been used. This word is actually one of the approaches discussed in chapter two, but if nothing else is mentioned it is used as a term describing all the different approaches in architecture which are aiming towards a more sustainable, green, ecological approach or what else people like to call them.

The Harvard system is used for references and notes, and images and figures are all numbered. In the figure list all figures and images which has not been drawn or taken by me are listed with source of the materials.

Introduction

During the last couple of decades there has been a big debate in public and political circles about climate changes. Already in the beginning of the industrial revolution in the nineteenth century it was predicted that the massive amount of coal burned would cause environmental problems later on. This discussion has then surfaced in the public for shorter periods of time, until the sixties where tests showed that the predictions were right. Since then the discussion has been more permanent and the debate has grown bigger in regards of the effect of the rising CO_2 levels, and how it will affect our climate. Today one can without any doubt call it an omnipresent debate [McKibben, 1991].

The debate about what causes the climate changes has led to different discussions about sustainability in architecture during the last sixty years, starting with Buckminster Fullers suggestions for self-sustained housing (figure 0.0.1) in the late forties over Paolo Soleris ecological cities (figure 0.0.2) in the seventies to many different approaches after that. Especially during the oil crises in the beginning of the seventies sustainable housing became a focus area. Rising oil prices forced architects to think different, and energy efficiency started to be a point of focus for some architects, which gave rise to a growing ecological and green movement [Steele, 2005]. Furthermore the oil crises led to a change in the building regulations by the end of the seventies, where some countries started to change these regulations. Instead of only structural codes. Codes concerning energy efficiency and indoor climate became a part of it [OECD, 2003]. Today there is still a significant amount of different approaches to

Figure 0.0.1

Figure 0.0.2

Figure 0.0.3

sustainability within architecture, which makes a discussion about it difficult. Sustainability can be about economical, environmental and cultural sustainability, which makes a clear definition crucial for the understanding.

During the last twenty years the focus on the debate about climate changes, and what causes them, has made everybody more aware of our impact on nature [Gore, 2006]. Leading architects like Sir Norman Foster (figure 0.0.3) and Richard Rogers (figure 0.0.4) have been working with sustainable architecture in a high tech approach in their search of solutions to the CO_2 emissions from the building industry. Others like Glen Murcutt (figure 0.0.5)and Peter Stutchbury (figure 0.0.6) have taken a more natural approach to the work, where recyclable materials and passive principles have been important factors. No matter which approach is used it is a sign of a concern for the environment among architects.

The part of departure for this thesis is this ongoing discussion, where the focus is on how we as humans can minimize our current impact on nature. With this as a starting point the study will evolve into a study of how architects approach this discussion within their profession, and then lead to a discussion about we in the western culture see this in terms of ethics and how that affects architects and their work

Figure 0.0.4

Figure 0.0.5

Figure 0.0.6

Methods

- **Literary studies**

The aim for the methodological approach is to provide a framework for the discussion in present thesis. Such a framework should both create a connection between the different parts of the thesis as well as creating a framework for a critical approach towards the studies. These methods define the path through the thesis.

The methodological approach to the project will vary depending on the content of the chapters. The aim for the different methods used is to achieve a connection between the chapters, and to create a base on which the interviews are formed as well as a frame, in which to evaluate these. The approaches for the first two chapters are mainly based in the tradition of social sciences, where the focus is on how we perceive the world – in this case sustainability in relation to the world – and for the third chapter the approach is based on a humanistic tradition where the aim is to investigate how architecture relates to the world, with a focus on how it relates to sustainability.

Chapter 1: Sustainability

For this chapter the aim is to give an introduction to the discussion about sustainability and climate changes, and through that start the discussion about sustainability in architecture. The first investigation into the subject is based on literature concerning the topic as well as newspaper articles. It is not scientific literature, but literature for the broad public, with references to scientific reports and articles.

The methodological approach is based on gaining an understanding and then summarizing the different aspects in order to create a broad framework for the following chapters.

Chapter 2: Sustainable architectures

This chapter is dealing with sustainability in architecture, with a focus on the different approaches that are used. This study is based on literature focused on how architects approach sustainability. Furthermore they deal with the origins of the different concerns and how the different approaches relates to different movements and groups. These literary studies also provides a basis for evaluating the interviews, that will be described later.

The methodological approach to this chapter will be focused on discussing how architects work with sustainable issues in their designs. It will be focused on analyzing this, and take a critical discussion of how the different approaches are used in architecture.

As for the interviews in this chapter the approach is based on Steinar Kvales semi-structured model for interviews, which allows for a relatively free conversation, where different subjects can be pursued, if they seem interesting in connection with the overall subject in the interview. It has been chosen to interview architects working with sustainability in order to be sure that they have an awareness of the subject, and that they have an opinion about the discussed subjects. Such an approach to the discussion does of course make it possible to question the objectivity of the discussion. The purpose of present thesis is not to investigate if architects are concerned about sustainability or not but to investigate and discuss how architects approach the term sustainability in architecture and through that how they work with it. Therefore it has been chosen to interview architects who have an approach towards sustainability in architecture.

The practical approach to the interviews consisted of the following. First research was done in order to find architects who could be interesting for the thesis. This was done through reading different architect's home pages to investigate how they "branded" them self as architects in terms of sustainability. The basis for this random search was previous knowledge of projects made, where they had been working with sustainable issues, as well articles in different architectural journals and newspaper articles about architects and architectural works. From this quick research a list of four architectural offices were made, and they were contacted in order to arrange an interview with them. The first contact also provided them with a quick summary of the idea behind the thesis, and how the interviews fitted in to this context. Before the interviews the interview guide [appendix A] was sent to them, in order to make it possible for them to prepare for the interview, which should make it possible to give more feedback to present thesis. The architects who were interviewed are mentioned below, and a further elaboration for choosing these architects is written in connection with the interviews in chapter two

Lars Kvist (architectural technician), Head of environmental department at Arkitema
Joy-Anne Fleming (architectural assistant), Assistant to head of environmental department at Grimshaw Architects
Ian Mckay (Architect), Director at BBM – Sustainable Design
Vibeke Grupe Larsen (Architect maa), Owner of VGL CPH

The analysis of the interviews and the way the architects approach architecture in their practical work is critical. A critical approach is in place here in order to dissect the interviews. It is not the aim of the critical approach to demean the architects or their work, but rather to be able to relate their approaches and how they work with sustainability to the framework, which is established beforehand. The architects have been chosen due to both sustainable concerns and architectural quality.

The approach to this last part of chapter two is a mix between critical and hermeneutical. It is critical towards how we see the world today, and how we live in it, and it is hermeneutical towards the two philosophies. Both of these can be considered alternatives to our current lifestyle, and it is not the purpose to object to their statements, but to try to discuss our current approach in architecture, especially in terms of the three interviewed offices in relation to the two philosophies.

Chapter 3: Ethics and sustainable architecture

In the last chapter the aim is to link the architectural discussion in chapter two to a more general understanding. This is done through a brief summary of different positions within ethics, and then a discussion about what ethics is in architecture. This is done through studies of literature focused on architectural philosophies concerned with how architecture relates to the world, and how it relates to us being in the world

The methodological approach to this chapter is focused on how architecture is a part of how our understanding of the world, and how it expresses these things.

Chapter/method	Main literature
Sustainability/ Hermeneutic approach to mainly books and articles meant to be understood by the broad public, refering to scientific articles and reports about climate changes and sustianability	- Flannery - Mckibben
Sustainable architectures/ Critical hermeneutical approach to literature specificly pointed at the discussion about sustainable architecture. Furthermore critical towards the interviews	- Bennetts et al. - Steele - Kvale
Ethics in sustainable architecture/ Hermeneutical approach towards the litterature pointed specific towards sustianable ethics, phenom-enology and tectonics	- Bennetts et al. - Naess - Abel - Harries - Frampton

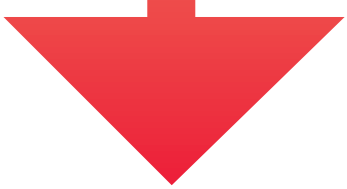


Fig 0.0.7

Delimitations

In the discussion about environmental sustainability and climate changes there are certain delimitations due to the very complex matter. First of all talking about sustainability it can be considered in several different ways. In relation to present thesis though, it will not be considered in an economical way. The reason for this is the very complex economical theories which are a part of that discussion and it is not the aim of this thesis to discuss such matters.

Another way to define sustainability is within a cultural context, and in present thesis the cultural context is a western democratic context, that mainly can be defined as a consumer culture [Abel, 1997]. One can argue if such a culture is sustainable, and argue that it would be more appropriate to place the discussion within a different cultural context, which as a starting point is more sustainable. Such a culture could be a third world country, where people live in sheds, and uses almost no energy. The reason for limiting the discussion to the western consumer culture is that this is what most countries in the world are trying to achieve. In regards of this it is important to discuss the matters in relation to the problems we face, with our highly developed technological society, and how these things can be affected to be more sustainable.

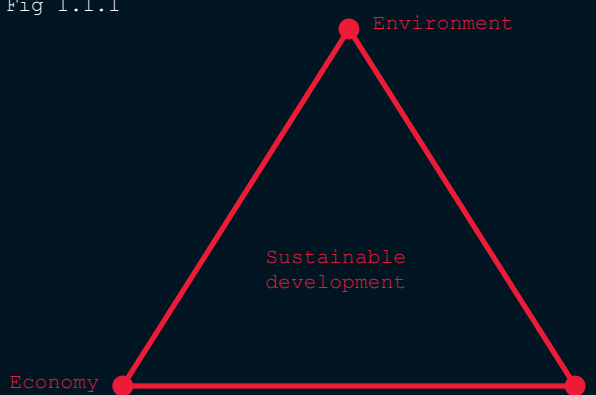
In relation to sustainability and culture the discussion about how we in the west exploits third world countries in order to maintain our high living standards, and that our pollution is the reason for a lot of their problems will not be discussed. Again there is evidence to that it is the case, but it is not the aim of this thesis to discuss global politics

In the discussion about climate changes it will not be discussed whether climate changes are caused by natural changes or human behaviour. There is a common ground among scientists that climate changes are caused by human behaviour, and furthermore it is outside of this thesis aim to discuss highly complex scientific matters. Furthermore one can argue that a discussion about how the building industry can make more energy efficient and cheaper houses will be a benefit to everybody.

1. Sustainability

"Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs… Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs."
[WCED 1990: 8]

Fig 1.1.1



The three main subjects within sustainability can be put in a triangular diagram, where the sustainable development then is defined within the triangle. It can then be drawn towards the different corners, but ideally it should be in the middle where there is an equilibrium between environment, culture and economy

- 1.1 Introduction

The quote on page 14 is the most common definition of sustainability today, and it was first used in "Our common future" in 1987. One could question, if it is still valid today taking into consideration, that the planet is overpopulated, and it would require an extra twenty percent of planet to sustain today's population. By 2050 it would require two planets to sustain the population. A population that is estimated to around nine billion people by then. Furthermore we are facing major climate changes. Some scientists question whether it is possible to stop that development [Flannery, 2005: 79].

This will be the starting point of the first part of the thesis, where the aim is to summarize the ongoing discussion about climate changes and environmental sustainability. More specifically the aim is to take the discussion that often evolves around energy savings, water savings, CO_2 emissions and the likes, and question whether these quantitative measures are the centre of the discussion. One could question, if there behind these, is a more culturally defined and qualitative aspect. By focusing on the qualitative issues in the discussion the aim is to investigate how our western values affect the discussion, and determine if a change, from a consumer orientated culture towards, what one could call, an "eco-culture", and could be part of the solution [Abel, 1997: 202-214].

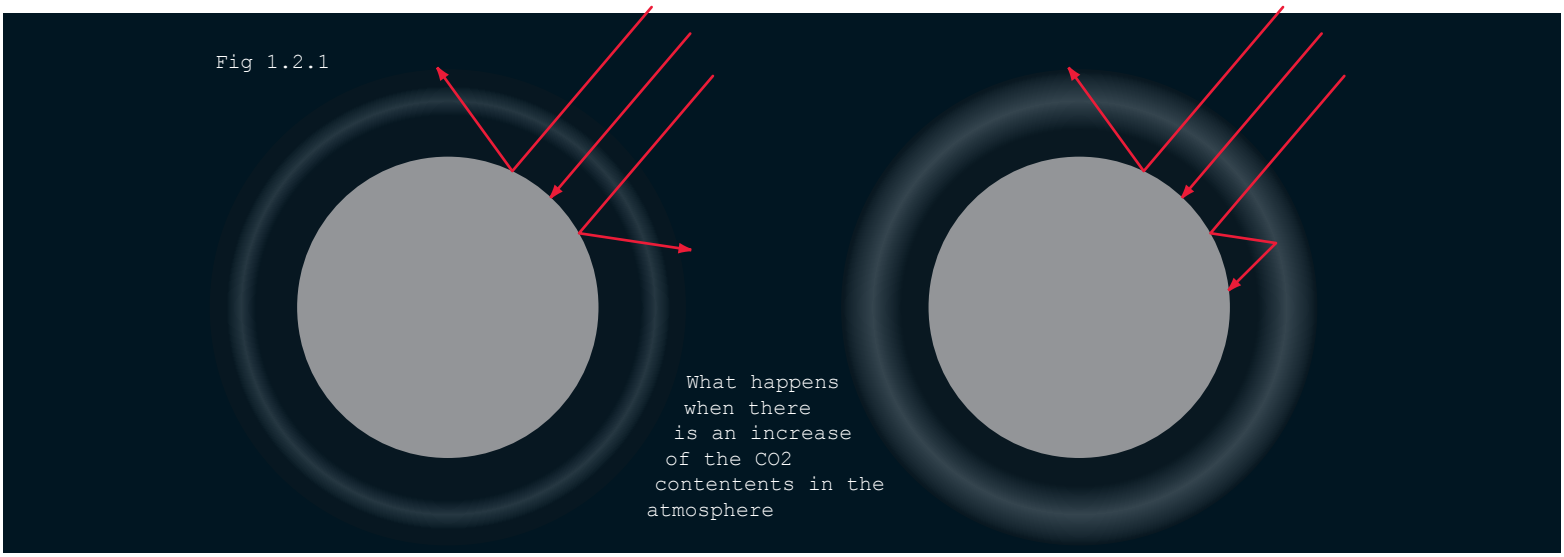


Fig 1.2.1

The purpose of summarizing this general discussion about climate changes and environmental sustainability is to use that as an overall framework for the discussion about sustainability in architecture, and furthermore it is to stress that the focus on sustainability in architecture is only a part of the solution to the problem. Instead the intention in the discussion is to make a more general evaluation of the values we have in today's western culture.

- 1.2 History

Talking about climate changes automatically leads to a discussion about CO_2 emissions and its connection to global warming and climate changes - both of which leads to a discussion about environmental sustainability that by now has become a buzz word in the western world. The issue by now is so big, that people has started to get what could be called green fatigue [Wilson, 2007]. A condition one reaches, when one gets tired of listening to the discussion about environmental sustainability and climate changes. Furthermore it can be seen as a move against what we as individuals, are told we can do in order to solve the problem – actions that it is often difficult to see the results of. Or as Wilson states we should do as the famous people say not as they do [Wilson, 2007].

But when did this discussion about human impact on nature and possible climate changes start? It might seem like something that started recently or maybe back during the oil crises in the seventies, but in fact it was already known by scientists in the eighteenth and nineteenth century that the massive burning of coal during the industrial revolution would increase the amount of CO_2 in the atmosphere. It was predicted, that such an increase in the amount of CO_2 in the atmosphere would cause more infrared light to be reflected back to the earth as shown in figure 1.2.2 [page 15]. This was compared to what happens in a greenhouse by Jean-Baptiste Fourier in the late eighteenth century. In the late nineteenth century Svante Arrhenius made the first calculations of the possible consequences of the increased CO_2 emissions by humans [Mckibben, 1991]. It was not something that made a big impact in public or political circles at the time and the discussion faded out relatively quickly. In the beginning of the fifties Charles Keeling started to measure the CO_2 content in the atmosphere. After a few years it became evident to him that the CO_2 levels in the atmosphere were rising, which to his concern were due to the massive burning of fossil fuels [Flannery, 2005]. His data shows a very distinctive graph today known as the Keeling graph, where the yearly changes are clear, and the rise in the CO_2 levels year by year is evident as seen in figure 1.2.3. During the following years this tendency continued. In the beginning of the seventies and again in

Fig 1.2.2 Keeling curve of atmospheric carbon dioxide from Mauna Loa, Hawaii

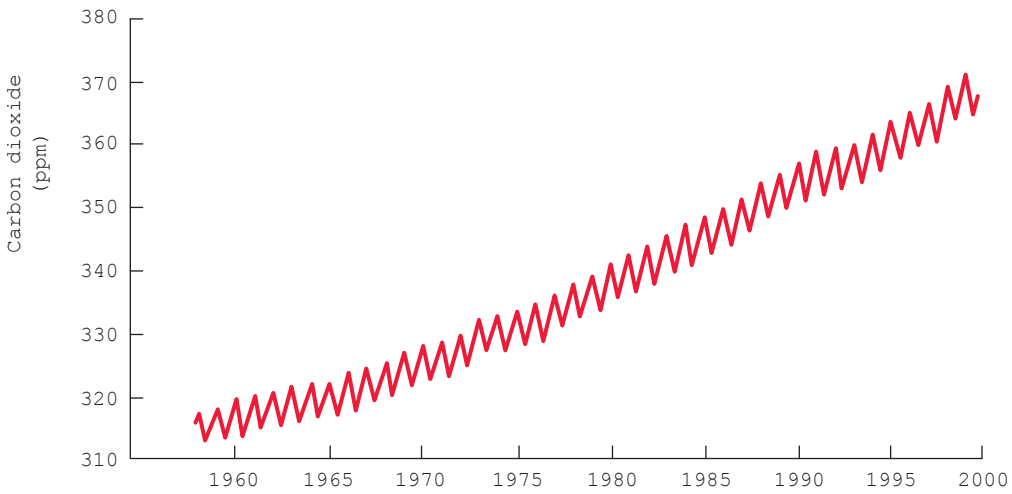
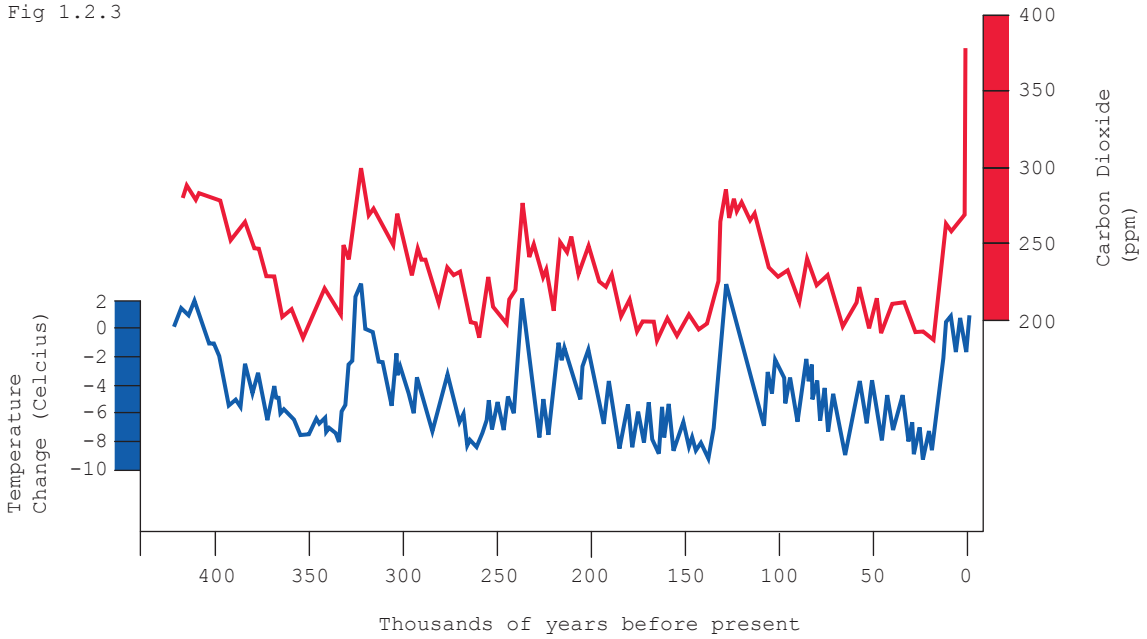


Fig 1.2.3



the late seventies the oil crisis stroke, which gave the western world an idea of how dependent we are on oil supplies. The oil crisis then again caused western countries to explore their own territories for especially oil. During the oil crisis different government measures were taken to make people save energy and oil. In Denmark for example cars were banned from the streets on Sundays. But already in the late sixties changes had started to happen, where an increased focus on pollution, toxic waste and population growth formed the basic concerns of today's ecological movement. These organizations later turned into global organizations like Greenpeace, which were founded in Vancouver in 1971 [Steele, 2005].

During the seventies James Lovelock then joined in with his theory about the earth as a complex organism that he called GAIA after the ancient Greek earth Goddess – a model that is based on a thought about everything being interrelated and that everything then has a purpose on the planet [Flannery, 2005: 11-79]. One of the main problems stated in the discussion, or one of the things which has been a part of causing this problem, is that we as humans have always seen nature and the world as something immensely big, where our actions would not have an impact on nature – or in other words we as humans are so small that we cannot possible have an impact on such an immense thing as an entire planet [Gore, 2006]. This is not just in relation to the CO_2 emissions. For example the deforestation of the Western European forests in the sixteenth and seventeenth century is another example – a deforestation which was due to the need for building materials for ships and houses, as well as a need for firewood [Cavanagh et al., 2005].

Since the fifties, when Keeling started to measure the increase in the CO_2 levels in the atmosphere, there have been discussions about the causes of it, where some scientists have claimed that it had natural causes such as sunspots and volcanic activities. Furthermore some has seen it as a part of a natural pattern on the planet. Today research in the field has shown that the level of CO_2 in the atmosphere has never been higher in the past 600.000 years, and that the increase of the CO_2 levels started in the beginning of the industrial revolution, which is a clear sign on that the rising CO_2 levels could be caused by human activity. This rise in the CO_2 contents of the atmosphere has also caused the temperature to rise as seen in figure 1.2.4, which then again affects the entire climate of the planet with possible catastrophic consequences. Today though there is a common agreement among scientists that this is caused by humans and the burning of fossils fuels [Flannery, 2005].

- 1.3 Environmental sustainability

So what is environmental sustainability today? If one looks up the definition of sustainability in a dictionary, it says that it

"…is a characteristic of a process or state that can be maintained at a certain level indefinitely"
[www.wikipedia.org].

This is in line with the Brundtland commissions' definition about sustainable development, which states that

"...it is to meet the needs of the present without compromising the ability of future generations to meet their needs"
[WCED 1990: 8]

According to the predictions from scientist this can be difficult though. As mentioned in the introduction experts estimate, that with the current development it will take two planets to support the population by 2050 [Flannery, 2005: 79]. The most common answer to this today is that we in time will develop a technology that will help to solve such a problem. As it is today it seems like gene modified crops are one of the answers to this problem. Of course such a thing raises the question about what it does to our environment. This is a question which Bill McKibben raises, when he asks if climate changes, gene modified crops and the effects they have, still makes it possible to perceive the world around us as natural. Everything will then be affected by human interaction, and the natural developments in nature disappear - nature will be dead [McKibben, 1991]. These things will maybe help us to survive and maintain our way of life at least in the developed countries, but it also raises some questions about how we see the environment around us, and how we relate to it.

As mentioned in the introduction the ecological movement in the sixties started out as a protest against toxic waste, pollution and population growth, and they tried to develop ways in which we could live in symbiosis with nature. Most of these methods were based on quite radical approaches, where modern conveniences were discarded - an approach which for most modern people has a quite negative connotation [Naess, 1989]. People's awareness of the sustainable issues today is far greater than they have been before. Sustainable issues are discussed regularly in both the media and political circles, which cause awareness among people. Furthermore the discussed climate changes are also concerning people. Still the ecological approach is seen as reactionary, where we have to live in primitive straw bale houses, but in the discussion later about sustainable

architecture this view of ecology will be questioned through a discussion, where a grading of ecology is made and how different views on nature can be introduced to our culture [Naess, 1989].

- 1.4 Minimizing the impact

A discussion about what environmental sustainability is today, naturally leads to a discussion about what we can do in order to achieve a more environmentally sustainable lifestyle. Most of the discussions in the media today evolves around what we can do as individuals. It is small changes of habits like using energy efficient light bulbs, turn of the power to appliances instead of leaving them on standby, turn off the water in the shower when we wash our hair and other things like that. These are all small changes that are fairly easy to achieve and therefore they are a good starting point, without having to make significant changes to our lifestyle. None of these basic things are actually new. They have been present in different parts of our society from the late sixties and up until today - mostly in smaller scale where people have had a vision. Unfortunately, some people would say, these things have never caught the eye of the broad public or politicians. Today though, one can see things starting to move in a direction, where these early moves toward a more sustainable way of living, prove to be valuable information and they can provide a stepping stone for new initiatives. There are of course more significant changes, which can be made and that are more comprehensive in comparison to the above mentioned. Such changes might have a bigger impact on how we live our lives and in the end on how we see the world around us.

One of the bigger changes which can be done is within transportation. Here one of the more obvious things is to use more fuel efficient cars, which easily will lower the CO_2 emissions. In connection with such a thing another obvious possibility is car pooling, where people who are working together or working in the same area share a car or at least takes turn in driving to work, which will help lowering the CO_2 emission per person driving. Ideally that would mean that five people takes turn in driving to and from work in one car instead of five cars driving each day with one in each car. A more radical approach within transportation would be to sell the car and use public transportation, but in the western society that might be considered as a limitation of ones personal freedom. Some of these things are very dependent on where people lives, so a thing like using more public transportation is probably easier to achieve in cities with an extensive public transportation system, where as car pooling might be effective, when people live in rural areas and work in a bigger city.

Fig 1.4.1, Final energy consumprion by sectors in EU

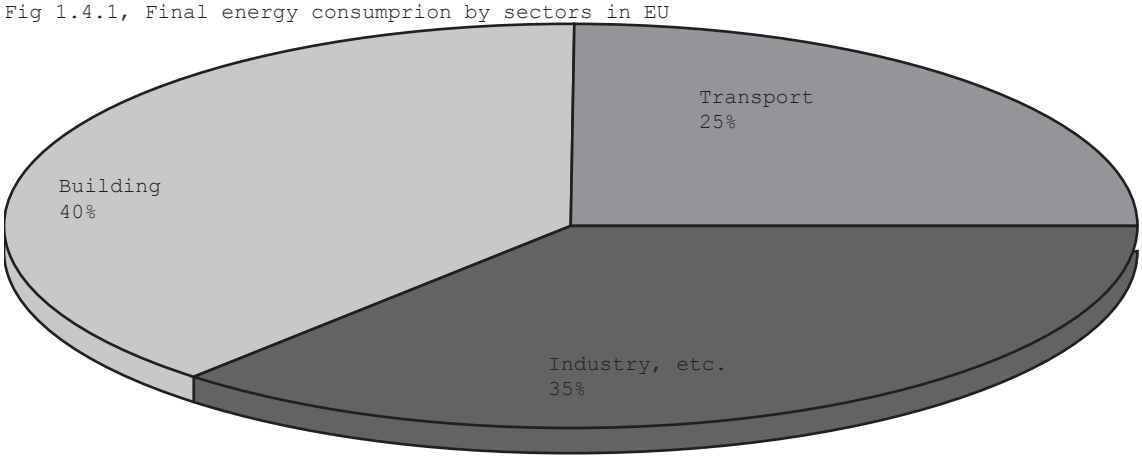


Fig 1.4.2, Breakdown of final energy consumption by end use in EU in commercial buildings

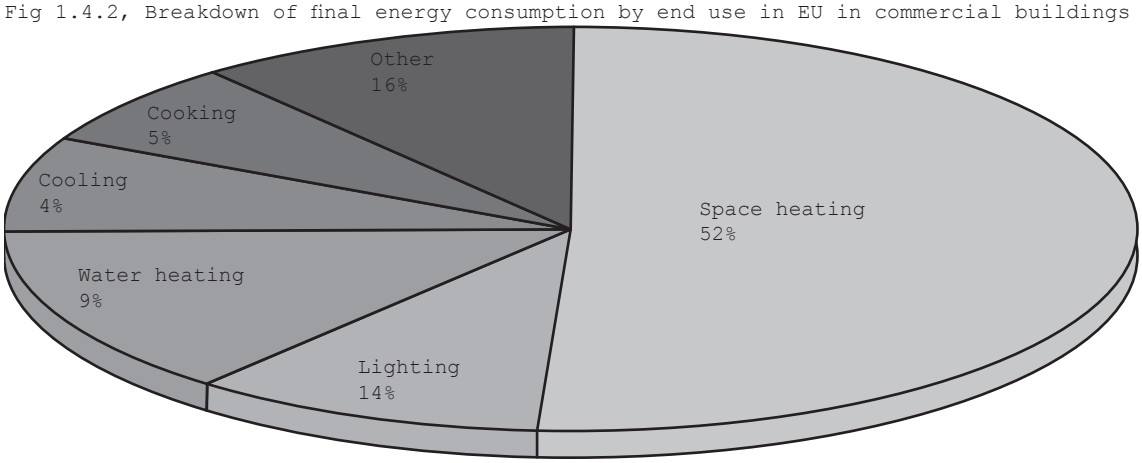
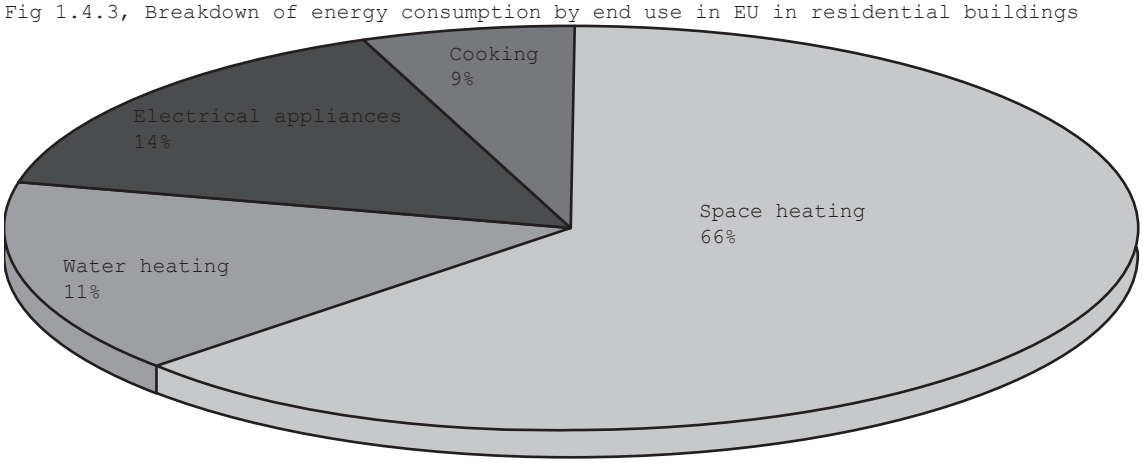


Fig 1.4.3, Breakdown of energy consumption by end use in EU in residential buildings



Another thing, which probably is more difficult to achieve, is a change in what we eat. There are several levels in this. One is the amount of red meat, and the other is the use of local grown food. As for the red meat the reason for maybe changing ones habits is that about twenty percent of the CO_2 emissions come from farming and most of that is from livestock. Furthermore the water consumption is about 46000 liters of water per kilo red meat produced, whereas the water consumption for a kilo of potatoes is 1000 liters [Jensen et al., 2007]. This might be considered a bigger change, and quite a big interference with our lifestyle, but it would not only help in the fight against global warming it would actually improve our health. As for the local grown food the obvious thing that can be achieved here is a cut in the CO_2 emissions from the transportation of food. Furthermore this will help to improve a more cultural integrated food culture [Holm, 2007].

The last thing of interest to be mentioned here is concerning buildings. One can argue how relevant this is for a Danish discussion since the Danish building regulations already are quite strict and there are already plans for even stricter measures. Within the building industry different measures can be taken. One of the most effective things is to work with designs that minimizes the need for heating and cooling in buildings. Another is the use of local materials, to minimize the emission from transportation as mentioned earlier. Some other aspects that can be useful within the building industry is to build buildings with fully or partially energy production for their own use. Often energy producing elements are seen as retro fittings on older buildings as well, in order to lower their need for energy from the public energy suppliers, and through that


Fig 1.4.4

achieve a more sustainable building - all things that governmental agencies try to implement through legislation [OECD, 2003].

This is just a few fairly basic things that can be done in order to minimize our CO_2 emissions. One thing is what we can do our self another is what different industries can do. This part of the discussion often seems to be forgotten or neglected in the debate, but it plays quite an important role, because it is necessary in order to achieve long time goals, and because the fossil fuels are limited, which ultimately means that our energy sources will disappear at some point. No matter what, it is necessary to think differently and develop new technologies to solve it, as well as focus more on how our lifestyle have an impact on nature. The current climate crisis is just another reason to speed up the process.

As mentioned the farming industry can do something. Another obvious one is the energy sector, where new methods of energy production can be developed. The first thing is to find technologies which can supplement the renewable energy sources like wind and solar energy, but where the long term aim should be only to use renewable energy. For the transport sector the aim should be the same, with solutions for optimizing the efficiency of the current technologies, and then research in to new technologies as substitutes for the old polluting ones.

The last thing to mention here is politicians. Politicians create the framework of laws and rules we work within. Therefore they have the ability to, at least to some extend, shape our actions. It is not until recent years politicians have started to be aware of this,

Fig 1.4.5

or maybe it would be more appropriate to say that it is not until recently that the politicians actually having the power have started to be aware of it. A reason for this is most likely Al Gore's lobbying for the issue. He has provided both the public as well as politicians with inputs, and put focus on the issues concerning this. In the end it is the politicians that take the decisions and create the frame work, but we as common people have the ability to make them aware of such things.

- 1.5 Conclusion

As one can see through this brief summary of the discussion about climate changes and how we deal with it. It is a fairly complex discussion. Everything is interrelated. If something changes in one place it affects something else. The focus here is on the environmental sustainability though. Of course environmental sustainability is heavily dependent on both cultural and economical aspects, especially because the western world's culture is closely related to economical progress [Naess, 1989]. According to the experts it is possible to be both environmentally and economically sustainable. Actually they agree on that we should strive to be that. One can then question why we are not that yet. As mentioned earlier certain things in our culture "prevent" that. In the sixties the ecological movement tried to show a different way of living with respect for nature. Unfortunately what they proposed was seen as something that would decrease our standard of living, and therefore it was rejected as a solution. Instead the belief in technology as a solution was promoted. Maybe it is time to re-evaluate that position and investigate what other possibilities can bring. It should not be understood as a regressive movement bringing us back to earth huts and caves, or to gather our own food in the forest. It should be understood as a view where decisions taken are evaluated in a way so that the impact the decisions have on nature, is the focus point instead of economical or technological developments [Naess, 1989]. Maybe it is time we evaluate our lives in terms of quality instead standard of living.

As mentioned before none of these issues are actually new. They are more re-inventions or one could say re-discoveries of ideas that have been realized earlier. In Denmark there are several examples on such realizations. One very well known example is Christiania (figure 1.5.1). It might not be well known for its original ideas today, but it started out as an alternative way of living, where Christiania was meant to be self-sufficient. Small workshops for different crafts, growing there own organic crops and things like that. It was a life size experiment for an alternative way of living in an urban environment or as it is known today – an urban ecology [Danielsen,

2005: 94-96]. A newer example of such a direction in culture is Friland (figure 1.5.2 and 1.5.3), that was promoted through the Danish Radio Broadcast and a series of broadcastings were made about the concept. Again the idea is to promote a different way of living, but instead of an urban environment as Christiania this is a rural development. The approach to life here is to make as little impact on nature as possible - growing organic crops, using natural building materials like straw bales, clay, shells and things like that. Both of these are recognizable due to their move away from mass production methods and consumerism towards a more localized production, where the things you have in the local area is used for production. Today such things are starting to surface again. Especially within food production in Denmark, where focus today is on biodynamic and organic food production. In such cases information and knowledge is gathered from both local Danish farmers who have been working with it for some time, as well as knowledge from productions in other countries, where for example Spain and Italy have proud traditions in their production of for example air dried hams, sausages and Parmesan cheese [Holm, 2007].

But then how does this discussion relate to architecture? The common picture of sustainable architecture, ecological architecture or any other architecture related to these terms is often that of an earth hut, a house of straw-bales, or an existing house with retrofitted PV-cells, and other such things. That is often an image that does not correspond to our understanding of buildings in a modern world, or as something that creates a frame around a modern life. There is great scepticism for a project like Friland. People are inspired and see it as a romantic thought, but to see one self living a life like that, in a setting like that is difficult, but it serves as an example of how things can be done.

As mentioned the small changes we can do now is a starting point. But the question today is if such initiatives are enough, which is a point stressed among scientists today [Nielsen, 2007]. When scientists working with climate changes and the impact of those are starting to doubt whether such changes in our habits and our believe in technological solutions are enough, and call for more focus on how we live as humans it is important to notice and discuss such issues. What they say is actually in line with the ecological movement, that challenges our view at the world – a thing that it is worth noticing. There seems to be a change among economists and natural scientists, where our impact on nature and its value to us and the way we live is starting to become more important, and make such qualitative considerations a part of the discussion.

"…such an example is when we made the kindergarten named Stenurten that is located on the inner part of Nørrebro, where natural materials were used, and you can almost feel how the building is breathing in relation to the people, who is there. When I came over there after it had been taken into use, I expected it to look like every other institution…. There was not a single plastic toy car. It was wooden toys, weaved chairs and things like that. Today it has an ISO 14001 environmental certification. You could say that where our building process stopped, they continued the intentions. They probably wouldn't have done that, if we had just given them a stock product."

[Quote from interview with Lars Kvist from Arkitema, translated from Danish]

Fig 1.5.1

Fig 1.5.2

Fig 1.5.3

2. Sustainable architectures

- 2.1 Introduction

The aim for this chapter is to discuss the current approaches to sustainability in architecture. This provides knowledge and understanding of the current situation and it helps to gain an understanding of how architects think and work today. Furthermore the discussion here creates a basis for the third chapter that evolves around the meaning of architecture in our culture and the ethical understanding of the different subjects concerning sustainability and architecture

The first part is a historical summary of sustainability's development in architecture, and how it has been a part of the architectural development in the past century, even though the term sustainable architecture only has been in focus since the seventies. It is also linked to the ideas of modernism, which can be seen as a move towards a more sustainable direction in terms of how people lived at that time, or in other words as giving them more quality in their lives.

The aim for the second part of this chapter is to discuss how the term sustainability is used in architecture. It is investigated how the different terms, often used interchangeable in architecture, are defined in terms of architecture. The starting point for this part of the discussion is Hanne Tine Ring Hansen's diagram that has been published in an article and was made as a part of her PhD study "Methodical Approaches to Environmentally Sustainable Architecture". Here the different approaches in relation to the design methods used as well as the main concerns within the discussion about sustainability in architecture are connected. The approaches are as follows:

Self sufficient, ecological, green, sustainable, bioclimatic, environmental and solar
[Knudstrup et al. 2007]

The discussion of these approaches and how they are used in architecture forms the basis of the third part of the chapter, which evolves around four interviews with architects working with sustainability. The architects interviewed are three working with architecture in practice, where they are involved in the environmental management of the offices and the last one is teaching sustainability for architectural students and giving architects supplementary training. The aim here is to investigate how architects work with sustainability in practice, and discuss how their work relates to the theoretical understanding of the different sustainable approaches.

Furthermore it is a discussion about how innovative their approaches actually are.

- 2.2 History

When talking about environmental sustainability in architecture it dates back to the forties with Buckminster Fullers suggestions for self-sufficient housing. A concept he proposed due to his concerns about the exploitation of the planet's natural resources. Or maybe it would be more appropriate to say that the focus on the sustainable issues started back there, when a concern for human's impact on nature started to emerge.

Most environmental concerns in architecture derives from different environmental movements like the ecological movement from the late sixties and the green movement from the seventies and eighties [Steele, 2005]. Another such movement was the passive house movement starting in Rocky Mountains. Today it is widely spread in Austria and Germany [Isover, 2007]. By now the passive house movement's influence in Europe is seen in relation to building codes, where their strict regulations are starting to appear as benchmarks for energy consumption, as they are seen as an important tool in the fight against CO_2 emissions and climate changes.

Architecture has to some extend always been working with sustainability especially through choice of materials, and how it is set in the surrounding landscape. Studying vernacular architecture one will see that vernacular buildings are adapted to their environment and they use local materials, which are some of the major issues discussed today within sustainability in architecture. Furthermore it is formed through the local culture and environment, where culture as well as access to materials are two very determining factors.

Today there is a lot of criticism of the modern movement for trying to design houses that could just be fitted in everywhere with no regards of the local climate, and where their main issue were industrialization of the buildings. In contradiction to the common perception, the starting point were actually a wish to improve peoples standard of living and provide fresh air and sun to everybody – a vision that should be seen in relation to the living conditions of the day that were terrible with small dark apartments for most of the workers living in the cities. Furthermore there was still a massive migration to the cities, that made the need for apartments extreme. The focus on air and sun for people meant that apartment

buildings started to be orientated towards the sun, and big lawns were established outside in order to provide areas for relaxation as well as small gardens, where people could grow vegetables. Furthermore roof top gardens were introduced as well as mixed use buildings. An example of such thoughts is Le Corbusier's Unité d'Habitation in Marseille from 1945 (figure 2.2.1) [Nielsen et al., 1994]. Later, masters like Le Corbusier and Louis Kahn, both started to work with natural ventilation, which is seen in for example Chandigahr (figure 2.2.2), which is the state capital of Punjab, India, by Le Corbusier and Louis Kahn with the new parliament in Bangladesh (figure 2.2.3) - both good examples where natural ventilation has been utilized. The use of these measures, to create a comfortable indoor environment, was heavily influenced by Balkrishna Doshi who was native to the region and understood the climate and how to work with it [Steele, 2005]. Before that Alvar Aalto had started to adapt the modernism of the thirties to the Nordic climate and materials, which is best expressed in Villa Mairea (figure 2.2.4), where this certain sensibility in the choice of materials is seen. So this criticism of the modernistic movement is to some extend wrong. They had a concern for how people were living and tried to improve their living conditions. Furthermore they worked with natural and climatic forces to obtain such improvements in people's living conditions.

As pointed out earlier the ecological movement started in the sixties. The ecological movement also had an impact on some architects, and there started to be a greater focus on sustainability in architecture [Bennetts et al., 2003]. In Denmark this concern was especially evident during the oil crises's in the seventies, where architects became experts in sustainability over night. Some of these architects continued to work with sustainable issues in their practice after the oil crises. In recent years the focus on sustainable issues has become even greater in political, public as well as architectural circles, which is due to first the focus on the depletion of the ozone layer and later the emergent climate changes. These concerns have caused a variety of different approaches to solving the problems, or to optimize buildings, in architecture. Approaches spanning from the very basic approaches with simple measures like orientation towards the sun and using local materials, to the more technological, where for example computerized and mechanical installations responds to the climatic conditions in and outside the building

As seen here sustainability in architecture has a quite long history. Even without the term sustainable architecture, there are directions within architecture that works with methods and designs that today is being considered a part of a sustainable approach towards architecture. In modernism through the focus on people's lives and how

Figure 2.2.1

Figure 2.2.2

Figure 2.2.3

Figure 2.2.4

to improve their standard of living – giving them sun and air in their homes. Vernacular architecture going further back being dependent on local materials and creating a lasting frame around a culture. Today the focus is more on how to save energy – how to optimize buildings in terms of their energy consumption. Even though the focus has changed towards, what could be called, a more quantitative focus it does not mean that the concerns and design methodologies from earlier has been rendered obsolete. They are still important tools in the design process. This is for example seen with Sir Nicholas Grimshaws work that has developed from a very traditional modernistic approach in the late sixties, to a more sophisticated architecture today, where different high tech approaches and tools are used in connection with the more basic design methods in order to obtain their qualitative aims in architecture [Pearman, 2000].

This historical summary also shows that even though sustainability has not been a focus point in architecture for a long time, it has a much bigger role in the discussion about architecture today. As Christian Cold, director of Entasis in Copenhagen, states – the focus on sustainability is merely a small ripple on the surface of all architecture, when seen in a historical perspective [Cold, 2007].

- 2.3 Approaches

The aim here is, as mentioned, to investigate how the term sustainability is used in architecture and to investigate what it actually means. Today the term is used interchangeable, which makes it quite ambiguous. Furthermore it is a quite nebulous term, especially as it is defined in "Our common future" (Page 14). The basis of the study here is an article made in relation to Hanne Tine Ring Hansen's PhD study, "Methodical Approaches to Environmentally Sustainable Architecture", where she investigates the different approaches to sustainable architecture in temperate climates, and the design methods they use, as seen in figure 2.3.1, and how the different approaches relates to some overall concerns about how we relate to the world around us as seen in figure 2.3.2.

As one can see from figure 2.3.2 the different approaches all have overlaps in their concerns, where green architecture and solar architecture are having two concerns, ecological and sustainable architecture are concerned with all four terms. But what does these terms signify in this discussion, and how do they affect the architecture. First of all it is important to state that these concerns are not something that is special for architecture. It is concerns that are general for us in the western society today. This aspect of the discussion will be discussed further in chapter three,

Figure 2.3.1

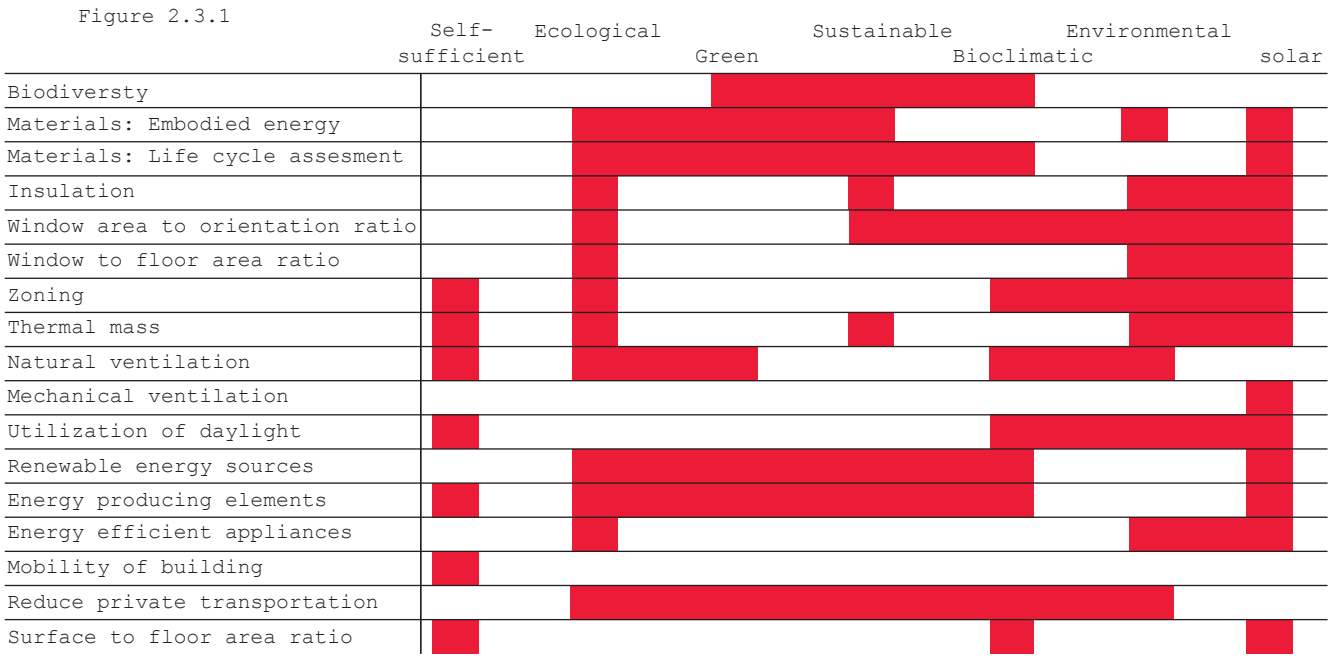
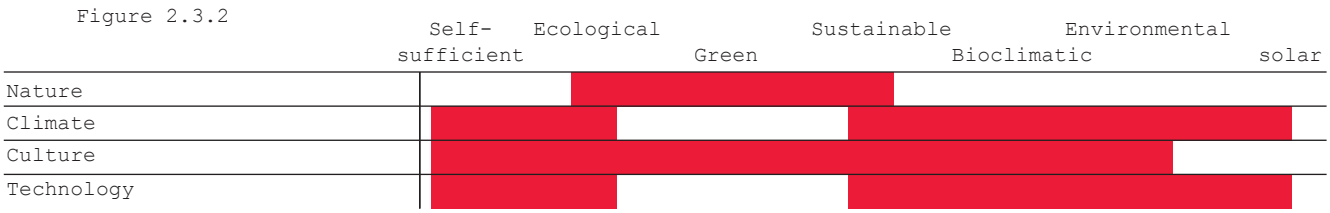


Figure 2.3.2



The figures here are based on a figure from an article made in connection with Hanne Tine Ring Hansens PhD "Methodical approaches to environmentally sustainable architecture". Figure 2.3.1 describes the different methods used in connection with the different approaches, within sustainable architecture, whereas figure 2.3.2 shows which concerns there are within the different approaches

and the focus here will be on these concerns influence in relation to sustainable architecture.

The first concern of nature is about how we as humans have an impact on nature. In its most radical approach it is to preserve nature as it is and not touch it, as it is seen in the deep ecological movement. In a more intermediate interpretation of this it is about how we can live and manage nature as to preserve it, but still being able to use it both for recreational and commercial purposes. In architecture this is discussed in terms of what impact the building has on nature. A very common quote used in this connection, "touch the earth lightly", often used among Australian architects inspired by Glenn Murcutt. [Bennetts et al., 2003]. In relation to this quote it is important to state that his architecture is closely related to the natural and climatic conditions where he lives, and therefore a direct use of his principles are not possible in a temperate climate like the Danish.

The concern about climate is about how changes in climate will affect us. Its expression in architecture is the use of climatic conditions in a certain area to create for example natural ventilation, or the orientation of the building in order to create outdoor spaces adjacent to the building that are not exposed to the wind. The concern here is what happens if the climatic conditions changes. This focus on specific climatic conditions in an area, and the use of the landscape and building orientation to achieve the best possible conditions, creates a quite distinct architectural style in different areas. [Olgyay, 1992]

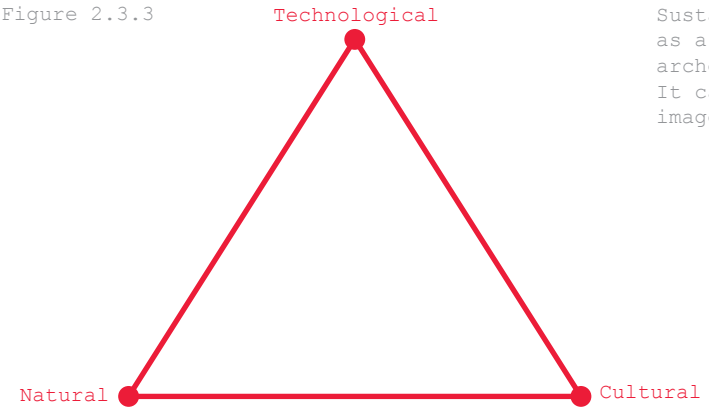
The cultural concern is about how culture affects our lifestyle. Our western culture today is a consumer culture, and it has developed in that direction since the end of the second world war, where the focus on progress has been an increase in production – a focus on economical progress and an improvement in living standard [Abel, 1997]. In architecture this has taken its beginning with modernism and its fascination with industrialization and the possibilities it gave in terms of improved living conditions – more space and light. This culture of progress in economy and materialistic values has changed our lifestyle towards what could be called negligence towards nature. [Naess, 1989]

The final concern being technology is about our focus on technology's importance for our lives and the possibilities it gives us. It focuses on technology as a tool, that can help us to solve problems, without changing our life. In architecture it is evident in for example major office buildings, where huge glass facades, which normally would cause problems in the indoor environment are used, and computerized

control systems are then incorporated in order to control the indoor climate with different tools. It can be opening windows in order to increase natural ventilation, controlling blinds in order to decrease solar gains and similar things. Furthermore it focuses on developing even more efficient technologies to lower the exploitation of natural recourses.

All of the four concerns above have the aim to make architecture more sustainable, and they all reflect different views on, how a more sustainable architecture should be achieved. None of these concerns can be said to be more correct than the others in terms of architecture, but they give widely different kinds of architecture. As it is also seen none of the approaches are based on a single one of these concerns. The two with the least concerns so to say, is green architecture and solar architecture, whereas the two based on all four concerns are ecological and sustainable architectures. These concerns create different kinds of images within architecture – images we are able to identify with something we are familiar with. These images are the natural image concerning how to work with nature and let architecture become a part of it, as it is seen with Glen Murcutt's architecture (figure 2.3.4) – the cultural image, where it is assumed that a given culture has adapted to a place, and therefore through trial and error has developed a knowledge about how to build in order to achieve reasonable living conditions depending on the location, as it is seen with Hassan Fathy's architecture (figure 2.3.5) – and the technological image which is about how technology can help to solve the problems in relation to our dealing with specific climatic conditions around the world, as seen in for example Sir Norman Fosters architecture (figure 2.3.6) [Bennetts et al. 2003]. These images are

Figure 2.3.3



Sustainable architecture can be seen as a synthesis between the three archetypical images in the triangle. It can them be closer to one or two images than the others

Figure 2.3.4

Figure 2.3.5

Figure 2.3.6

not unambiguous and as figure 2.3.3 shows the actual architecture is a combination of these three archetypical images, with a tendency to move towards one of the stereotypes.
Like the approaches are related to the four concerns they are also related to different design methods as seen in figure 2.3.1. As mentioned earlier most of the terms, related to the approaches, are used interchangeable and therefore discussions concerning sustainable architecture often can be hard to follow, because the expressions or terms used to describe it does not mean the same to all involved parties – they become ambiguous as seen especially when talking about, ecological, green or sustainable architecture. All terms that are often used in a very uncritical way [Steele, 2005]. By focusing on the design methods it becomes possible to differentiate between the different approaches. The design methods provide the architects with different tools to use in order to achieve the aims set. As one can see there is a significant difference in the amount of design methods used in the different approaches. For example green and self-sufficient architecture "only" utilizes seven different design methods, whereas for example ecological and solar architecture utilizes up to thirteen different design methods. The amount of design methods utilized does not determine how sustainable an approach is. It is more a matter of the amount of possibilities one, as an architect, has to achieve the goals set. Furthermore it is how the different methods are implemented. If they are not implemented in a proper way, the architecture most likely will not be sustainable. The focus on these design methods is not new. For example the use of solar energy to water heating has been used in the Mediterranean for many years, window to floor area ratio is seen in traditional Arabic architecture and so on. What has happened is that the focus on these things has grown, and the effect they have on energy consumption, pollution and CO_2 emissions has grown. As mentioned in the first chapter the means to achieve improvements are not new and revolutionary, but they are improved due to technological developments.

This dissection of the approaches gives a good picture of the different approaches and the tools that defines them. It gives one the possibility to differentiate between what architects talking about sustainability in architecture say and do. Furthermore it makes it easier to discuss sustainability in architecture because it becomes possible to track the different methods used to achieve the aim. The discussion of these approaches therefore creates a framework, which enables one to discus these things in a language, where there is a common understanding and a common glossary. Another important thing which can be discussed in relation to this is, if the "label" put on a building actually describes it in the right way. One could say that it allows us to determine if things are just a branding without any

contents, or if there actually is something to such a "labelling".

In relation to the different approaches and the before mentioned archetypical images, there is another important aspect, that also can be seen in connection with who builds it. Here it is worth noticing that for example green architecture according to figure 2.3.1 and 2.3.2 comes out as simple, in terms of where the focus is, where as solar architecture appears to be very complicated and require a lot of knowledge. Traditional seen green architecture and to some extend also ecological architecture are related to self builders, where the technological aspects and knowledge is quite limited. It is seen though that ecological architecture does have a concern for technology and technological design methods are applied in order to achieve the goals today, but the basis is the simplicity as was also seen in the early ecological movement. On the other hand solar architecture was mentioned as coming out as much more dependent on technological developments and knowledge. For example knowledge about insulation and how to make a completely airtight building, as well as knowledge about mechanical ventilation is needed. Both of these things require experience with the things as well as education in how they are put together. In relation to the ventilation for example knowledge about how to make extremely silent and compact systems are needed. This shows that it is not just about picking an approach, it is also about the means one has available.

As mentioned earlier the concerns about nature, climate, culture and technology are not new in architecture, but the focus on them and the importance of them in terms of what they mean for our society today, regarding climate changes and human behaviour, is new. This new focus is not recognized by all architects. Because they do not recognize them as more important in architecture than before, does not mean that they are not concerned with the issues, or does not work with them. Instead they see them as issues that are inherent in architecture, and furthermore they perceive the discussions about the different sustainable architectural styles as branding of a product. A branding that also creates a specific archetypical image, which they are not interested in their architectural work being related to such an image [Stang et al., 2005]. Often architects, that does not recognize these issues as special, argues that the special focus on such things will tend to make architecture come in second place in relation to the sustainability issues as Walter Unterrainer expresses it [Unterrainer, 2006]. For him it is not special to work with these issues, so he considers it to be an integrated part of his architecture. At the other end of the scale an architect like Christian Cold from Entasis states that "the focus on sustainability is merely a small ripple on the surface of all architecture, when seen in a historical

perspective". Such a statement is mostly to tell people that they are aware of that there is a problem, but in terms of how they deal with it, it tells absolutely nothing

Ideally architecture is an expression of these approaches and their concerns – architecture creates an image of these, as explained above. Furthermore the different approaches provide us with a list of design methods that can be utilized in order to achieve a sustainable approach. As mentioned the design methods are not newly developed for the approaches, but they have been utilized in different contexts, as for example vernacular architecture, where several of the approaches are present, which was mentioned with the window to floor area ratio and thermal mass in Arabic vernacular architecture. Furthermore this also brings up the question of branding. Is the focus on these design methods more than just branding of the architect's work? In some cases it most likely is branding. When an architect stuffs PV panels on the top of the house, in order to reduce the use of electricity in a house, where there have not been given any thought to the energy consumption, it can be questioned if it is sustainable. In a case like that it is a measure taken in order to make it look sustainable. Are these different approaches concerning sustainability then bad for architecture? If the aim in itself becomes sustainability and the architectural idea gets lost somewhere in the process of achieving a sustainable aim it is bad. One can question if it is actually architecture then. If the ideas about sustainability and the design methods are integrated in the process and evaluated along the way it can be a good thing. It requires that they are an integrated part of the architectural idea though. Last but not least it creates a discussion about the subject within architecture. It forces architects to participate in the discussion and relate to the problem. Even though they do not use the term sustainability or try to achieve sustainable goals which are more extensive than the measures set in the building regulations they are forced to consider it through the discussion.

- 2.4 Architects and their approaches

In order to investigate how these different approaches mentioned above works within a more practical approach to architecture, it has been chosen to interview different architects about the topic. The aim of these interviews is to investigate how different architects perceive questions about sustainability in their work, and through that investigate what that means for their architecture. The questions are focused on three overall subjects, which are:

Their own understanding of what sustainability is – how they more specifically work with sustainability in architecture and finally how they develop their perception and work with sustainability in architecture.

These three subjects have allowed the architects to speak freely and elaborate their points through projects in order to show more specifically how they work. As mentioned in the chapter about methods [Page 9] this is done through a semi structured interview based on Steinar Kvales model [Kvale,1990]. Such a practical aspect also makes it possible to dissect the different architect's incentives.

In the interviews the main question concerning the theme will be asked, and a summary of the answers within that theme will be given. The summary given is not based on a transcription but only on the interviews as they are recorded. This part will be written in italics. Each of these themes will then be discussed in terms of how it relates to the approaches and what they actually do.

- 2.4.1 Arkitema

The first company to interview about sustainability was Arkitema. It was chosen to interview Arkitema, because of the interest they show in sustainability on their home page, and because they have an active approach to it, both with an environmental department and with a research department. On their home page they state that they have a concern for sustainability and that it is more specifically about environmental issues. Furthermore they have a folder, where they state that they work on an international level and a local level. On the international level they are concerned with renewable energy and reduction of CO_2 emissions and on the local level they work with materials in order to create a healthy indoor environment, without toxic gasses from a bad choice of materials, and water.

What is sustainability to you – how would you define it?
Sustainability for them is based on the Brundtland commission's statement with the three subjects, economy, culture and environment. This foundation can also be seen in their concern for the way we use oil for fuel instead of for rubbers and plastic, where it is used as well. In relation to this they mention our dependency on oil from especially Middle Eastern countries. Such a dependency concerns them, and for them it is an incentive to try to make us independent of such sources. More specific within architecture sustainability is not just about the building. It is also about how the building is used, and how it performs in relation with the users. These are all subjects they try to inform the clients about. Their starting point for discussing these things with their clients is carbon emissions and renewable energy as well as materials. As a last point it is also stressed, that there is a certain amount of business in talking about sustainability. It attracts clients, but they are not willing to pay whatever it costs.

The main thing to notice here is that their understanding of sustainability is based on the Brundtland report. It immediately brings a picture of an ambiguous discussion and understanding. In their understanding there is relation to how natural resources are used, as seen with using oil for fuel instead of materials, the culture, which can be seen through their concern for being dependent on other countries, that are considered unstable by western countries, and of course economical, as seen in relation to clients. When discussing these things with clients they try to have an easily understandable starting point, which is provided with the focus on renewable energy, carbon emissions and materials. All things that a client easily can relate to. One can of course discuss how important these are. Carbon

emissions are enforced through the energy consumption in the building regulations, renewable energy is very much up to the client to buy, or to get through PV-cells, and toxic fumes from the materials are also controlled through the building regulations. Another issue for them is incentives through legislation in order to get clients to ask for more sustainability.

How do you work with sustainable architecture?
The main focus here is the development of an environmental program [miljøprogram], which is developed in a dialog with the client. Here the starting point for the dialog is Arkitema's concern with renewable energy and reduction of CO_2 emissions and their focus on materials and avoiding toxic gasses in the building from materials. Depending on the project, they can then add other things, which might be of interest for that specific project, as it was for example done in connection with a new abattoir for Danish Crown, where animal welfare among other things was important. Their main focus in this part is to map what the client is interested in doing, and what the client wants to achieve in order to achieve equilibrium between these two factors. Ideally they start to work with their consultants from day one, but in reality they are not involved until the first concept has emerged. On some projects they do not get in until later in the process. By involving consultants early in the process, they find that it makes it easier to avoid problems regarding environmental issues, because they get specific expertise for these issues. They find that the dialog between architects and consultants is a positive thing for the process and creates a synergetic effect. They stress though that not all consultants are prepared to work this way yet, and that some are not prepared to work in the design process because it gives too much freedom. They prefer a set frame to solve the problems in. In the future they see it as possible that engineers, architects and possible other professions work in the same company, where the new digital tools will make the design process and evaluation of design developments easier. It might make the work of the environmental department easier because they can work closer together with the teams.

Their focus on the environmental program [miljøprogram] is a very good starting point. By starting to discuss such issues early in the process they are able to incorporate the different measures that it is necessary to achieve the goals in the process. The starting point is as they say the before mentioned concerns, renewable energy, carbon emissions and toxic fumes from materials. Furthermore the discussion with the client about these things allows them to incorporate different aspects as well as it gives them an understanding of what the client wants.

They state they have a clear intention when it comes to cooperation with consultants, where they find it important to work together from day one. But later they state that it is not what is happening in the real world. A sign on that their new working process is not incorporated yet. Their experience tells them that not all consultants are ready to work on a job from the beginning. There is a clear expectation that the introduction of new and better digital tools will promote a closer cooperation with consultants. An interesting thing is that they say that it might make the environmental department's job easier. All of the things shows that the processes they need to be able to achieve these things are not there yet. This is especially seen when they talk about that digital tools can make the communication easier, but if the tools are integrated so they can communicate better it does make the work process better. In relation to this there seems to be difficulties adjusting to different work cultures.

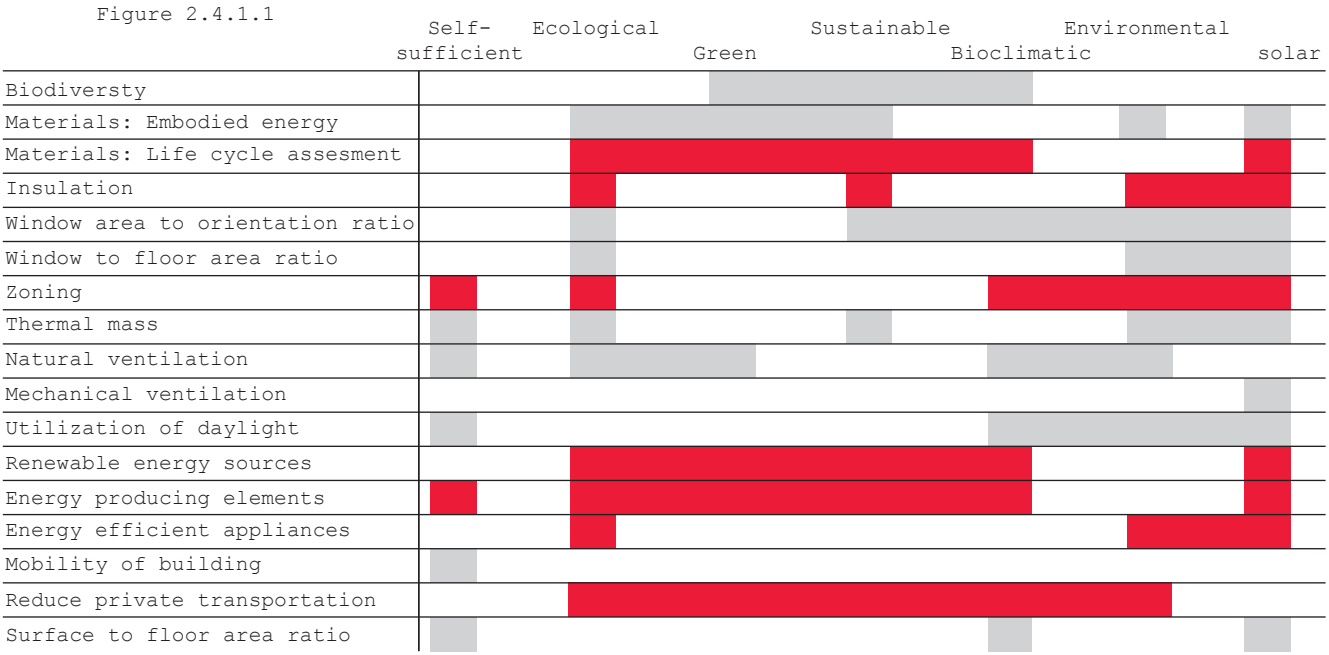
How do you develop your knowledge and work with sustainability?
Their main developments within sustainable architecture are the use of networks both internally and externally. These networks are used to exchange information about the different issues. One such network is the Passive House network, where the development and experiences within passive house technology is discussed. Furthermore they develop their approach by trying to study how different things have impacts on both nature and culture. As an example they mention bio fuel, which is good for us driving our cars, but it has a huge impact on rainforest and people who are affected by a raise on the price of food. Another thing which is important in their development is a dialog between the authorities supplying the programs for evaluating their designs in terms of environmental sustainability. For them this dialog should lead to simpler programs where the different impacts are easier available.

The last part shows that there are two directions within their approach to gain new knowledge of sustainability. The first is the professional networks of which they are a part. Here specific experiences and knowledge is exchanged with other architects and consultants within the building industry. The networks allows them to develop their professional knowledge and skills even further. The second source of inspiration is the more political one, where the ongoing discussion about what we can do in general. This last source is mainly a search for issues that can be of importance in the technologies used. It is for example related to transport and fuel, to new issues within ongoing discussions, that can have an effect on some

of the technologies they depend upon

Summarizing these things brings up some issues. First it is seen that they have intentions towards becoming more sustainable, and they are aware of the problems. It is seen both in their ideal for a working process and their definition of sustainability. Studying the things they actually do to achieve such things, it is seen that they are working with a narrow array of methods to achieve it. Most of these are passive measures towards it, like zoning, insulation and energy savings through energy efficient appliances as seen in figure 2.4.1.1. All things that are easily understandable for the client. Then there are lifecycle assessments and the effect materials have on the environment in the building, which is a benefit for the client and finally renewable energy, which is a thing that is easy to discuss. It is more a subject where the client has to be aware. In terms of the process it is also seen that it is more words than action at the moment. They are as it seems now in the beginning of a process, where they have clear intentions, but are not sure of how they actually achieve it, which then ends up in relatively easy understandable solutions, where the client can see direct benefits of the actions.

Figure 2.4.1.1



The red bars are the ones that Arkitema is utilizing in some of their designs

Stenurten - A kindergarten build on the inner Nørrebro in Copenhagen. The environmental course set out during construction was continued when taken into use. No plastic toys are found here only toys made of wood

Figure 2.4.1.2

Figure 2.4.1.3

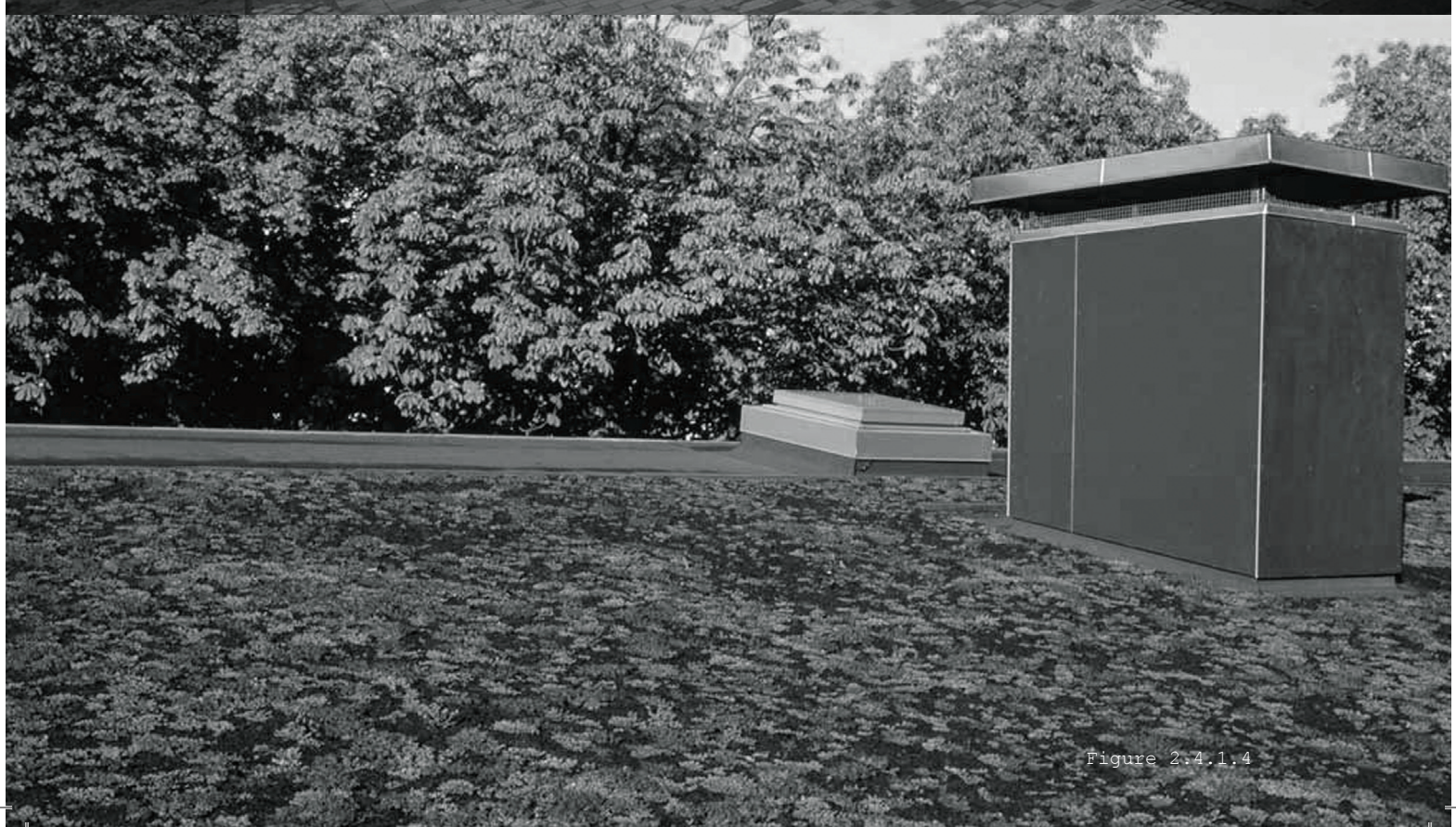


Figure 2.4.1.4

- 2.4.2 Grimshaw Architects

The second company that has been interviewed is Grimshaw Architects. The reason for choosing them was, that they have made some projects, which are well known as sustainable projects. Furthermore they have an active environmental policy in the office with an ISO 14001 environmental certification, as well as a membership of the Green Building Council, where the office's carbon footprint is audited every year. Their home page does not say too much about sustainability, and how they see it in connection with architecture. As for the more design specific aspects they tell about Environmental Viable Architecture (EVA), which is described as a tool, that allows architects to asses the project's impact on the environment from the point of conception

What is sustainability to you – how would you define it?
Materials lifecycle is important – not from cradle to grave but from cradle to cradle. This is one of the main factors for them. Furthermore they recognize that the building industry has a huge impact on these things. In the office they work with sustainability on two levels. The first level is the design process, where they incorporate the different environmental measures and second level is the running of the office. In connection with the design process, they also try to educate their clients in how to take sustainable measures, which is mostly related to the buildings. As for the running of the office they are aware of how their work has an impact on the environment. They are members of the Green Building Council, where they get an annually audit of their carbon footprint. Furthermore they try to make incentives for the employees to for example take their bicycle to work, and make the way they work more environmental sustainable.

The first part here shows that they have two approaches to sustainability. One regarding their designs and one regarding how the office can be more sustainable. For them sustainability is more than just their approach to the work. It is just as much the impact they have on their surroundings as an office, which is seen through the membership of the Green Building Council. It seems like they try to be a good example for their clients as well. As for sustainability in architecture their focus is as they say mainly on the materials lifecycle. When they say cradle to cradle it can be seen as a sign of that they try to think ahead, and plan for the reuse of materials after buildings are raked.

How do you work with sustainable architecture?
The sustainable issues considered in the design process are a part of their overall quality assurance on all projects – it is an office

policy. This quality control is insured through the use of a tool to evaluate Environmental Viable Architecture (EVA), which allows them to track environmental concerns and decisions through out the process. It can be seen as a kind of a checklist, where the impacts on humans, biodiversity, hydrology, climate, embodied energy, transport, energy in use, energy loss, clean energy, land and soil, community and culture are checked. It works as an incentive for the architects not as aims. It is implemented from the beginning of the project, and through out the project it provides the architect with advises about which things to research and where to find information that is relevant for the different stages of the design process. Another aspect of this quality control is that the different issues can be weighted differently from project to project, but they all have to be considered. In connection with their process they involve consultants as early as possible. The earlier they can get them in the better - especially on complex projects. The use of consultants at the early stages allows them to work close together on the design and evaluate different solutions as they go along - Furthermore they have both design team meetings and workshops, where the knowledge from the different professions is incorporated into the project. As a last thing they are very aware of new tools that can help them evaluate different solutions during the design process.

The most essential part of Grimshaw Architects approach to sustainability is EVA, where the twelve different topics evaluated more or less covers all the different considerations within sustainability as seen in figure 2.4.2.1 and according to that it should be very sustainable. It is important though to notice that it is not the aim of EVA to achieve a certain goal. It is an aim to check if all these issues have been considered – a fact that does not guarantee a sustainable result. Some of the issues are essential in architecture as for example the impact it has on humans and community and culture. Other issues like the impact on land and soil and water in the earth are also things which are usually considered, as is energy in use and energy loss in the building. The rest of the issues are things that have started to emerge in the debate about climate changes. If taken part by part there is not really anything, that is revolutionary in this tool.

As for the design process and the way they work with their consultants some interesting observations can be done. First of all it seems like they work very close with their consultants and quite early in the process they involve them in the design teams so that consultants and architects can benefit from each others knowledge. The more complex the project is, the more important it is to them. They have examples, where engineers have made calculations on different design

solutions early in the process, in order to help them to develop the ideas further in terms of how energy efficient they were. At the same time they try to implement different tools that allow them to make qualitative evaluations of different design solutions in order to evaluate these in a quick and easy way. They have gotten far in the process of using their consultants actively in the design process and they are very aware of finding tools that can make it easier and more efficient to do it, which is a really positive thing.

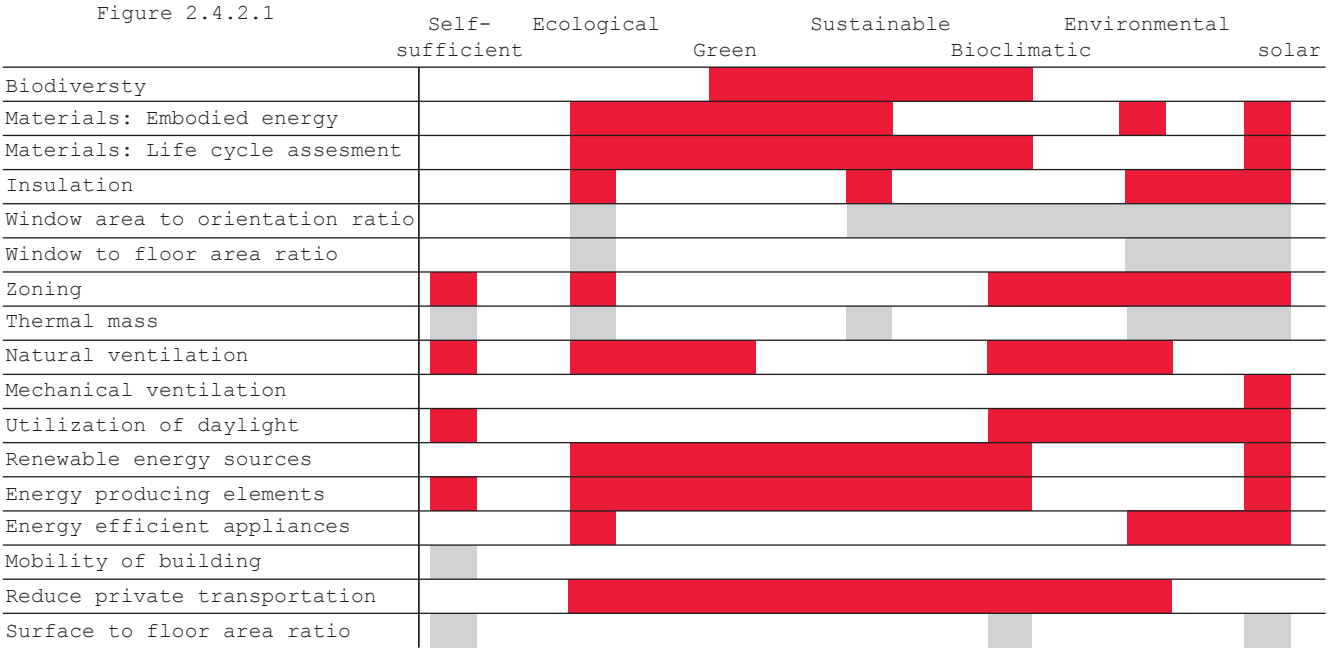
How do you develop your knowledge and work with sustainability?
Within the office they recently established a research and design group that consists of different staff members from all the different staff functions. Their function is to conduct research into the specific subject areas of EVA, where the main object is material specification. This group meets on a regular basis to exchange information and recently they have also started to conduct presentations for the rest of the staff in order to inform them of new things. Besides this research of the different subjects in EVA, there is also a focus on new tools which can be used in connection with different projects. One of the tools recently introduced was Ecotect, which allows them to evaluate different subjects in the design process regarding sustainable issues like energy performance, sun angles, wind angles and things like that. Furthermore the initiatives do not just come from the top. It is an open process, where all have a saying, and the directors are open to new suggestions.

The last part here confirms a very active approach to the work with sustainable issues, where they involve the staff in the development and research into the field. It is not just architects or architectural technicians that have to do it, but it is involving all the different functions in the office, which allows for an effective strategy. The research is in general based on their concerns stated in EVA, and in tools that can help them make their work process better and simpler. The information for EVA allows them to make it more efficient as a tool and gives the architects more information they can use in the process on all projects, as it is implemented in all projects. On the other hand the more specific design tools allows them to make qualitative evaluations on specific parts of the design. By putting an effort in to making research in these two areas they are able to maintain a high level of knowledge that can be used in more intuitive ways in the process as well more specific design tools, that allows them to see the more exact effects of what they do.

Overall Grimshaw Architects gives a positive impression. As mentioned the issues they are dealing with are not new or revolutionary. The positive thing, is that they are trying to develop an active approach

towards them and tries to develop a program that forces the architects to consider all of the things from the beginning. The issues are not something that is added, but the considerations of them are now a natural part of the process. Furthermore the program provides the architects with information about where to seek help and knowledge about the different subjects. The program is not a guarantee that the architecture will be more sustainable though, and as they state the sustainable issues are considered along with other issues like construction and detailing. In order for it to be more sustainable it requires that the client is aware of it as well. A lot of their clients, which are fairly big corporate clients can have an effect, because it can be a part of branding their company. By now many companies are aware of how the focus on such things can be used, so that might be an incentive to actually do something about it. Their awareness of the offices own sustainability is also worth noticing. It is a branding of the office, and some clients do come to them because of that. There are still things that can be questioned. For example the use of steel and glass which are both materials with a big amount of embodied energy. This is something that challenges what they are actually saying. So even though they have some really active measures and they have gotten a part of the way towards being more sustainable there are still measures that can be taken.

Figure 2.4.2.1



The red bars are the ones that Grimshaw Architects are utilizing in some of their designs

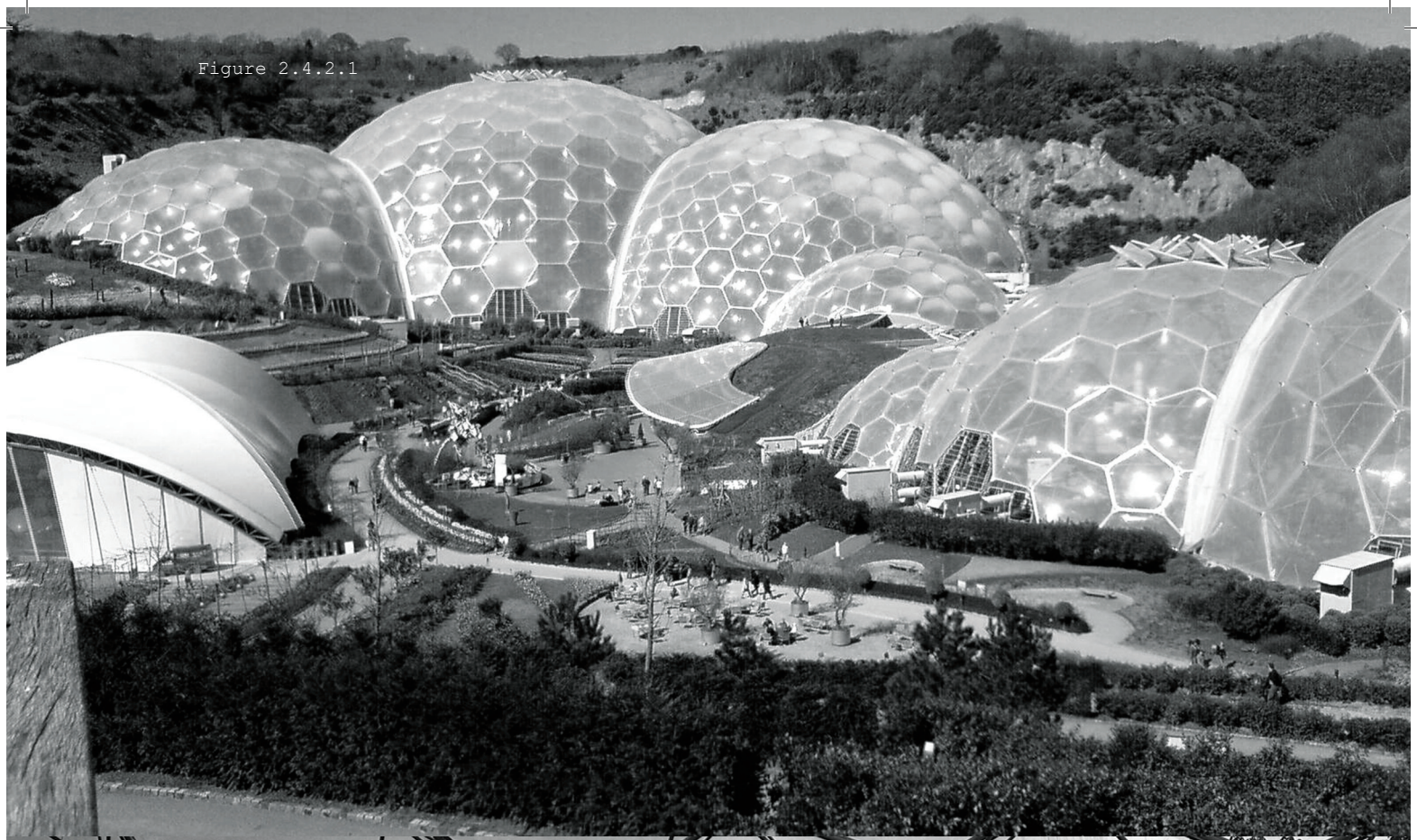


Figure 2.4.2.1

Eden Project is a key project in terms of sustainability for Grimshaw Architects. It is a project people knows and some clients approaches them because of the sustianble issues in relation to this project

Figure 2.4.2.2

Figure 2.4.2.3

- 2.4.3 BBM – Sustainable Design

The last company that has been interviewed in terms of sustainability is BBM- Sustainable Design. This company was chosen, because it is a small company and therefore it would be possible to study how they were working with sustainable issues in comparison to the two bigger companies. Furthermore they have a clearly defined environmental policy in the office, which is also mentioned on their home page. Among the things they do is to encourage their staff to use public transport or take their bike to work. When client meetings are held in the local area they use public transport and things like that. Furthermore they have a clearly stated design strategy and the focus is to reduce CO_2 emissions.

What is sustainability to you – how would you define it?
This was the first question in the interview and the answer is quite interesting – first of all, their name BBM – Sustainable Design. As they say it is a name that attracts clients. For them sustainability is to reach an equilibrium with the ecological capacity of the planet, and until it happens it is a process, where ones measures within sustainability can always be improved. A thing that has triggered this interest was the depletion of the ozone layer back in the eighties and later it has been the discussion about climate changes and carbon emissions. As mentioned the name is branding and clients who have seen the name in articles or magazines comes because of that. At that stage in the process they start by telling that because they get a house where there is a focus on local materials and the embodied energy is low, and furthermore the processing of the materials is as low as possible, does not make them sustainable as people. A point they stress very clearly. Because you have a sustainable house, does not mean that you as a person is sustainable.

Their understanding of sustainability is based on an ecological concern, where the overall goal is to achieve an equilibrium with the ecological capacity of the planet. The focus area for them is materials and their lifecycle, as well as energy used in production of these. Transport is also an issue, and there is a strong focus on local environments and what they can use from them. Besides these things they acknowledge that lifestyle is an important factor. Something they try to make their clients aware of as well. This is also seen in the sustainable policy of the office, where biking and public transport are important parameters in achieving a more sustainable office. Such an awareness of the impact the office has can also serve as an example for their clients.

How do you work with sustainability in architecture?
The main focus here is, as mentioned before materials, and their interest is the landscapes and the materials the landscape provides. By focusing on this it gives a unique possibility to work with architecture, that is heavily influenced by the local landscape and local resources. Their approach is quite intuitive with test and trial, and nothing really scientific about it. They rely on their knowledge from previous projects. They are aware of that the things they do might not have the biggest impact, and the improvements in embodied energy and the improvements regarding the energy consumption of the building during use might be limited. As they say calculations of air changes in the building and all the smart gadgets is not their way of working. There are people far better at those things than they are. Another aspect which is important to them is the reuse of materials. In their design they are quite focused on putting the building together in a way that allows people to take it apart at some point and reuse the materials without breaking it down and destroying it. As for the process it is different from the two previous companies. They mostly work on their own, without too much contact with consultants during the design process. The main reason for this is that it is mainly small residential buildings they work with. Furthermore during the building process they work closely with the workmen on site. For them it is very important that there is a close cooperation between them self and the workmen in order to achieve a high quality in the materials, and to make sure that the treatment of the materials is correct. Furthermore it is important for them that the workmen understand the idea behind, so that they feel an involvement as well. As a last thing, in connection to this, that it ideally would be best if they worked with consultants from the beginning of a project.

A thing that is really important here is that they are not sure of how big an impact their buildings actually have. This very intuitive process does bring up certain questions about how sustainable their buildings actually are. Their focus being on materials and if they can be recycled and reused, as well as making it possible in the design of the building is important. If these things are put into figure 2.3.1 the result will be as seen in figure 2.4.3.1. All of these things are simple things to achieve, and the evaluation of them is qualitative and based on their experience as well as intuition. The focus on these simple things also has to be seen in relation to the size of the office and what clients they have. It is clients with a very limited budget – most often private clients.

When talking about the work process and their cooperation with consultants it is a linear process. The architects make the drawings and the engineers solve the problems and make the solutions to

the architect's specifications. Again this process has to be seen in relation to the client and budget. Another issue they mention in relation to this is the consultants. It is usually small local companies with a limited number of employees, and limited means. Furthermore they are usually conservative in their approach to the work, meaning that the knowledge they posses are based on what they are used to work with. This is a very big limitation if trying to implement a more dynamic work process, where architects and consultants are working closer together in teams. Furthermore it is important for them to have a good relationship to both consultants and builders. They have to feel they are a part of it, and that things are not forced upon them, which again limits the possibilities. This said there seems to be a slow development towards a process where they are working closer together with the consultants.

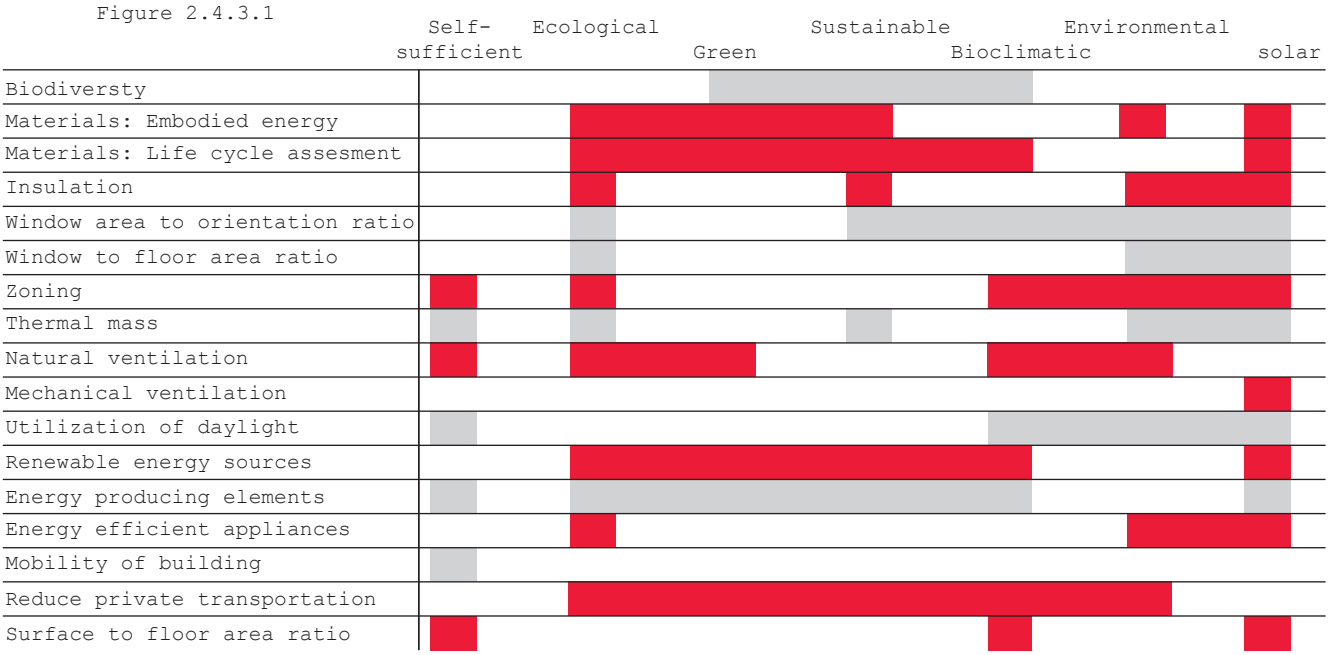
How do you develop your knowledge and work with sustainability?
Curiosity towards new technologies as well as inspiration from how things work in nature is the main source. The example mentioned in the interview was an open lecture about how humans can learn form nature – how it can be mimicked in different things as for example buildings. Furthermore they try to learn from their experiences. As mentioned before, where new things primarily are tested on their own homes, before they are used in a wider public. They are searching for materials and methods to process the materials in a way that is as simple as possible in order to use them. Another example of things, which is possible today because of new glues and sawmills technology, is the use of wood grown by grafts, that allows the tree to grow faster. So they rely on technological developments and inspiration from nature. Inspiration from nature is not just how to mimic it but also to find materials in an area that can be used, as well as looking at older building techniques that can be used for different purposes in the building.

As seen here they search for solutions and inspiration in new technologies as well as nature. Even though they do not utilize very technological solutions they know that technology is a part of this and that it provides them with new possibilities. Furthermore it is based on trial and error. Not very scientific as they have stated, but it seems to be the way to do it for a small company with limited means. It cannot be said that they have new highly scientific knowledge or approaches to develop these things, but it seems like it is a very ideological approach instead.

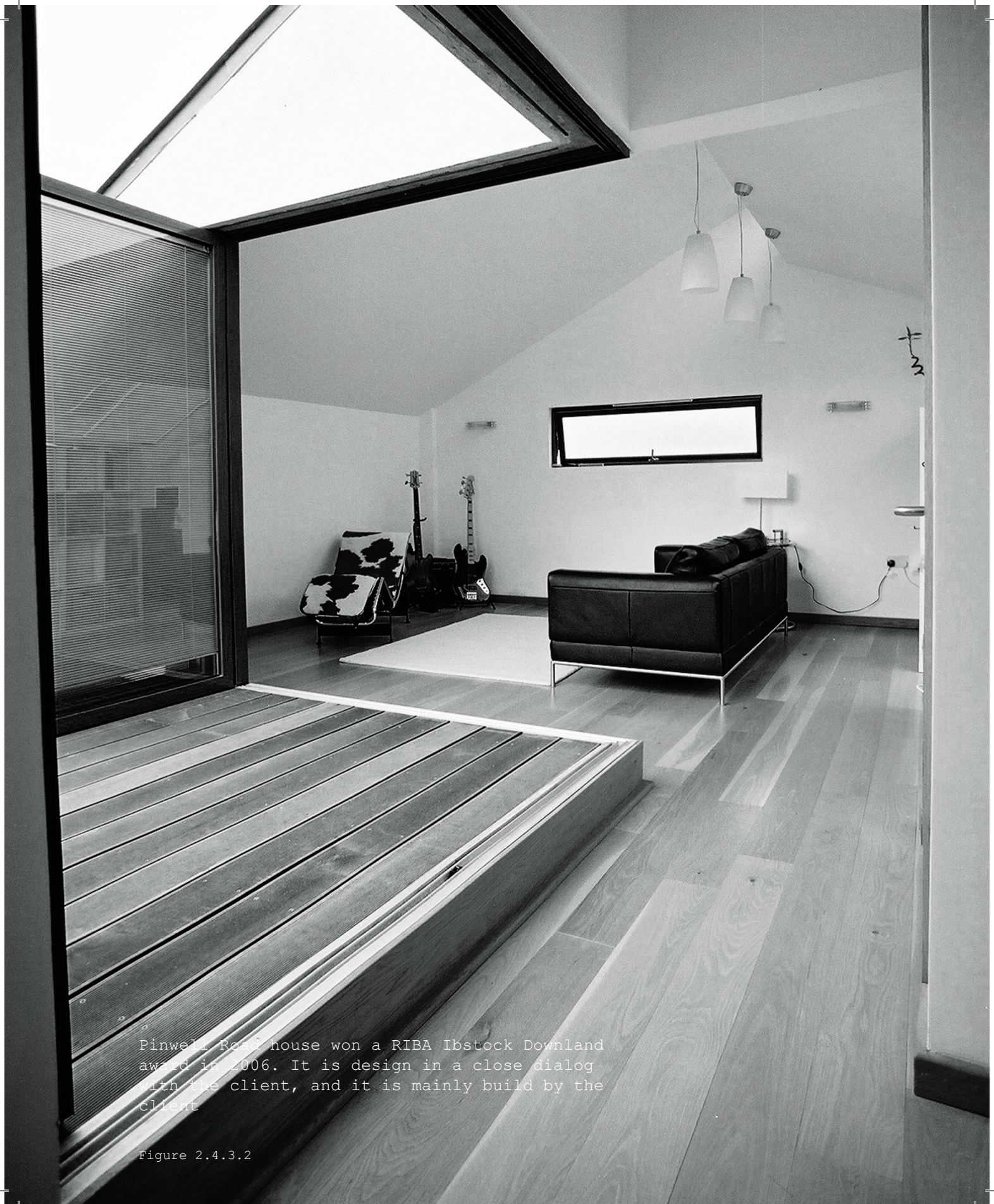
Summarizing this interview it can be questioned how sustainable they actually are. The means they have are quite limited the design methods based on intuition, and they state them self, that it can be questioned

if they actually achieve their goals. But if one focuses on what they do it is evident that they do something actively to become more sustainable. They pursue a goal with the means they have available. Being a small company they do not have the means to use technological tools, and the consultants are conservative and do things as they are used to. New approaches are hard for them to handle because they do not posses the knowledge to deal with it. These are the main issues for questioning their sustainable achievements. There are positive things as well though. They focus on simple things that are accessible to the average family. This is something that underscores the connection between means available, in terms of knowledge as well as economy, and the approach taken towards sustainability. They have to focus on things that people can understand and relate to, and tries to develop their architecture on such a basis. Furthermore they are very aware of that the building alone is not what makes people sustainable. It is their habits.

Figure 2.4.3.1



The red bars are the ones that BBM - Sustainable Design is utilizing in some of their designs



Pinwell Road house won a RIBA Ibstock Downland award in 2006. It is design in a close dialog with the client, and it is mainly build by the client

Figure 2.4.3.2

Figure 2.4.3.3

- 2.4.4 VGL CPH

The last interview made was not with a practicing architect, but with an architect, who teaches sustainability in architecture for both students and graduated architects. The architect chosen here was Vibeke Grupe Larsen owner of VGL CPH. She was chosen, because she has been teaching both students and educated architects since the end of the nineties, and she is conducting workshops about the subject. Furthermore she is part of the environmental committee in Akademisk Arkitektforening, and she is working with different architectural offices in order to help them get the ISO 14001 environmental certification.

What is sustainability to you – how would you define it?
Sustainability in architecture has three levels. The first level is the technical level concerning resources and consumption, where materials and energy savings are some of the issues. The second level is the cultural, where the aim is design of spatial quality – to design spaces where people feel a home or feel they belong. The third level is the economical level, where it is considered, if it is viable to implement the two before mentioned levels. Architecture's starting point is the context, where the two first levels are very important with resources in relation to the place as well as the cultural perception of spatiality, and what makes one feel at home.

Sustainable architecture as seen here is closely related to the definition of sustainability in "Our common future" from 1987 with the cultural, environmental and economical aspects. Within architecture all of the three has to be present, where the environment is dealt with in practical solutions. The point is to design in a way so that energy is saved. The cultural is more about how we feel in the spaces. They have to relate to how we live. And as mentioned the economical is very important, because if it is not perceived as economical viable it will not be build.

What is important when working with sustainable architecture?
An important aspect in working with sustainability is, that there is a framework for it, that creates incentives for the architect and client. A voluntary basis will just attract idealists not a broad spectre of architects and clients. That being said the idealists are important, because they challenge some of the conventions. Another important issue, is not to make it something divined, that is seen as unreachable. It has to be founded in a practical approach with strong connections to the real world. This can for example be done in workshops, by making projects, that are already running in an office, the starting point for the discussion. By doing that the architects

can relate to the different things instead of just having vague ideas about, what the discussion is about. In connection with sustainable architecture one can split architects into three groups. The first one being old experienced architects, that more often than not, have a critical approach towards new initiatives concerning sustainability – the second group being young not too experienced architects, that has a much more open mind towards sustainability, and sees it as a challenge – the third group being students, that sees it as a condition for their profession, and have a personal commitment towards it. When it then comes to dealing with new approaches, it is not related to these roughly defined groups, but more to how people have been taught. When taught in very specific ways of solving a problem there tend to be a certain resistance towards alternative approaches, whereas people who have been forced to find alternative solutions, are more open towards new approaches. This is a very important factor when working with sustainability, because it is important to work with an open mind towards alternative solutions. This allows architects and engineers to work close together, which is essential in order to avoid problems. In the end it should be more economically viable, because the problem solving and redesigning in the end of the process can be avoided. As a last thing, it is important that the directors in the architectural offices realize the importance of the sustainable issues. Often the educational workshops and courses for practicing architects are attended by the same idealists every time. Instead it would be positive, if directors attended them in order to provide themselves with more knowledge about the issues.

As for how sustainability should be approached in architecture there are several levels. First of all it is important, that it is based on practical aspects. The architects needs to able to relate to the methods. As for the process an integrated design process is mentioned, where architects and consultants work close together on the projects. Here the different participants' openness towards new things is important. In order to get such a design process to work, the participants has to be inquisitive and be able to use different approaches towards the same problem as well as utilizing these things when working. It is something that sounds easy but nowhere is it mentioned how this can be done.

How do you develop your knowledge and work with sustainability?
Inspiration and new inputs comes from all kinds of things. New approaches and new themes in the discussion are found in all different kinds of issues. Not that they necessarily have a relation to architecture, but the curiosity towards the different issues is important, and new directions and relationships within the discussion may be found. For example a student asking what sustainability is in

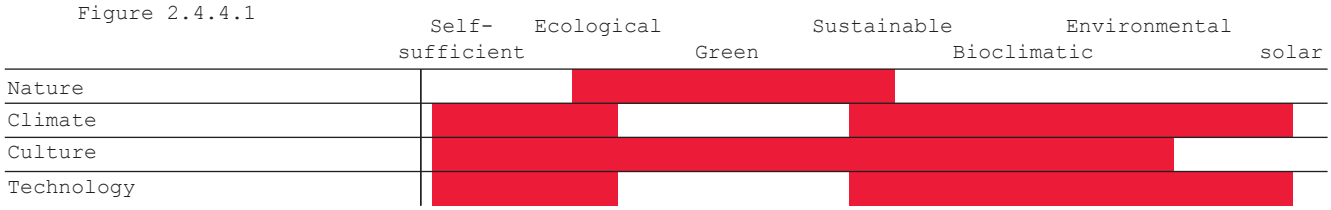
Iceland? It opens for a discussion about what sustainability is in all kinds of different places. What is sustainable in Denmark, may not be sustainable in Iceland. It is a combination of political, cultural and climatic conditions in different places.

New knowledge and ideas concerning sustainability does not necessarily come from architecture. It is often a search for relations and topics in the world around us. By studying such things it is possible to find new relations, that are relevant to architecture. Furthermore it can be seen as a way of investigating how different relations affect the world and a curiosity towards interrelationships in general. Such an interest in interrelationships is also a sign on how architecture is affected by a wide variety of fluctuations in our society.

Overall there is a call for a very pragmatic approach to sustainability in architecture here. It has to be something that is understandable for both architects and clients, and something they can relate to and feel is an expression of its time and culture. The idealistic approach is not the way to go, as she sees it, and furthermore the dusty image of sustainable architecture has today, has to be changed towards a more contemporary image. As for the design process it is a process where architects and consultants work close together from the very beginning of the project – a very good intention but without any answer of how it can be done except for a bit of talk about the participants having to be open to new things. It can be questioned what incentives they have to move faster in that direction, and what it takes to make them do it. It was something she stated has to happen, but there were no answers or ideas of how to do it.

It has been chosen to show, where she fits in this in relation to concerns and not methods. The reason for doing this is that she no specific methods are mentioned, and there are no practical examples to show, where she would belong there. She is put in the sustainable approach here, because of the way she sees it as a mix between culture, environment and economy, that are very closely related to the Brundtland reports statements. This is also the basis for the sustainable approach (figure 2.4.4.1).

Figure 2.4.4.1



The red bars are the ones that BBM - Sustainable Design is utilizing in some of their designs

2.4.5 Conclusion

From the four interviews there are some quite distinct things, that are worth noting. One of the first things is the branding of sustainability in architecture. As it is mentioned in the interviews, sustainability and that people are aware of such issues now, is important for the companies. As BBM – Sustainable Design puts it:

"it keeps the clients coming"
[Interview with Ian Mckay codirector of BBM – Sustainable Design]

A comment that is taken out of the actual context of the interview, but it is a really good expression of how much sustainability and being branded as being a sustainable practice means today.

All of the interviewed architects had concerns about sustainable issues, and they all have intentions of improving their work with it in the offices. But at the same time it was evident that there is a difference from having an intention to actually doing something about it. The interview that really showed that was with Arkitema. There was no doubt that they had concerns about being sustainable, and they knew what they wanted to do, but they had not really implemented the tools, that made it possible. They struggled with finding solutions to how some of these ideas actually could be implemented. Furthermore it was seen when talking about how to work with it. Here it was mentioned that the ideal process was when architects and consultants were working closely together from the very beginning. But right after that it was stated that it was difficult because not everybody was ready for that yet.

At the other end of the scale regarding the incorporation of sustainable issues in the practice was Grimshaw Architects. They clearly had incorporated measures which allowed them to track decisions regarding sustainable issues during the process, and it is used on all projects today. Of course the use of such a tool does not guarantee a sustainable building. Furthermore it was seen that they were very aware of how to use their consultants in the process, and it seemed liked they were able to work in a very constructive way with them. Furthermore there was a very active approach to develop their own skills and knowledge in that area.

Another interesting aspect which is evident in the interviews is the means available for the offices. Here BBM – Sustainable Design being a small office had far less means than both Arkitema and Grimshaw Architects, and their focus were on a very limited number of factors, all of which were possible to work with without having different

programs. Furthermore they did not work with consultants during the process. The reason for having such an approach was that there is a lack of local consultants that possesses the knowledge needed to develop these ideas further, so the architects are forced to use the means they can. It was stated though that they tried to develop relationships with some more progressive local consultants, which then at some point could be involved in a closer work relationship. Furthermore the size of the projects dictated that it often was impossible to work closely with consultants, and their own knowledge would have to be sufficient. This, of course, brings up the question of how sustainable their buildings actually are. The uncertainty is caused by the lack of calculations, and the lack of measurements afterwards. The users have no doubts about the qualities of the buildings, and they express a fondness for them.

The size of the projects Grimshaw Architects worked at, was far greater and the economical means in them allowed for them to work closely with the consultants from the beginning. A fact which would most likely also save money in the end, because problems would not have to be solved, but instead solutions were designed to avoid such problems. Furthermore there were numerous calculations and evaluations mainly qualitative but also some quantitative during the process, and monitoring of the buildings afterwards to ensure that the buildings performance were as predicted.

If these things are seen in relation to what Vibeke Grupe Larsen said the similarities are big. The interviewed companies are trying to achieve these things the best way they can. But there is as mentioned a big difference in what is said and the actions taken. All agreed on that a process where architects and consultants worked close together from the beginning was important, but it was seen that there was problems with how to actually implement it. Grimshaw Architects were relatively far in that process, whereas Arkitema had just started. One of the issues related to this is the participant's attitude and readiness to think in new ways and cooperate with other professions. A certain conservatism could be observed when talking about these issues, and it seemed like the architects interviewed was weary of taking steps towards being more open towards consultants. They all new it was necessary to work with them but uncertainty of how it should work in practice was seen

- 2.5 Conclusion

As seen the different design methods within the sustainable discussion are not new to architecture, but have all been present in architecture before. What has happened, is that some architects have started to be

more aware of them, and how they can affect architecture in terms of being more sustainable. This in connection with different approaches towards sustainability in general, has led to the different approaches within sustainable architecture. The different approaches then relates to different concerns that are general for society today. This gives an idea about how architecture is affected by the surrounding society. Discussing these different approaches also showed that the terms used to describe them were used rather interchangeable. It is of course this interchangeable use that makes the discussion about sustainability in architecture confusing, but as seen when the design methods and concerns are taken into consideration it is possible to make a differentiation between these approaches, and through that they become an effective tool in the discussion about such issues.

Applying that knowledge to the interviews, a framework for comparing the different architects were created. The framework made it possible to discuss and compare the different architectural companies and their approaches to sustainability in architecture. By making the comparison certain issues became evident. Most importantly the branding sustainability gives. Even though it might not be intended everybody said that a reason for some clients to approach them, was their work with sustainability. It also showed that the companies were in different stages of their implementation of these things. Some were far in the process as for example Grimshaw Architects, whereas Arkitema, seemed to be in the beginning of the process of implementing sustainable measures. Another interesting aspect was the difference in size and means and how that had an impact on the "sustainable style" chosen. Here a small company like BBM – Sustainable Design was working with few means to obtain a sustainable approach, whereas Grimshaw Architects had the possibility of using different measures to achieve sustainability.

Seen in this perspective the sustainable approaches do provide architecture with new focus on known methods. Furthermore the approaches are influenced by the general concerns about climate changes today, and works as to position architecture in that debate. When seen in a general perspective it is important to study further how it relates to architecture, and how it can be a part of repositioning architecture in a way, that makes the different approaches to sustainability in architecture more integrated than it is today. By making it more integrated it can also help to change the image of sustainable architecture from the primitive image it has today and make it more contemporary. In order to achieve that, it is necessary to investigate how we see the concerns nature, climate, culture and technology, discussed in relation to sustainability in terms of what it means to us.

3. Ethics in sustainable architecture

- 3.1 Introduction

The aim for the third chapter is to investigate how the four concerns, nature, climate, culture and technology, briefly discussed in chapter two, are related to architecture. The study is made because the terms today have a strong moral and ethical connotation. When discussed it is often about what we should do, and they do have a very strong influence on how we behave, which again has an influence on architecture, and how architecture can use this strong ethical concern in order to reposition itself in today's world.

The first part of this chapter will take its point of departure in a discussion about ethics in general, in order to provide a framework for the following parts. Furthermore this part will focus on how the different positions within ethics, are related to discussions about sustainability. The focus of that part of the discussion will be to investigate briefly how it relates to the deep ecological movement, as it is discussed by Arne Naess.

The second part will be focused more on the ethical function of architecture. The starting point here will be the architect's responsibility towards the clients and legislation. It could be said, that it is the legal duties for the architectural profession. This will then be investigated further to determine if there are other dimensions in relation to the ethical function of architecture. The point of departure here is Karsten Harries's discussion about the ethical function of architecture, and how it is seen as a common ground for people to understand architecture, and give it a meaning that is deeper, than the almost purely functional that is often the main focus today. Furthermore this is elaborated through Alberto Pérez-Gómez and his discussion of what architecture is build upon. When he is talking about what architecture is build upon, he is talking about values and thoughts, not the physical measures [Pérez-Gómez, 2006].

The last part of this chapter will focus on how the common ethics, concerning sustainability, and the ethical function of architecture can be used to reposition architecture in today's world. The point of departure here will be the discussion about tectonics by Bötticher and Semper from the middle of the nineteenth century. Their discussion takes its starting point in the debate about which formal style to replicate in the middle of the nineteenth century. Instead of taking a stand point there, they proposed two different approaches towards architecture. Bötticher proposed that an analysis of the physical and

social context as the starting point, whereas Semper proposed that architecture should be founded on a study of the essence of early human settlements.

The tectonic approach has no direct relation to the discussion about sustainability, but there are certain similarities between the discussion in the middle of the nineteenth century and now. Those similarities make a study of the tectonic discussion interesting, and it can help to provide a framework, where the sustainable concerns becomes a more integrated part of the architectural process. Such a framework can help to place architecture more firmly in today's cultural movement and by doing that help to reposition architecture.

- 3.2 Ethics

Basically ethics is about how we treat other people and how we should live in and treat the world around us. It is a practically matter about how we should act in a moral and responsible way [Bennetts et al., 2003: 42]. It does sound like a simple thing but there are several different positions within the ethical discussion, that briefly will be summarized here. The point of departure will be ethics in general, which then will be related to the discussion about sustainability.

A discussion about ethics leads to a discussion about values, since values is what defines what we as people in a western society find is right or wrong. The discussion here is limited to a western cultural context. As mentioned these values help us to define what is right or wrong, and by doing that tells us how to behave. In other words it tells us what we ought to do and what we should do. But values can be several things. Values for an economist are most likely different from those of a philosopher. In general values can be seen in two ways. There is the instrumental value, meaning that something has a value to us as humans. For example a place where we like to go because it gives us a possibility to do something there, or just because it is a nice place we like to go and relax. As seen it has a value to us. The other kind of value is an intrinsic value, meaning that something has a value in it self. This value is not dependent on our thinking. It has a value of its own, or one can say it has a good of its own, that is independent of other things [Bennetts et al., 2003: 44]. With this as a starting point there are three different positions in the discussion about ethics, namely the moral class, rights and duties and the consequentialist position, which will briefly be summarized here.

The first position to discuss is the moral class. The focus here is on who the stakeholders in the decisions are. Traditional in western culture the stakeholders are humans, or maybe even more radical, humans living in the western world. This is referred to as an anthropocentric orientation. We as the stakeholders then take the decisions, meaning, when discussed in relation to sustainability, that unless the degradation of nature and the exploitation of natural resources has an impact on our well being, it is not considered to be unethical, because it is not a part of the moral class [Bennetts et al., 2003: 47]. There are other grades of the moral class so to say, and on the other end of the scale is the eco-centric orientation. Here all living beings as well as natural environments are considered to be a part of the moral class as well. By natural environments is meant mountains, flood valleys and other things in nature, that are normally considered to be "dead" [Bennetts et al., 2003: 47]. Being a part of the moral class means that exploitation of natural resources and degradation of nature is considered unethical, and therefore cannot be accepted. This is a stand point that is closely related to the deep ecological movement, which will be discussed later. Furthermore the general opinion seems to be moving towards such a standpoint on the "moral class scale" today, where the values of nature are getting more and more attention, not only in economical terms.

The second position is concerning rights and duties. Here the focus is an acceptance of a responsibility towards maintaining a life, that does not interfere with the rights we as humans has. This means that if one has a right to a certain standard of living, one also has a duty not to do anything, that can interfere and threaten that standard of living. So by saying we have a right to something we also accept that we have a duty to protect that right. The most obvious in this relation is the human rights, that all countries and people have a duty to protect. If this is seen in relation to the discussion about sustainability there are certain points that become important. First of all rights can be assigned to both living and "dead" things - things in general which are considered to have value. One thing that can be discussed in relation to this is that we consider our self to have a right to use natural resources in order to develop our society. If the position of rights and duties is then taken, then we also have a duty to maintain nature, which provide us with these resources. One of the difficult things in this relation is that it does not deal with the consequences of our actions here. An easy way to describe this position is that we should act in a way towards others as we would like them to act towards us – we should act consistently with our statements. [Bennetts et al., 2003: 48].

The last position here is the consequentialist position, which, as it

says, is about the consequences of our actions. In short it is about producing the best consequences. The question then is what are the best consequences and who decides such a thing. The perception of this varies naturally from person to person, and is dependent on how one sees the world – ones values. Within this position there is in general no recognition of absolute rules or rights and duties. Here the concern is not the duty, but the result of an action. For example the aim can be to achieve as much sunlight as possible in a building. That could be achieved by building a tall building in a low rise area, but that would bring some unfortunate circumstances in the surroundings. The building would deprive the neighbours a part of their sunlight. So to just focus on the consequences of the actions is very dependent on the values that are set [Bennetts et al., 2003: 51].

Ethics in sustainability is mostly discussed as three different positions, namely the shallow, intermediate and deep environmentalism. The shallow environmentalism can very shortly be said to be concerned with humans being on the top of the system and only considering nature if it has an impact on our wellbeing as was seen in the anthropocentric orientation, whereas the deep environmentalism is seeing everything on the planet as being equal as it was seen in the eco-centric orientation. Seen in relation to the three above mentioned positions within ethics the three positions used in connection with sustainability consists of a mixture between the moral class, rights and duties and the consequentialists. To say that sustainable ethics is closer related to one or the other is not possible. The crucial in this discussion is what we define as having a value, and what kind of value it has. Here the deep environmental approach will be discussed in order to investigate if such a position is possible to implement in our current culture.

Deep environmentalism, or deep ecology, as discussed by Arne Naess, is usually seen as a regressive movement calling for a primitive way of living, where it, to use a popular term, could be said, that we should live from hand to mouth in a very primitive cultural society. A further investigation into the movement of deep ecology, as is made by Arne Naess, shows a different picture. The main objective in the movement is to live in a symbiotic relationship with nature. As it is with today's population, it will require a decrease in the planet's population. Furthermore it requires a different view upon certain things in our western culture, like the perception of development, the approach to technology and the perception of living standard [Naess, 1989]. It is these three things that briefly will be summarized here.

The first issue to discuss here is the approach to technology. The image people usually get, when discussing the ecological movement's approach

to technology, is one of a very primitive world with manual labour and no technological developments, as we know them today. According to Arne Naess this is not right. That being said the focus on technology has to change according to them. Today's view on technology is mostly that of being as efficient as possible in order to make a profit. To some extend it becomes technology for the sake of technology, which is mostly causing big centralised production units, with mass production as a result [Abel, 1997: 3]. The local production units and differences in cultural developments and needs are neglected and as a result a standardization and cultural uniformity is seen. Furthermore these technological developments do not take impacts on nature into the calculation. What the deep ecologist's call for is a technological development that takes impacts on nature into consideration. This means that both the impact the production units, as well as materials and transportation of materials and products, have to be considered. This is not the same as saying that we have to live in small secluded communities without any contact, but it is calling for more awareness of how our lives and our consumer habits has an impact on nature. Not just in regards to climate changes, but just as much to other kinds of pollution as well as exploitation of natural resources [Naess, 1989]. Another thing that can be achieved by working with much more local production units is that the cultural differences can be maintained and developed. The very standardized and consumerist western culture today, can be made much more differentiated in terms of local products and local materials. In terms of how architecture can provide a much more local cultural tradition, with the aid from highly versatile tools, that are already available today [Abel, 1997: 202].

The second thing to investigate here is development. Again the common picture in relation to development and ecology is a very regressive picture. Development today is usually measured in terms of gross national product (GNP), which is a purely economical factor measuring the production. If the production grows the GNP grows (Figure 3.2.1) and then there is a development. But it does not say anything about what kind of development. It is a purely quantitative measure. What the ecologist calls for is a more qualitative measure, where both growths in terms of social equality are taken into account as well as measures of the developments impact on nature. In order to talk about a positive development social equality as well as ecological equilibrium has to be fulfilled. Furthermore it has to be fulfilled on a worldwide scale, and not just in individual countries [Naess, 1989].

The third and last issue to take into account here is our perception of living standard. The living standard of today is often perceived in terms of how much we have in a materialistic sense. To put it bluntly it could be measured in terms of the amount of cars per family, the

size of our homes or other such things. But none of it tells anything about if our basic needs are fulfilled. What the ecologists call for here, is instead of a measure of our living standard a measure of our quality of life. One can then ask what the difference is between those two. Talking about our quality of life is talking about if our basic needs are fulfilled. It is about if we have the things we actually need in order to be able to live a decent life. It has nothing to do with the amount of cars or the size of our home, but instead it is if we live in a healthy environment without pollution – it is if we are able to live in a way, that allow our surroundings to be healthy as well [Naess,1989].

Ethics is very much about values and our perceptions of things as seen above. By changing such things it is also possible to change our behaviour and it could mean a more sustainable way of living. When introducing the deep ecological movement in this discussion it is not to say that it is the only way, but it is in order to show, that what at first might seem like a radical change in our lives, might be something that is within our capabilities and when seen in terms of ethics, it might be considered as a source of inspiration. Such a change does not happen over night. It is a long process with small steps – something that is also recognized by the ecologists. One thing that has already started to change now, is the perception of consequences. A greater knowledge about the impacts we have on our surroundings is starting to show in the making of policies. But to focus on policies alone to solve the problem is probably not enough. A change in the way we see the moral class is also necessary - moving away from the anthropocentric orientation towards a more eco-centric orientation – a tendency that is also starting to become evident.

Figure 3.2.1

GNP + Import = Consumption + Gross investments + Increase of stocks + Exports

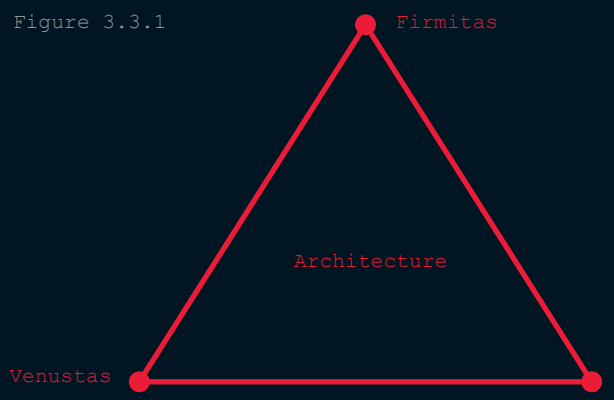
Gross National Product (GNP) is the result from adding up all the national accounts every year. It is the sum of the entire production in a country.
[Naess, 1989: 110]

Growth in production = growth in GNP -> development

- 3.3 The ethical function of architecture

When talking about ethics in relation to architecture there are several dimensions to it. The first is the duty to comply with the building codes. This is closely related to the rights and duties mentioned before. People have a right to a place to live, which lives up to certain standards defined in the building codes. Architects have a duty to fulfil these rights. But to see it only in relation to this is very narrow sighted, so this can be defined as the mostly legal aspect of the ethical code for architects [Bennetts et al., 2003: 48]. Besides what the building code says the architect also has to consider what the actual needs are for the client, and how the building fits into a social, cultural and physical context. These are not defined in the codes, but can be defined in planning legislation – sometimes there might not be any clear regulation in relation to these. No matter if there are clear regulations or not the architect has a responsibility to consider such things in relation to the client's needs, as well as the building codes. This could be called a code of conduct for architects. According to Tom Spector this code of conduct states that architects have to work with the three terms firmitas, utilitas and venustas, as they are defined by Vitruvius, and cannot only work to solve one of these. The architect has to reach a higher level, where all of these three terms are merged into one symbiotic relationship (figure 3.3.1). Furthermore there is a need for architects to be aware of the society around. The architects cannot just focus on the building, but has to be aware of what it does for or to the surrounding society. These are all things that are not stated in the building legislation, but things the architect has to be aware of and consider during the design process [Spector, 2001].

Figure 3.3.1



Vitruvius defined architecture as the synthesis between three pillars in architecture. Firmitas being the construction, utilitas being the function and venustas being the beauty

This perspective of ethics in architecture hints that there is a dimension in it, that is not often considered in public, but which plays a very important part in an architects work – giving architecture another, more metaphysical, dimension. Such a metaphysical dimension can be a help for people to identify with architecture not just in relation to the functional aspect that today is often considered the most important.

In order to investigate this other dimension to ethics in architecture, or one could say the ethical function of architecture, a study of the more metaphysical dimension of architecture, that is seen in relation to phenomenology has been made. The starting point for this is Karsten Harries and the two following quotes, where the ethical function of architecture is defined as

"...its task to help articulate a common ethos"
[Harries, 1997: 4]

Ethos here being

"…the way human beings exist in the world: their way of dwelling"
[Harries, 1997: 4]

What Karsten Harries states here, is basically that architecture is an expression of how we as humans are in the world, or in other words how we see and perceive the world. This is a difficult task today, where there is a wide variety of different perception of the world and how it should be, and so it has been since the enlightenment in the eighteenth century. To create such a common ethos, as Karsten Harries is asking for might be a difficult task. In the ancient Greece, architecture evolved around a common place. It was a place, where the citizens of the Polis met to exchange opinions. Architecture here was closely related to expressing a place for gathering – a place for democracy. It could be said that architecture was based upon an ideal image of the democratic gatherings. Later in the middle ages when the Gothic architecture started to evolve it was a different ideal. Here the Gothic churches were places for gathering around religion. The churches became an expression of peoples religious believes and their striving towards Heaven. The image here was that of the Heavenly city, which were described in the bible [Harries, 1997]. Both of these examples show how architecture has expressed human's relation to the world. Such expression or relation can also be seen as a kind of memory. Such memories are created through common values and pictures in societies, which then again creates images of an ideal image that the society strives towards. The ideal image creates a safe place of

memory, that provides the society with a security against the unknown. This security against the unknown can then lead to a regressive approach towards architecture, where the security of the known becomes the image which architecture represents [Horwitz, 2005]. This means that instead of utilizing our knowledge to develop our society, we stay in a static secure state, where architecture as well as the society does not evolve.

As mentioned in the beginning this is closely related to a phenomenological approach to architecture. These issues are discussed by Christian Norberg-Schultz when he is discussing presence, language and place, but what do these things actually mean in an architectural context. Presence is about relationships. Not physical relationships but a relationship between human and place. The place in which humans live their everyday life, and which has significance for them. Language is the architecture, or to be more precise it is how architecture expresses its presence in the world. It tells about architectures metaphysical dimension as well as places it in a certain physical place in the world. Place is the synthesis between presence and language. It is about how our presence has an interrelationship with the physical place of the building, which Christian Norberg-Schultz calls the Genius Loci [Norberg-Schultz, 2000].

The notion of these three terms is closely related to Karsten Harries's discussion about the ethical function of architecture. Where he is talking about the common image on which architecture is built, Norberg-Schultz is talking about presence. This presence is, as mentioned, about the human's relation to place. Furthermore this presence signifies the metaphysical relation we as humans have with the physical world in which we act. The metaphysical relation is dependent on our ideals on how we believe the world should be seen. This also relates to the discussion about ethics in the beginning of this chapter. One could say that this presence as Christian Norberg-Schultz is talking about and the common image that Kasrten Harries is talking about is a picture of how the world ought to be – the ideal world. This ideal world is what Karsten Harries describes, when he describes the democratic image in ancient Greece and the Heavenly City of the middle ages.

Today though, there is no singular image in which we can describe this presence. Within phenomenological architecture today, there is still a presence and a sense of language and place as described by Christian Norberg-Schultz. For example seen in Louis Kahn's works, where one of the most noticeable is Salt Institute in La Jolla, California (Figure 3.3.2). In this there is a clear synthesis between the ideas the presence of a space in which people and scientists have their daily

Figure 3.3.2

life, where openness, light, air is combined with the language seen in how this design is being transformed into form and how it communicates with the place. Allowing the building to overview the Pacific Ocean and almost becomes one with the ocean when standing on the plaza watching the little stream continue out to the horizon. It is a synthesis between presence, language and place, that creates a piece of architecture where people in their everyday life and work feel they belong.

In the end all of these things come down to how we perceive the world, and how architects express this through their architecture. How they interpret presence into language ending up with an synthesis between presence and place expressed through language. These things points towards architecture as being something which is more than a purely functional thing for humans. It points towards architecture as having a meaning in our lives, and expressing some basic needs and thoughts about how we are as humans, and how we relate to the world we live in. But one can question, if it is possible in today's architecture to express such common things. In the following part the concerns, and how they can be related to architecture will be investigated further.

- 3.4 Sustainable concerns in architecture

Nature, culture, climate and technology are the four terms, which in general expresses our concerns when talking about sustainable architecture. The aim here is to investigate how these terms can be utilized in a process, that allows them to play a more significant and inherent role in architecture, and furthermore allows architecture to move beyond the approaches discussed in chapter two. By saying "moving beyond" is meant that these terms which can be perceived as a way of labelling or branding architecture, and instead of that something that is closer related to architecture should be in focus. The starting point for this is the discussion about the ethical function of architecture above, which determines that architecture is more than just the function. It is an expression of the concerns and ideals of a society. The point of departure in this part is the tectonic discussion, which were started in the middle of the nineteenth century with writings by Semper and Bötticher. As a reaction against the post modern architecture it was then revived by Kenneth Frampton in the seventies, where he used it as an argument against Venturi's decorated shed [Frampton, 1990].

The starting point here is Bötticher and Sempers concern for architecture in the middle of the nineteenth century. Both of them were concerned about the discussion of what architecture should be at that time – a discussion that evolved around what architectural style

the architecture of the time should be built upon – the classical or the Gothic. Instead of taking part in this discussion they proposed two different approaches independently of each other, where they instead of imitating something tried to reposition architecture. These approaches has different starting points, but both of them are trying to achieve a repositioning of architecture, which will be discussed here in order to create a framework for the following discussion about sustainability [Frampton, 2002]

Sempers approach to tectonics is based on a search for the origins of human settlement. He argued that these origins, that were earlier understood by architects, had been forgotten. In his search for the origins of human settlement he hoped to find inspiration and knowledge, that could help to redefine architecture and instead of discussing what style architecture at that point in time should be build upon, namely Gothic or classical, it could find its own language through studies of the past. These studies lead him to four terms that he believed were the origins of buildings and the four basic elements in architecture, which could not be overshadowed by any style. The first and central element was the hearth, signifying the fire and gathering point for humans. The second element was the mound, that signified the plan of the shelter and kept the fire of the ground. The third element was the roof and structure, which kept the fire dry from rain and created the top of the shelter. The fourth and last element was the walls protecting the fire and people in the shelter from the wind. These four elements were derived from the primitive hut which he saw as the origin of human settlement (figure 3.4.1 - 3.4.2 - 3.4.3). Each of these elements were originally assigned different materials, where the hearth and mound were heavy materials, like clay or stone, the roof and structure were timber and the walls were of cloth or a membrane. Each of these materials had an intrinsic value, which made them purposeful in their function. The original thought about materials was based on a nomadic culture, where the settlements had to be easy to move around and rebuild. When the settlements then moved from the nomadic culture towards more permanent settlements the materials reflected this, through more heavy and durable materials in the walls and roof as well [Frampton, 2002].

Bötticher on the other hand tried to develop architecture in terms of the building’s ontological status and the representative role of the ornament. This led him to discuss what he called the Kunstform and the Werkform. The Werkform was the actual construction of the building, what was essential to erect it, whereas the Kunstform was the covering or the ornament of the building. Even though it was a covering the construction still had to be clear, meaning that the symbolic work of the ornament could never be allowed to cover or overshadow the

fundamental, constructional form. The fundamental structural form should clearly show how the building worked and how it was supported. This issue was especially important to him because the new technologies and materials developed, offered new ways of construction. It was the exploration of possibilities in these new technologies and materials, where Bötticher saw the possibilities of developing a new style in architecture instead of imitate other styles. In connection to this he stated that the only thing architecture should imitate was it self. These things were developed through an analysis of the physical and social context in which the building was to be built in. It provided his approach with a very forward looking stand point in the discussion [Frampton, 2002].

An example of a traditional tectonic building is a traditional stabbur from Telemark in Norway (figure 3.4.4). It is build from timber, which is a local material, the technique used is traditional, and there is a clear analysis of the site. This example shows a traditional knowledge which has been utilized in the construction of this hut. Furthermore the joint of the timber is closely related to the material properties, where the weight of the timber over time will strengthen the construction.

This example is very clear and simple, and the knowledge and materials it utilizes is from a rather limited context, where both are related to a particular regional context. Today though, such a "limited" knowledge and choice of materials is rare. To use a popular expression the world has become smaller. It is possible to get almost anything, anywhere at any time. Furthermore cultures are merging and changing

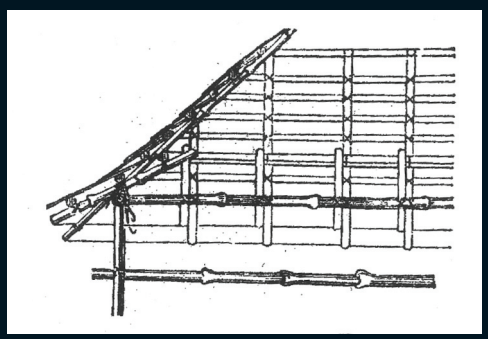


Figure 3.4.1

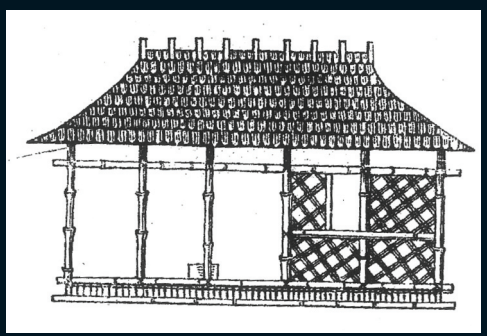


Figure 3.4.2

quickly, new sub cultures emerge, and society is quite dynamic. People travel all over the world and get new inputs, bring small parts of different cultures along with them. Furthermore the technological developments are happening quickly and new tools are developed very quickly and old tools are modified to become more precise, or easier to use. A more modern example of a tectonic building could show how these things can be understood today.

Sydney Opera House (figure 3.4.5 - 3.4.6) is well known as it lies in Sydney Harbour. If one studies it in terms of tectonic qualities some interesting things are seen. First of all, the entire base which has the back house functions. This part can be perceived as the mound. The concert and the opera hall as the hearth, where people gather, and the shells are the roof, and finally the glass allowing one to enjoy the view is the walls. Furthermore if one studies the materials used in relation to the different functions it is seen that the base made from sandstone creates a heavy base, the wooden concert and opera hall creates a warm atmosphere, with beautiful acoustics, where people can gather, and the concrete beams creates the shells and the main structure. Finally the glass creates the skin for the wall. In terms of technology some interesting developments can be seen in relation to this, where for example the pre-cast concrete beams used for supporting the shells, were a huge development. Furthermore the entire structure was extremely complex and very difficult for engineers to understand and later caused problems during construction. Seen in that perspective a variety of different technologies were developed and later these have been adopted in the building industry. Both Bötticher's and Semper's thoughts are present here.

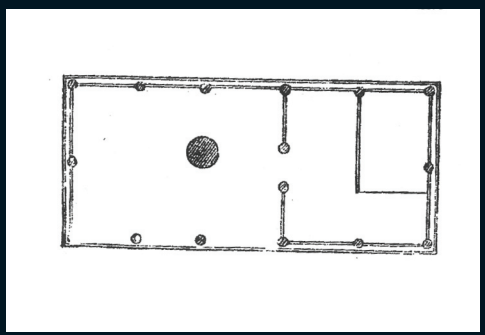


Figure 3.4.3

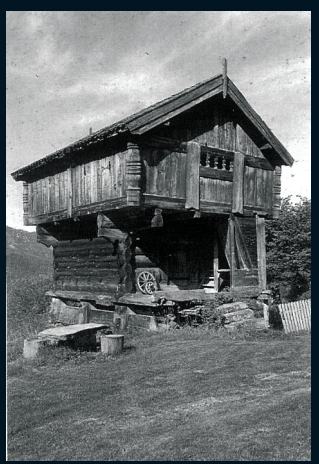


Figure 3.4.4

As the examples shows tectonic is closely related to construction and the possibilities different technologies and materials give. Today these possibilities are even greater, and makes matters even more complicated especially when the discussion is about the cultural and physical context. One can question where the limits are today, where the world is more or less a cultural melting pot. Then the question now is how the discussion about tectonics can be related to the current discussion about sustainability in architecture.

There is no direct connection between the thoughts in tectonics, which, as mentioned, mainly evolves around construction, and the sustainable issues and concerns. If a building that is perceived as being tectonic, like the stabbur from Telemark, and it is seen as being environmentally sustainable at the same time, it is not because it is the intention of the building to be sustainable. It is merely a side effect. Where the discussion about tectonics becomes interesting in relation to sustainability is how it takes its starting point in the physical and social context. Seen in the case of Bötticher and Semper they argue against the purely formal discussion about architecture, and they argued that architecture was based on either a rational technological thinking or the origins of human settlement. Both of these are moving beyond the formality. Semper based in history with his origins and Bötticher thinking ahead with a basis in modern technology. Both of these can be related to the ethical discussion in the previous part. Semper is in that relation expressing the basics of living or the basic of what we as humans needs, whereas Bötticher is expressing modern thoughts and progress. In more general terms they are trying to express an ideal image through architecture. If this is seen in relation to the ongoing discussion about sustainability in architecture there is especially one important similarity. This is that some of the means for architecture to be more sustainable is something that is applied to architecture. It is not an integrated part of it. This can also be seen in the way that the terms are used interchangeable. But as mentioned in the ethical discussion our concerns about sustainable issues are growing today, our values are changing. This means that the same way that Bötticher and Semper based there discussion and approach in the discussions and movements in their time, can be an inspiration for us today. The discussion today is mostly based on what approach to follow, but instead of discussing what approach the overall aim for architecture should be discussed. It is to some extend similar to Framptons encounter with Post Modernism in the seventies. What is important in relation to this discussion about sustainability in architecture is to move on from the discussions about these “styles” within this field. Instead it should be discussed how architecture can utilize the knowledge and technology

Figure 3.4.5

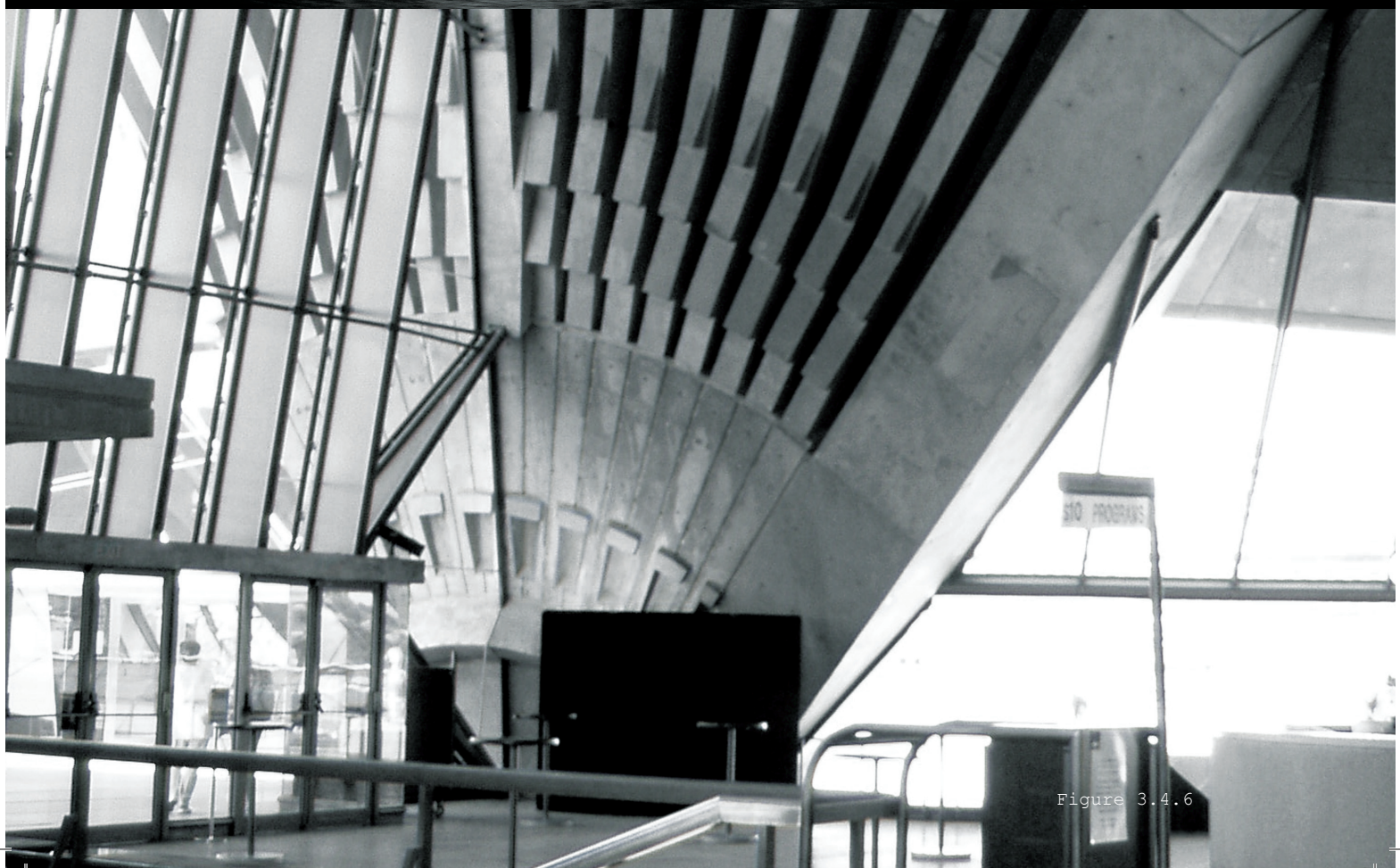


Figure 3.4.6

present today. In combination with an analysis of cultural movements as well as the physical place, that can be the starting point for repositioning architecture. Figure 3.4.7 shows a suggestion for a model based on these thoughts, that is based on an interpretation of how the thoughts about tectonics can form a basis for a model, where fluctuations in the social context as well as new knowledge can play a role in repositioning architecture today, in terms of a more sustainable approach to architecture. Such a model provides a tool both in terms of the analytical phase of the project as well as a design tool. In the following figure 3.4.7 will be described.

The first part of the model, which is defined by a dotted outer boundary, is symbolizing the culture in which the model is based. The dotted line is because different cultures have different ways of perceiving things. This has an effect on the values and concerns within the culture. In the end these concerns and values leads to a set of ethical rules. The line around is dotted because culture today cannot be seen as closed. It is affected by inputs from other cultures. These values, concerns and ethical rules form the basis of the analysis. They prescribe an intention for the analysis.

This intention then feeds into the next step, which is the analytical step. Within this step there are two parts – first of all, the context, where physical and social issues are analyzed, and the second part is concerning knowledge in terms of historical and innovative knowledge. The dotted boundary here is symbolizing the close relationship there is between the analysis and the impact the culture, in which it is made, has. The circles around the two parts are showing that they are two different topics, but still they are interrelated, which is shown by the arrow between them. These two together form the analytical part of the model.

The design step of this model is then based on the results from the analysis. Here there are three parts which plays a part. It is the metaphysical, cultural and physical part. These three forms the basis of the building. The metaphysical part is related to what the building represents, the cultural part is related to how the building is build and the physical part is related to the physical construction of the building. The dotted circles containing these three parts are symbolizing the interrelationship between them, and the overlapping is the ideal of the physical building. The full drawn line showing the boundary is symbolizing that this part is “only” dependent on the input from the analytical part.

The arrow between the analytical phase and the design phase is going in both directions to show that if the design does not fulfil the

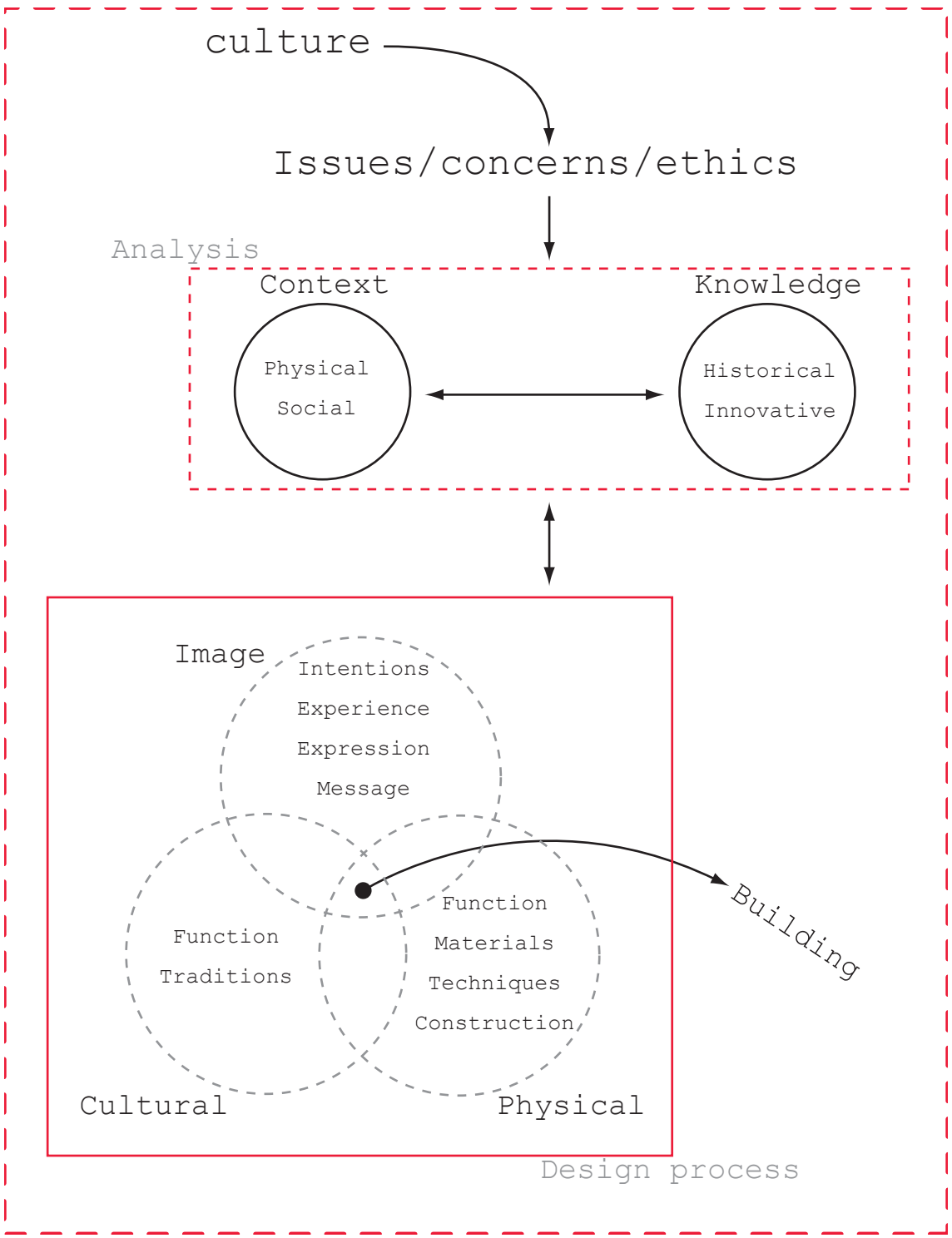


Figure 3.2.1

demands from the analysis a re-evaluation of the design is done in terms of the analysis before another phase in the design is started. When the design then fulfils the demands from the analysis the design becomes a part of the culture and thereby becomes a part of the concerns and values. It becomes a part of the development in the culture.

The result of this model is not necessarily sustainable, but it can be a step on the way to being more sustainable. What it provides is a model, which makes it possible to discuss and understand architecture in relation to the culture and time in which it is based. Furthermore the model is not based in one culture, it takes the values from different cultures into consideration, and establishes a link between the culture and the building.

- 3.5 Conclusion

From the discussion above it is seen that ethics plays an extensive role. The first thing to notice is the different positions within ethics. These different positions provide us with the possibility to analyze different situations in terms of what is right and what is wrong. Furthermore it is seen that they work on different levels, and that they all are interrelated. To see them as different aspects is more to clarify how each of them affects our thinking. Together they provide us with a framework, in which we as humans can interact with each other as well as with the world around us. This last part about interacting with the world around us, is starting to gain more focus both in terms of our relations to other cultures as well as our responsibility towards the planet, as was discussed through the deep ecological approach, and as it was seen in the general discussion about sustainability in chapter one.

In terms of architecture, ethics did not only have a legal dimension, as was discussed by Tom Spector. There was also a deeper dimension concerning first of all a concern about the needs of the clients, but also a concern of how we as humans relate to the world [Spector, 2001]. This concern was as seen in the brief discussion one of the corner stones in the phenomenological approach. It was the way we as humans are in the world, that should be expressed through architecture – our ideals one could say. These ideals were previously a singular image or concern, but in today's hectic world ideals have become very individual. What I consider as being essential here might not be what some one else considers essential. But if these things are seen in relation to the discussion about sustainability it seems like there is a tendency towards a common ground and a common concern for humans –

at least in western culture.

In the last part these concerns were discussed in relation to a tectonic approach to architecture, that was based on readings of Bötticher and Semper from the middle of the nineteenth century. Through these readings it was seen that certain similarities could be found, and furthermore, that inspiration from these could be a part of a different way of perceiving architecture. It is not something that can be said to be new in architecture, but it is more a rethinking of something, that is already known. This focus on what the concerns meant for Bötticher and Semper also provides architecture with an argument for taking these concerns and express them through architecture. The concerns before was, how to express new technologies and materials through architecture. This is still a necessity today, but furthermore focus has been put on how nature, culture, technology and climate affects us and are affected by us, which calls for architecture to try to reposition it self in order to answer that.

As a last remark here it is important to state that this is only one position within architecture. Other positions are present today, especially when discussing tectonics, where the digital tools and approaches today are the centre of the debate for repositioning tectonics. But if focus is kept on the sustainable issues it can be seen from this discussion that architecture today needs to rethink its position. As mentioned before the image of sustainable architecture is fairly dusty. Developing new technologies and materials is one step in the process of rethinking architecture. The other step is to start to analyze what is actually happening in the world around us. What is happening in our culture and what direction is it taking. These two things together can help to reposition architecture in terms of a more sustainable direction.

4. Conclusion

Through the theoretical part of the thesis it has been studied how the discussion about sustainability affects architects. The discussion has been evolving around the three main themes of sustainability, sustainable architecture and ethics in sustainable architecture. What the three themes has shown is, that there is a close relationship between what architects think and focuses on, and the concerns and areas of focus in the general public and political circles. Furthermore it has been established, that the different approaches towards sustainability in architecture discussed here, are useful in order to decipher what architects mean, when they discuss sustainability in architecture, because it lets one investigate it through the design methods used in the design of the building.

The first issue to focus on here is the before mentioned approaches and the design process, which is related to these. In the interviews it was seen that there was a big difference between how the different architectural offices approaches this. All of the companies had a quite distinct approach to sustainability and could relatively easily be fitted into the established table of approaches, but none of them seemed to be particular aware of it. It confirmed the interchangeable use of sustainable, ecological, green and other related architectural styles, that are present within this discussion. To some extend it could be said that it confirmed the thought of these styles being something that is applied to architecture in order to sell it, but at the same time the differences showed to be good in order to dissect the different architects and what they really meant. In relation to the process there were also differences. It ranged from BBM – Sustainable Designs intuitive and qualitative approach, where they focused on materials and how to reuse and recycle those, as well as using local materials, to Grimshaw Architects that had the most integrated design process, where quantitative measures was considered as well and where sustainable issues were tracked through the entire process as a part of the offices internal quality control. Furthermore engineers were consulted and assigned to the design teams at early stages of the project. In between those two Arkitema appeared as saying the right things and an intention of doing them, but without the proper means to actually put it into action yet. An interesting thing in this study was the relations between the size of the company and the way it could approach this integrated design process they all spoke about. A big world famous company like Grimshaw Architects did not seem to have any problems with it, and were far in the process of implementing new tools and controls to deal with it, whereas a small company like BBM – Sustainable Design had big problems with getting engineers and

consultants into the process because the consultants did not have the amount of knowledge needed. This of course raises the question of the direction architecture is taking today. Arkitema mentioned that they saw architectural offices being larger and employing both architects and engineers; a similar feeling was present at Grimshaw Architects, but was never mentioned during the interview. One can ask if this is really the direction architecture should take – being these huge "mass producing" units that the ecological and other environmental movements are trying to break down.

This leads to the other issue, which it is important to focus on here, namely the general discussion about sustainability and how it affects architecture. First of all it is important to see this general discussion in relation to the discussion about ethics in sustainable architecture. As it was seen the ongoing discussion, which today seems to be omnipresent, has an effect on the general public. People start to be concerned about the future and how they can affect it. In relation to this the four concerns, nature, climate, culture and technology, were mentioned within sustainable architecture. These concerns are today a part of what we discuss in general. They start to be matters of ethical discussions and everybody deals with them at some level. When this is put into relation with the discussion about the ethical function of architecture, it is seen that these concerns tells us something about, how we as humans relate to the world, or in other words how we are in the world. In terms of architecture this is an important knowledge, because architecture is as stated not just about the function and construction. Architecture according to phenomenologists is about expressing human's relation to the world. Architecture, as Karsten Harries states, is an expression of a common image, expressing the ideal community, which then creates a common understanding of how we are in the world.

As a last area to focus on, is the discussion based on a tectonic approach in the last part of the third chapter. One can question why these thoughts from the middle of the nineteenth century are interesting for architects today. One answer might be that such an approach to architecture allows the architect to develop architecture in terms of both cultural and social relations as well as historical and technical knowledge. Of course tectonics does not have anything to do with sustainability in its original sense, but some of the thoughts and ideas are similar to today's dilemmas. The reason for introducing these thoughts here is, that they serve as an example in architecture, where the progression in the world was used to redefine architecture. Architecture went from a discussion about following the clssical or

gothic formal language to discuss how the progressions in the world could be used in developing it. It started to discuss the essence of architecture. This is very interesting in terms of the ongoing discussion, where the approaches and methods used can be seen as fixes on the technological and functional plan, but the discussion about architectures direction and a redefinition of it is not present at the time being

A final note is the focus today. As it was mentioned in relation to the interviews the term sustainable architecture has become a branding - a branding for better or for worse. A branding that points towards architecture as being a thing that is consumed among other things in our daily lives. Especially the focus on the quantitative issues is pointing towards it, maybe because it is easy to understand for a layman - or maybe because it sells architecture! This focus is unavoidable today with the present legislation. But it seems like it has started to become a huge business, where we have to consume more to fix the problem that consumption created in the first place. But instead of getting lost in working with the different programs for certifying our buildings we should try to focus on how architecture can reposition itself today. Maybe our focus on fixing the problem with new things is not the solution. Maybe we should focus on what causes the problem instead. Maybe the focus on fixing just makes us consume more instead of focusing on the existing qualities in our building mass and try to redefine architecture through them.

5. Brief

- 5.1 Architectural brief

The architectural brief is based on the thoughts and ideas that have been given by Skive New Art Museum in their prospect about the initiative. These thoughts and ideas have been condensed into this architectural brief, where they are briefly described.

The architecture of Skive New art Museum should reflect the three following things:

Functionality, interaction, and materiality

In the following the three words will be described.

In terms of functionality the museum should, besides the traditional function as a place for mediation of art, be a place that works as a gathering point in the local community. Functionality here is about being able to span over a variety of functions, such as mediation, conferences and teaching. The architecture should reflect this span in the design, where the spatial solutions should be able to house different functions. This does not mean that every room should be able to house all the different functions, but it means that the different rooms through their specialized focus should be able to challenge other functions and create a different experience in relation to such functions.

In terms of interaction the aim is to make the museum communicate with the surroundings. The interaction is in the form of the building's response to movements in and around the building. Interaction here is not in a physical sense, where physical changes happens, but merely changes in the perception of the building, where light and sounds emitted from the building can be ways of achieving this.

The aim for the interactive approach to the museum also calls for considerations of the materiality of the museum. The materiality here is with a focus on both the interactive parts of the museum as well as for the visitors and users experience of the museum. It is about creating an environment where art, people and building are creating an synergetic effect, where the senses becomes a part of experiencing the building.

- 5.2 Environmental brief

In terms of the museums environmental impact the focus will be on the energy consumption. This point of focus has been chosen because of the very specific needs for the indoor environment for a museum. The needs are concerned with thermal comfort and light. The aim here is to obtain a minimum of low energy class two for the museum and a minimum of level B in the indoor environment according to CR 1752 in all areas except for areas where art is present. Here the aim is level A according to CR 1752

In terms of the thermal comfort the focus is the ventilation and its relation to temperature, humidity and pollutants. As mentioned this is important in a museum, therefore making it an interesting point of focus. Having such high standards the focus will be on mechanical ventilation, which it is possible to control in a strict way. In order to minimize the energy consumption in relation to this passive technologies such as solar heating, passive and natural cooling, zoning, the building envelope's level of insulation, materials and thermal mass, energy efficient appliances and natural light can be utilized.

Regarding the light the aim is to create an indoor environment, where the experience of the museum is supported by the use of light. As mentioned before the use of daylight is a part of reducing the amount of energy used, and therefore it will be an important factor in the design. The use of natural daylight can be difficult in a museum because of the artworks sensibility to especially ultra violet light, but also the amount of visible light is important and therefore the control of natural light will be important as well.

6. Site Analysis

- 6.1 Introduction

The aim of the following site analysis is to gain an understanding of the site and the nature of it. Through it the different characteristics will be described, which will mainly be done through images and diagrams. Both qualitative and quantitative aspects will be considered, and in combination they will form a description and interpretation of the site.

The first part of the site analysis is focused on a qualitative description of the site and its surroundings, in order to explore how it is sensed when moving around in it - an exploration of the qualities of the site, which is focused on the structure of the space in which the site is located.

This description of the site and its surroundings then leads to a interpretive analysis that is based mainly on Kevin Lynch's method described in "The image of the city" [Marling, Kiib, 2004], where he splits the city into five different elements, namely districts, edges, paths nodes and landmarks. These are the five physical elements humans perceive when moving around the city.

In connection to this it has been chosen to focus on how the city is read when moving, and how scale and speed are important factors when moving through the city. It has been chosen to analyze these things because the Museum wants to be able to attract attention both for people moving on foot in the park and people passing by in cars. This part is based on Robert Venturi's "Learning from Las Vegas" [Marling, Kiib, 2004].

Figure 6.1.1

Figure 6.1.2

Figure 6.1.3

Figure 6.1.4

Figure 6.1.5

Figure 6.1.6

Figure 6.1.7

Figure 6.1.8

Figure 6.1.9

Figure 6.1.10

Figure 6.1.11

Figure 6.1.12

Figure 6.1.13

Figure 6.1.14

Figure 6.1.15

Figure 6.1.16

Figure 6.1.17

Figure 6.1.18

Figure 6.1.19

Figure 6.1.20

- 6.2 Interpretations

Paths are defined by Lynch as movements at any speed or scale along certain lines in the city, where nodes are places that the observer of the city can enter. It can be junctions, crossings or the likes [Marling, Kiib, 2004]. On the site or in the near vicinity, there are two different levels of paths. There is the footpath meant for pedestrians. These are crossing the site mostly in a north/south direction but also linking the site to the west, with the park on the other side of Ågade. They serve as recreational paths, with a low tempo connecting the city centre with the creek and the forest. The other paths are the roads, where the speed is significantly higher. These also serve as edges in the city, which will be discussed later. The paths for cars are located to the north and the west of the site, whereas the paths for pedestrians are penetrating the site. Both of them have a north/south going direction as the most distinctive, as it can be seen in figure 6.1.13 and 6.1.17. The nodes here also relates to the two different levels of speed. As for cars there is a large node right next to the existing museum, where Ågade and Havnegade is crossing, and a large one where Ågade and Østerbro is crossing a bit further to the south. This last one is in close connection to parking and shopping, which also makes it important to the pedestrians moving in the area. Just to the south of the museum is a node for pedestrians, where several paths are crossing, and connecting the north/south movement with a path towards the west.

Edges and districts within Lynch's understanding are interrelated, where the edges are linear elements that are perceived as boundaries between districts in the city. Districts are sections in the city with a two dimensional extent [Marling Kiib, 2004]. In Skive there are naturally different districts within the city, and the building site is located in a district, where the buildings are mainly industrial warehouses and purely functional office buildings. The neighbouring districts are the old city centre and a district mainly consisting of villas, as seen in figure 6.1.6. The edges between these districts in town are mostly defined by the roads, that when moving on foot are difficult to cross. Two of these very significant edges are located right on the edge of the building site namely the north/south going road Ågade and the east/west going road Havnegade. Both of these are heavily trafficked and are hard to cross. The last edge near the site is actually crossing the district splitting it up in what could be perceived as two districts, and is defined by an old fenced of railway track. Due to the shape of the area where the building site is located the directions are strongly north to south, where the edges can be

Figure 6.2.1

crossed on special points. Not that they are specially fenced of, but the traffic dictates certain points where it is possible, which then again emphasizes the north/south direction on the site.

Turning to Robert Venturi, will help to understand the relationship between scale speed and symbols on and around the site. As mentioned before the speed on and around the site is different. Where the paths on the site are for pedestrians and the speed is low, whereas the surrounding paths, namely Ågade and Havnevej are meant for cars, where there is a much higher speed. This is also noticeable in the signs and symbols along these paths. Moving in the park the function of the museum is shown in the small sculptures placed around the park, whereas the symbols near the roads surrounding the site is a sign saying "Skive Kunstmuseum". Furthermore there are small sculptures close to the road but, they are hard to see and understand while passing in car. Discussing the scale with which cars and pedestrians are confronted, with a peculiar thing is evident. When moving as a pedestrian one is confronted easier with the big buildings than when moving by car. Moving in the park one passes a sports arena, a stadium and other fairly large structures that are made so it is possible to see them when passing in car. On the other hand the cars, have an embankment on the one site, and on the other they are moving along trees that allows for views to the different functions behind, like the stadium and different stores. This gives the area a sense of being in between two interrelated functions (figure 6.2.2).

S Speed

Symbol

Scale

N

Figure 6.2.2

- 6.3 On site

The visions for the site is described in plan 88 from the municipalities, where the purpose and restrictions are defined. Furthermore the vicinity of the site especially around Skive Å is affected by the overall plan from the municipalities concerning the entire city. This mainly has to do with the visions for Skive Å, which is seen as an area that should be developed into a more recreational area [Kommuneplan, 2002].

As mentioned plan 88 sets out the visions and restrictions of the site. Briefly described the site has to be maintained as a museum park, with the option of expanding the museum. The site marked on the diagrams is the one set out in plan 88. The restrictions for the area is as follows. The maximum building height is 8,5 metres or two storeys. Furthermore there is a wish to preserve the old trees on the site in order to maintain a green recreational park, where people can relax. Maintaining this feel of the site also keeps the relation to Anlægget on the opposite side of Ågade. On the eastern site of the current museum it is possible to establish a new parking lot for the museum guests (figure 6.3.1).

The climatic conditions of the site seems to be favorable. The sun can possibly be utilized as heating source with a clear view towards the east and to some extend west as well and partially shading towards the south as seen in figure 6.3.2. As for the wind the main direction is west as seen in figure 6.3.3, which is shaded of by the hill rising above to the west and the trees creating a fence sheltering for the wind.

Figure 6.3.1

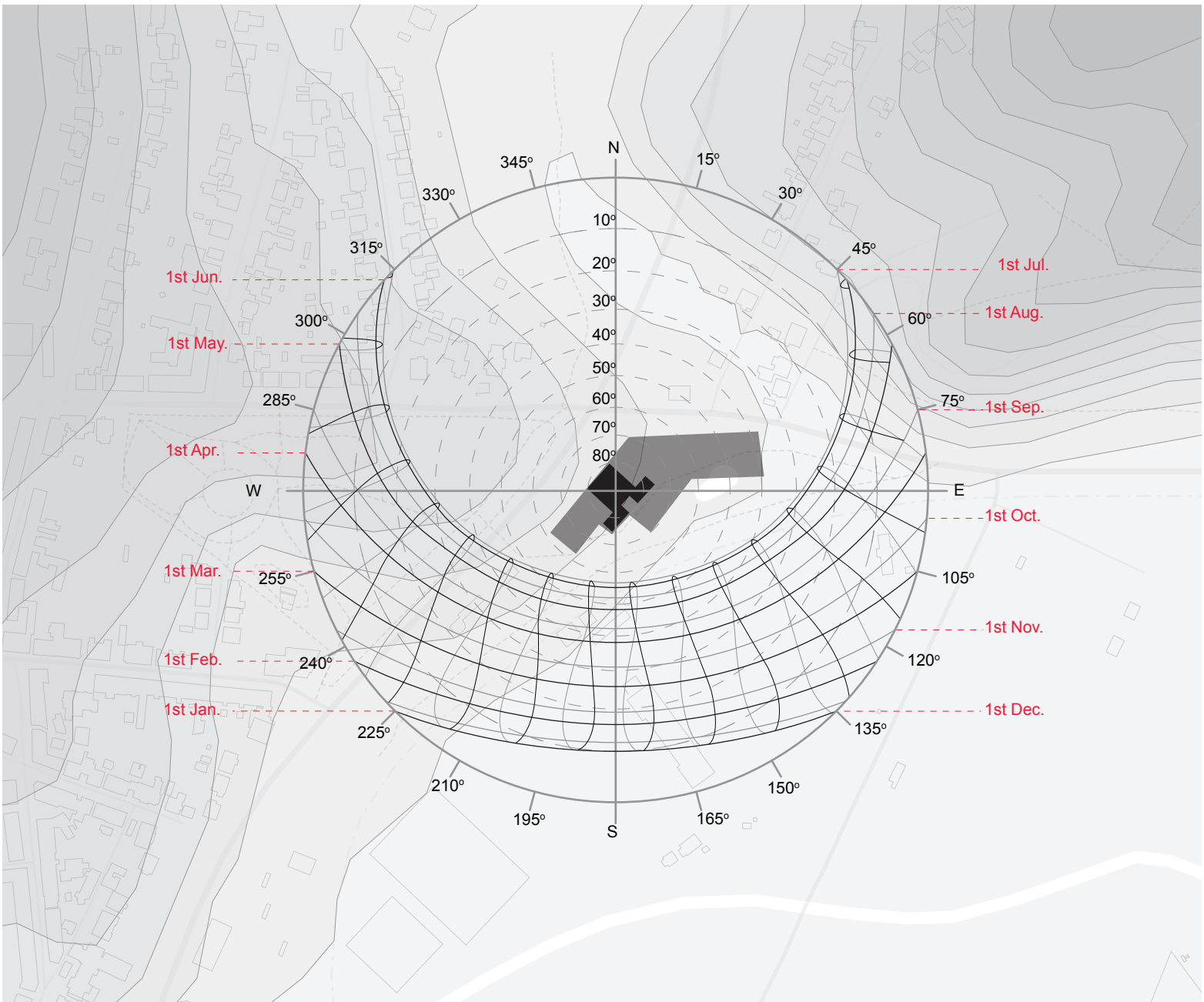


Figure 6.3.2

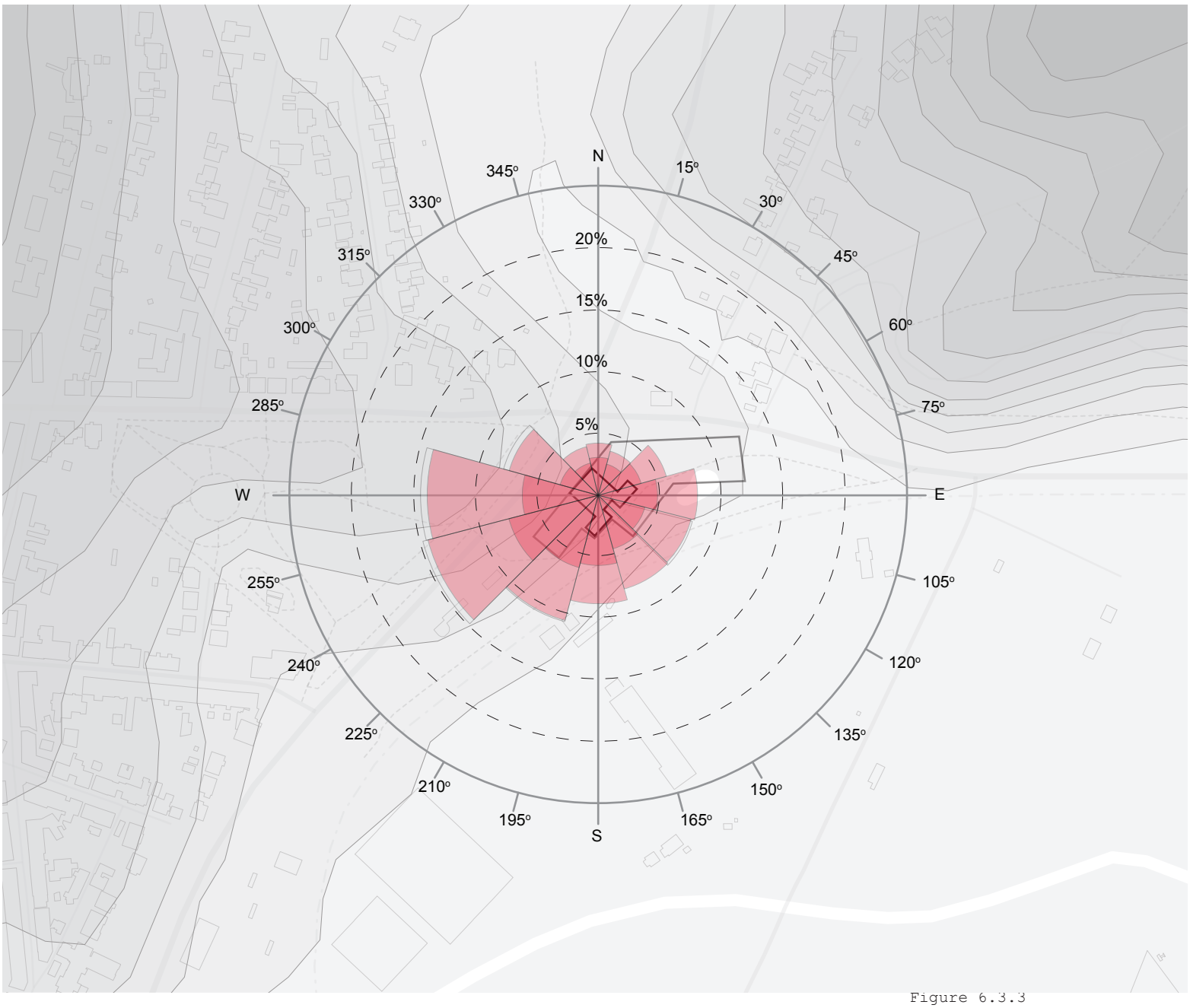


Figure 6.3.3

- 6.4 Conclusion

By using both Kevin Lynch and Robert Venturi the analysis embraces both the view of the pedestrians moving around in the city as well as the cars, and establishes connections between speed, scale and symbol, implying the different inherent properties in the city. Furthermore they help to break down the city in understandable parts, and through that describe the nature of the site.

Through the analysis it is seen that it is a site with good possibilities. It is located in an area that invites people to use it through its paths and its green recreational nature. At the same time it is in close connection to the city center and different modes of transport. Accessible both to pedestrians and cars. Furthermore the topography places the site on the edge of a hill that is artificially emphasized by the steep slope at the edge of the current museum. This slope both emphasizes the north/south direction on the site, but also creates a view towards the east and Limfjorden even though one cannot see it from there as seen on figure 6.3.4. When moving around in what clearly is a small valley, where the creek runs through a closer connection to it would give much more character to the area, and open it up more towards Limfjorden. Furthermore it would help to create more movement in an east/west direction and create stronger relation to Limfjorden than there is now.

The site also implies considerations about how a new museum communicates with both the pedestrians moving in the park as well as the cars passing. The roads implies a “back side” to a new museum, but also a “back side” that communicates and informs about the contents of the museum. On the other hand it has to open up to the park, and make it an inviting place giving glimpses to the inside.

Figure 6.3.4

The directions and flow on the site is as mentioned orientated towards a north/south axis. This movement should be picked up and used in the building, but the view on the site towards east is also an important factor. It is where the site opens up from its position at the foot of the hill and between the industrial buildings to the south and the forest to the north, right where the small valley turns and opens up towards Limfjorden. Utilizing these two movements becomes essential in order to make the building relate to the site.

The building should relate to the landscape in a way that invites people to explore both the building and its contents - awaken peoples curiosity both by appearance and by contents.

The building should relate to the area and utilize the drive and inventiveness inherent in its functions - emphasize physical and social connections in the city in an informal way.

7. Spatial Demands

- 7.1 Introduction

The aim of this chapter is to determine and analyze the spatial demands for Skive New Art Museum. This is done through a study of their brief concerning visions and ideas for the museum. Furthermore it is developed through three case studies of museums that has been chosen in terms of their size and their different interests within art. The museums are Nordjyllands Art Museum in Aalborg, Eyebeam in New York and Johannes Larsens Museum in Kerteminde. As a last source of information for the spatial demands is "the manual of museum exhibitions", which in general terms sets out how the functionality of the museum is, and how the different functions are related to each other.

Through these different sources of information the spatial demands are determined both in terms of the qualitative and quantitative needs. The studies are important to understand and develop both the functional aspects that are closely related to the museums functioning behind the scene, as well as the experience the visitor has in the museum.

- 7.2 Case studies

As mentioned before, the case studies here are Nordjyllands Art Museum, Eyebeam and Johannes Larsens Museum, all of which has special characteristics. These museums provides information about functionality, experience and their approach to the museum as a function in our society, spanning from the traditional museum function of mediating art, to the more research and development based function where art and industry starts to interact in a synthesis between artists and developers.

Nordjyllands Art Museum has been chosen for its size and functionality. In terms of size it is similar to what Skive New Art Museum is interested in, and therefor is an interesting study in terms of functionality and how a local museum can be used to redefine its position in the city as it did in the late sixties when it was build. Furthermore this study can help to gain knowledge about which functions can be maintained in house and which ones are sent out to external contractors for museum work.

The Johannes Larsen Museum has been chosen because of its relatively small size, and furthermore it is a local museum based mainly on a collection of Johannes Larsen's paintings. Once again the functionality is in focus, and the study of which functions they house as well as which ones are sent out to external contractors is continued here.

The last case is the Eyebeam museum, which has been chosen because of its position as a place of mediation and development. It is placed where art and science work side by side and where new initiatives are present in terms of how these two fields can interact. Furthermore there is a focus on new art forms like digital and performative art.

As seen these are three very different museums that each in their own way can help to gain more knowledge about how a museum works, and how to incorporate the different aspects into Skive New Art Museum.

- 7.2.1 Nordjyllands Art Museum - Aalborg

As mentioned the reason for choosing Nordjyllands Art Museum is the size, which is similar to the size of Skive New Art Museum. The museum was build in the late sixties early seventies and designed by Alvar Aalto. It is famous for its use of natural light and is a very flexible building allowing different setups for the different exhibitions.

Studying the functionality of Nordjyllands Art Museum it is seen that roughly fifty percent of the area is service areas, consisting of workshop, general storage, technical functions, offices and cafe, and the last fifty percent is exhibition areas. The general division between these functions is the ground level that is entered through the main entrance located at street level, and the servicing areas located at a lower level, with separate access through a parking area accessed by a ramp and located under the street level, meaning that it is not visible when passing on street level. Entering through this service entrance one is located in a corridor leading directly to all the servicing areas, making the lower part of the building very efficient. Art that is to be stored for a while also enter the museum on this level through a secure area and the workshops, where it is stored until exhibited. Art going directly on exhibit enters the museum through the main entrance, and is installed in the exhibition areas.

What is important to notice in relation to the functionality is the easy accessible service areas. From them there is easy access to the rest of the museum, making it a simple museum in terms of the logistic organization. It is important to note that they currently are working on different improvements in order to comply with international standards within the museum world. Furthermore the use of natural light is worth noticing, where the reflected sunlight is important for the museum. It is one of the things the museum is famous for, but it does cause problems, because there is no possibilities to control the light, which means that the art is exposed to too much light. This is a very important factor to notice.

Figure 7.2.1.1

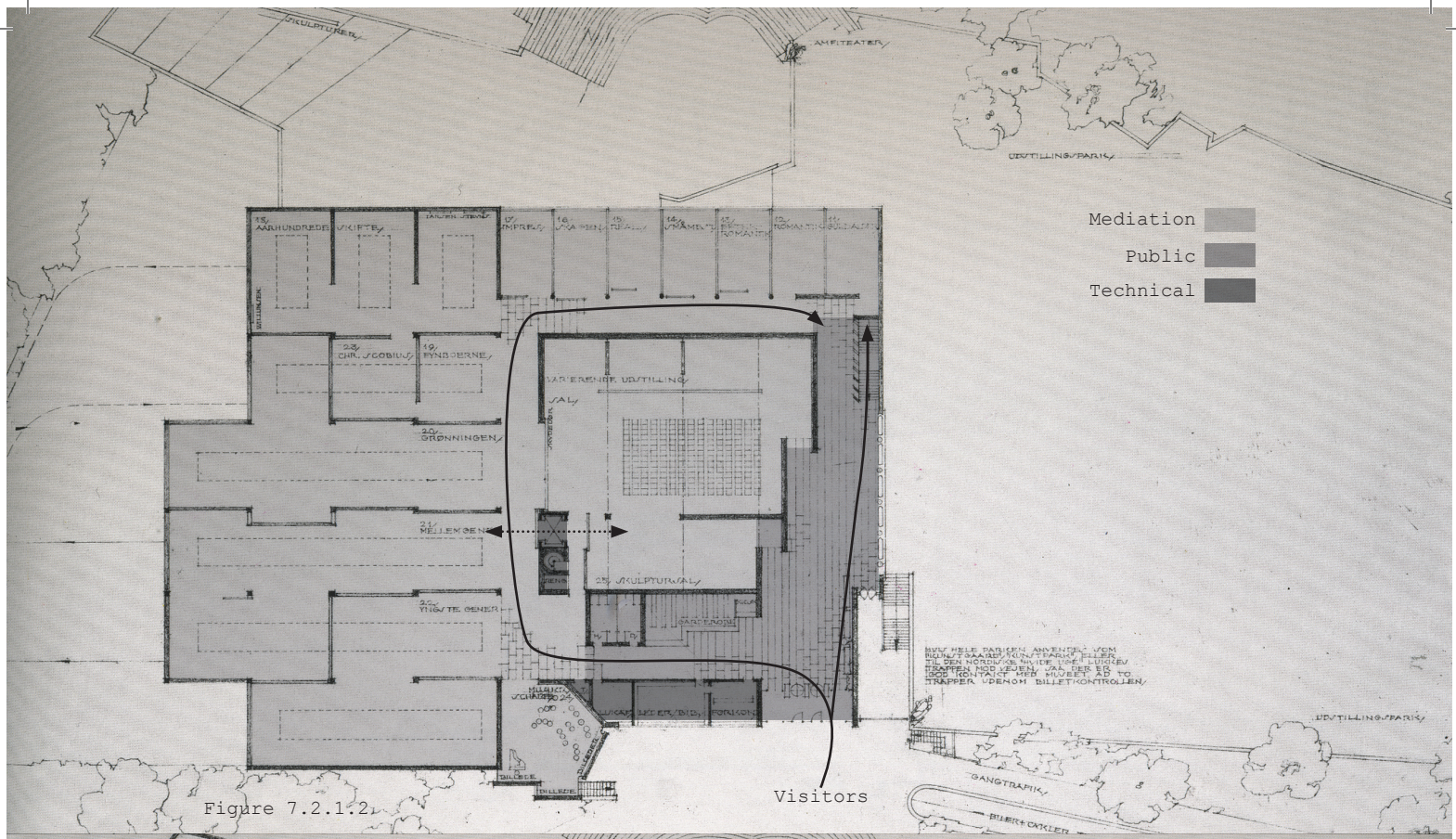


Figure 7.2.1.2

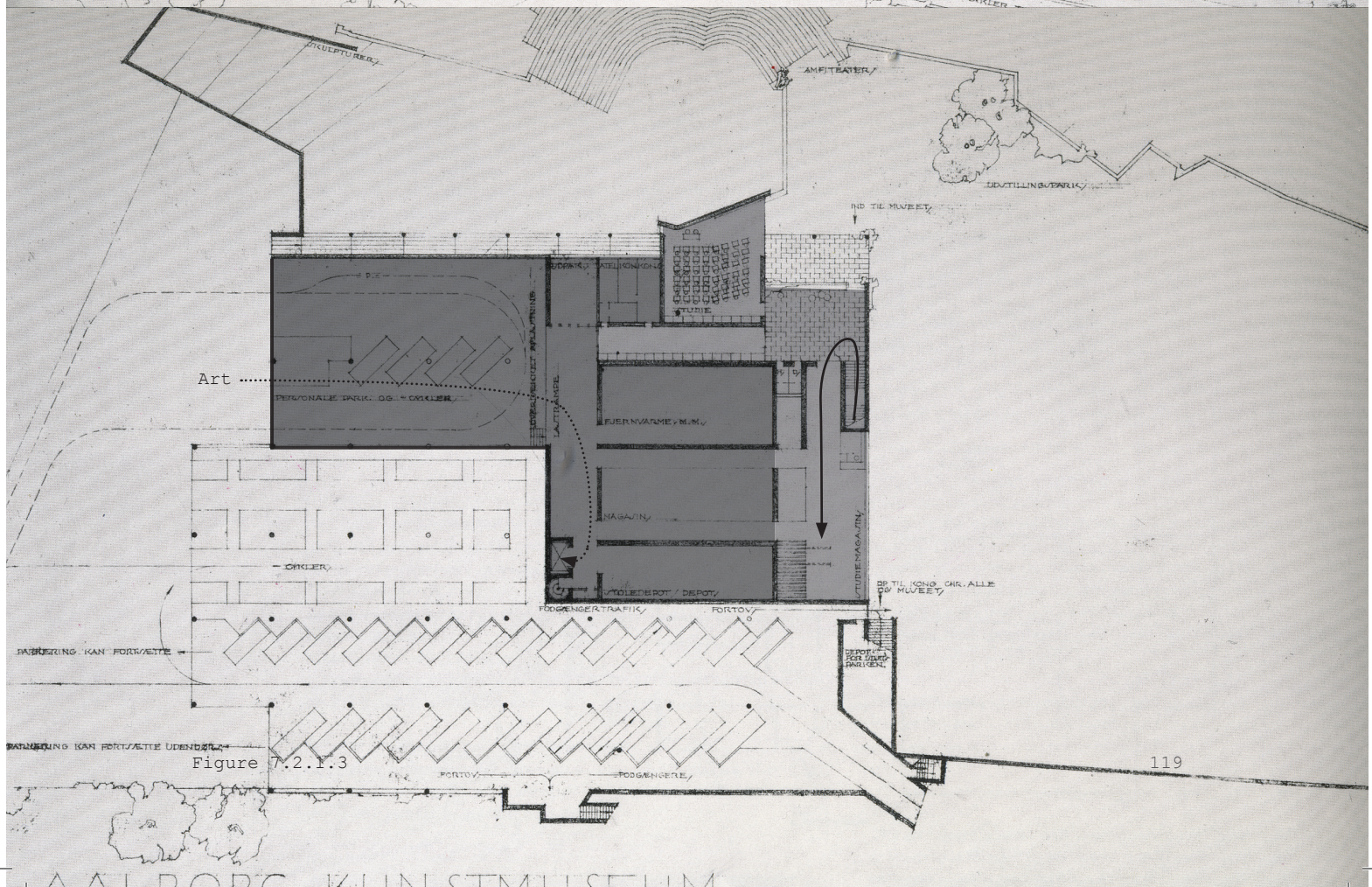


Figure 7.2.1.3

- 7.2.2 Johannes Larsen's Museum - Kerteminde

As mentioned the choice of Johannes Larsen's Museum in Kerteminde is mainly because of its strong local connection, and its position as something that is a part of the local history in the area, where the main collection is paintings by Johannes Larsen - a place with a very strong concept founded in the local area

The museums foundation in the local community goes back as far as to when Johannes Larsen was living there. At that point in time it was a gathering point for artists and musicians - a local center for creativity. A place very similar to Michael Ancher's house in Skagen. This is one of the main inspirational sources for the museum today, where they try to re-create an atmosphere at the museum that reflects its past. Their focus on the art made at the time, where focus was on nature - a thing that is reflected in all their activities that evolves around the theme "art and nature". Johannes Larsen's interest in nature is closely related to the architecture here, where the old buildings are designed by Carl Petersen with strong inspirations from Plesner and the Skagen Painters. A crucial thing is how the architecture, both the original buildings as well as the extension by Poul Ingemanm, is placed as a frame around nature, where the different views carefully frames certain parts of the garden, and the obvious view over the water is limited to end points in the buildings - points where one turns around.

The important thing to notice in this case is the concept, which serves as the guide for everything at the museum. Instead of having a broad range of art, there is a strong focus on a specific theme. Furthermore the temporary exhibitions are related to this theme and serves as a different perspective of their permanent exhibition. Another important aspect in relation to this is the idea of giving the guest an experience of being a guest of the house or the artist, instead of being a visitor to the museum, where everything is fenced off. By basing the museum on these things a special atmosphere is created - an atmosphere that is specific for this museum, and therefore creates a unique experience, instead of creating an experience that can be found in every other museum.

Figure 7.2.2.1

Figure 7.2.2.2

- 7.2.3 Eyebeam - New York

The reason for choosing Eyebeam as a case study here is the work going on there between art and development of new products, and the interest in digital art forms and interaction between the artist and the visitor.

The main factor in regards of Eyebeam is their open source environment, where ideas are put to the test and shared with others in order to develop them and give them a direction that can be suited to the different users, without the original developer has to be involved. It deals with the concept of copyrights. Instead of claiming the rights to the work, the work is there and free to be used and shaped in any direction. This thought is also interesting in terms of interactive art. Where does the work of the artist stop and how does the visitor interact with it? Another interesting aspect in relation to this is the combination of labs and exhibitions, where the different zones overlaps each other creating an environment where a dialog between the artist/developer and the visitor - a dialog that can help to develop and create different aspects of the art.

The Eyebeam building was designed by Diller + Scofidio, but has not been realized yet, but the general idea is a building where the mediation and development functions of the building weaves between each other creating spaces where the two functions interact, creating the before mentioned spaces for interaction between the different users of the building. This idea is clearly visible in the design, where two bands folds up.

In relation to Skive New Art Museum the interesting thing is the interaction between the art/artist and the visitor. This is one of the major visions. Through that they hope to redefine their position in relation to the kind of art they work with. It is seen in this case that the interaction between visitor and artist is an important factor, but also that it has to be limited areas, in order to provide the artist/developer with private spaces for their work. Through these initiatives it is possible to create a vibrant creative environment, where dialogs forms a basis for the creative work.

Figure 7.2.3.1

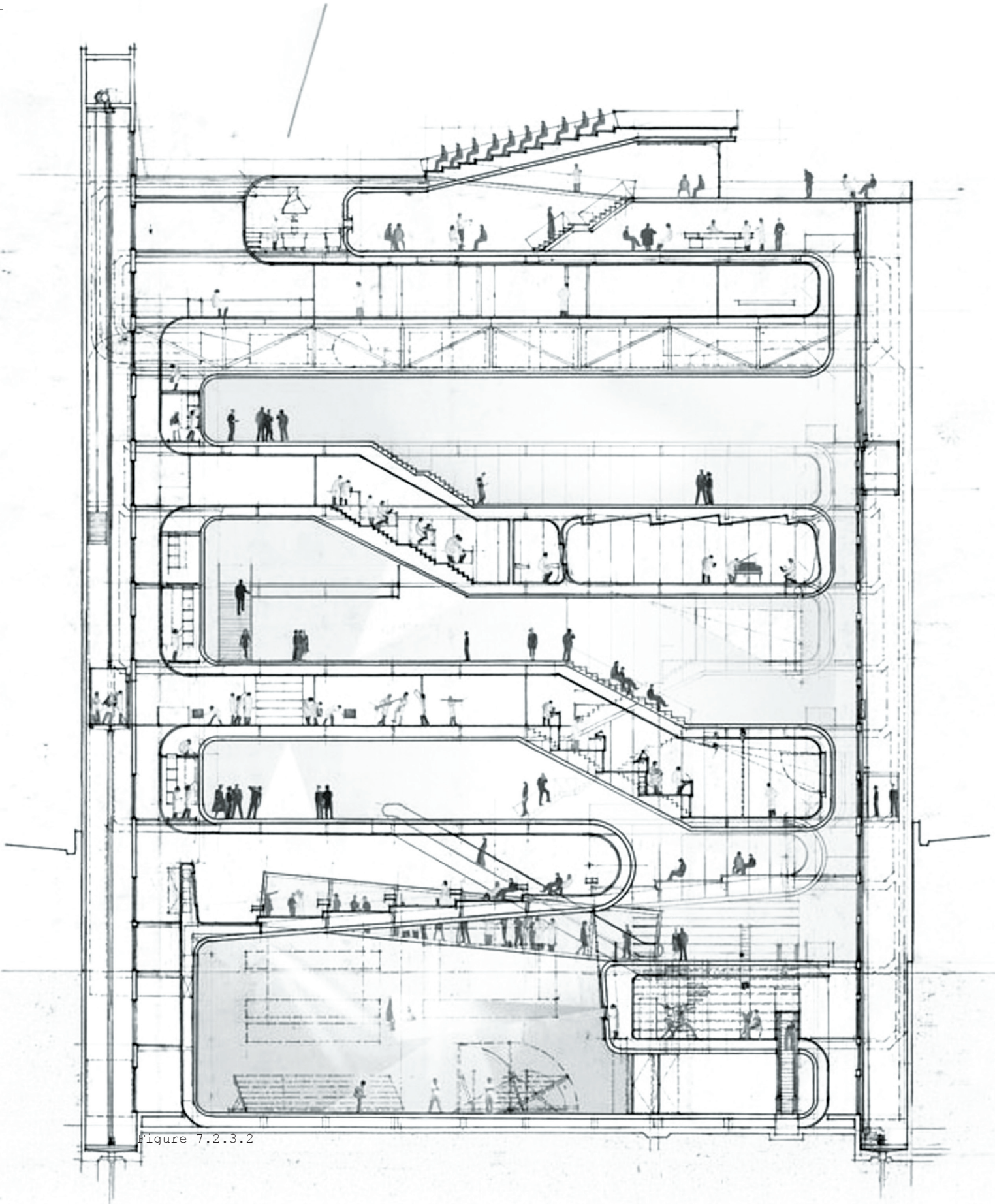


Figure 7.2.3.2

- 7.2.4 Conclusion

From these three case studies it is seen that inspiration can be drawn from them within the different areas Skive New Art Museum is interested in dealing with.

The first important thing is the concept of the museum. What is seen in relation to this is that a strong concept is needed, and more important a concept that is unique to the museum, as it was seen with Johannes Larsen's museum, where the concept evolved around the museum being a cultural centre point for the little town. By letting everything they do evolve around this significant concept the visitors knows what they can expect and they do expect it. Furthermore this concept is also reflected in the architecture, where the framing of the nature as well as how the buildings are placed in and around the garden.

The second important thing to notice is the synergetic effect that can be seen between artists, developers and scientists as seen in the case of Eyebeam, which creates a frame around this interactive playground. This is naturally also a part of a strong concept that is unique. As the architectural frame around it Diller + Scofidio won the competition, where the functions for visitors and the functions for artists, scientists and developers weaves into each other revealing small peeps into the different areas.

The third important thing to notice here is the functionality as it was seen in the case of Nordjyllands Kunstmuseum. What was seen there was a very clear partition between the functional areas and the exhibition areas. Furthermore the museum and the plan reflects a simplicity that allows for flexibility and functionality. This together with the use of natural light is what makes this museum unique.

- 7.3 Program of spatial distribution

The program of spatial distribution outlined in figure 7.3.1 is based on the case studies, the studies of "The manual of museum exhibitions" and conversations with Skive Art Museum. The following space program is the essence of this and is showing the estimated need for space for the different functions. Furthermore this program contains data for the indoor climate. These are all derived from appendix B, where calculations can be found.

Spaces	Area (m^2)	Occupancy	Activity (met)	Sensory load (olf)
Entrance	200	50	2	40.5
Cafe	200	50	2	40.5
Exhibition	1250	200	1.2	250.3
Conference area	250	50	1.2	50.3
Classroom	85	28	1.2	17.3
Mulimedia workshop	85	28	1.2	17.3
Library	100	10	1.2	20.4
Office	100	10	1.2	20.1
Loading	500	8	3	99.4
Art storage	200	15	1.2	90.0
Workshops	650	15	3	130.1
Storage	450	4	2.4	90.0

Figure 7.3.1

	Temperature (C)		Relative	
Spaces	Summer	Winter	humidity (%)	Light (lux)
Entrance	23.0-26.0	20.0-24.0	40-60	200
Cafe	22.5-26.5	19.5-24.5	40-60	200
Exhibition	18.8-23.2	18.8-23.2	45-55	50-200
Conference area	23.0,-26.0	20.0-24.0	40-60	200
Classroom	23.0-26.0	20.0-24.0	40-60	200-500
Mulimedia workshop	23.0-26.0	20.0-24.0	40-60	500
Library	23.0-26.0	20.0-24.0	40-60	200
Office	23.0-26.0	20.0-24.0	40-60	500
Loading	15.0-18.0	15.0-18.0	40-60	200
Art storage	18.8-23.2	18.8-23.2	45-55	100-200
Workshops	15.0-18.0	15.0-18.0	40-60	500-1000
Storage	23.0,-26.0	20.0-24.0	40-60	200

In connection with the space program it is important to stress that the two tables only describes the quantitative part. As for the qualitative part it is the architectural brief [page 92] that is the foundation for this. In general the building can be split into three main functions, which is also seen in on figure 7.4.1 [page 126], where it is seen that there are public spaces mediation spaces, and service spaces, that all have different qualitative measures that has to be fulfilled. All of these of course relates to the three keywords mentioned there.

CO_2 limit(ppm)	Ventilation recommended by CR1752 (l/(s*m^2))	Ventilation calculated in appendix B (l/(s*m^2))
1080	3.0	3.0
1080	5.6	2.5
780	1.6	1.4
1080	4.2	2.2
1080	4.2	2.2
1080	4.2	3.1
1080	1.4	1.7
1080	1.4	1.4
1080	8.4	0.9
780	1.4	1.3
1080	8.4	1.0
1080	8.4	0.8

- 7.4 Connections

As seen in the architectural brief [page 92] the functionality in the museum is one of the main focus points here - a fact that was confirmed by the case study of Nordjyllands Art Museum. In Skive New Art Museum this functionality has to connect three main functions, namely public functions, mediation functions and service functions. The first two can be accessed by the public, whereas the last one is what services the rest of the building. The connection between these functions can be seen in figure 7.4.1. The figure is showing how the different functions connect and who has access to them, and is an overall diagram of the functionality in the building, and is based on the case studies and studies of "the manual of museum exhibitions"

The main diagram can then be refined by overlaying it with different parameters as seen in figure 7.4.2, 7.4.3 and 7.4.4, where the parameters are security, climate control and light. Those three have been chosen because they are important for the experience of the museum. Of course security and climate control are "invisible" for the visitor, but they are essential to the museum as a building and essential for the museum in order to achieve their goal. The light is also important in that sense but it is also something that provides the visitor with an experience of the museum, as it was seen in the case of Nordjyllands Art Museum.

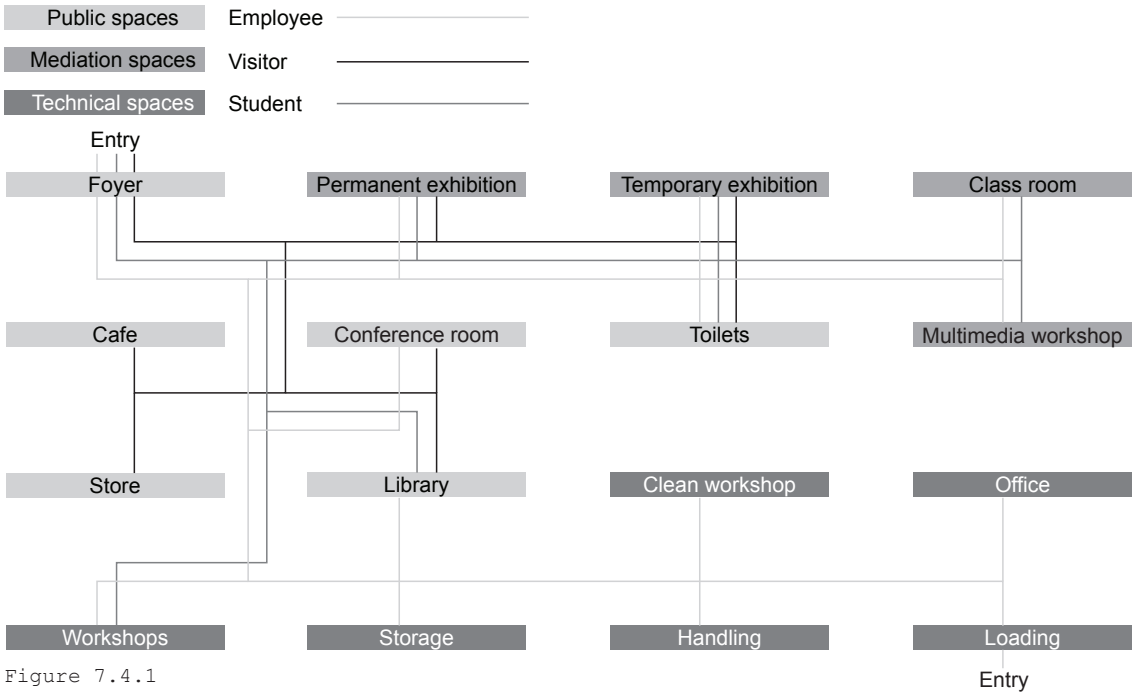


Figure 7.4.1

Figure 7.4.2

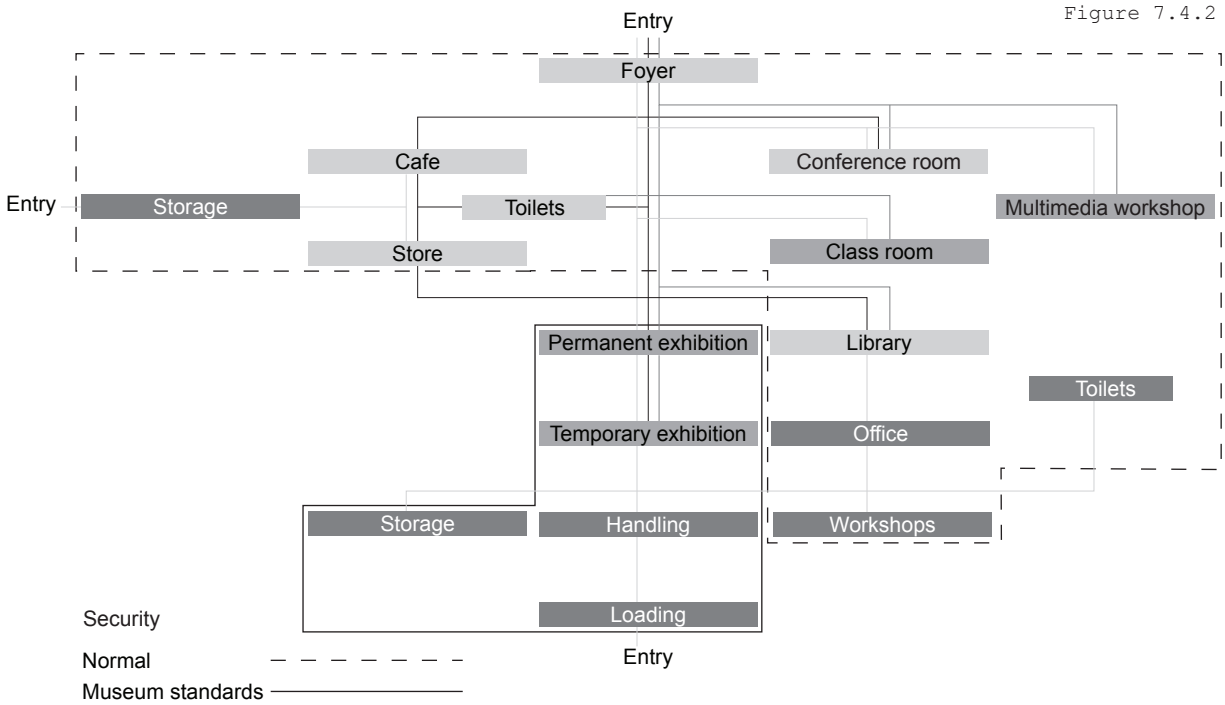
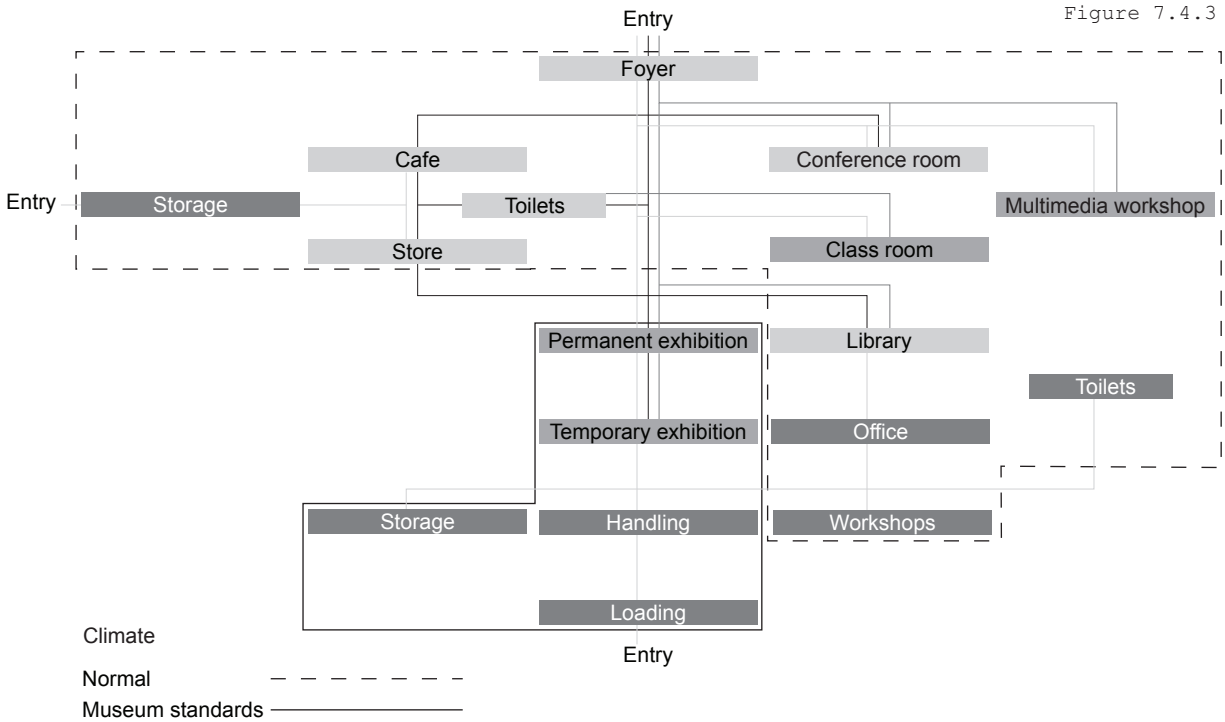
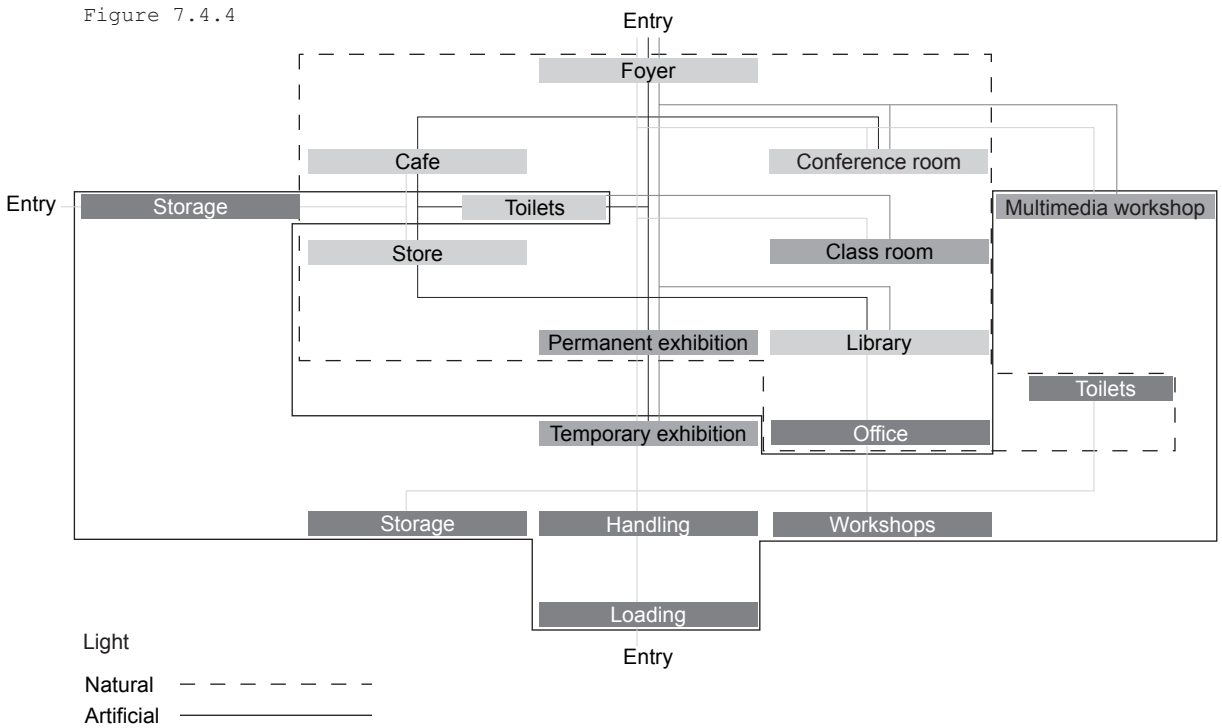


Figure 7.4.3



The figures show that the security and climatic demands are higher in the areas, where art is present, as it is also seen in figure 7.3.1 in the program of the spatial distribution. These factors are especially important because Skive New Art Museum aims at being a museum where international exhibition are present, meaning that they have to loan art from international museums, where a very specific set of codes has to be fulfilled in order to be able to loan art and get it insured.

Figure 7.4.4



- 7.5 Work flow

As mentioned the spaces servicing the public and meditative spaces are of great importance because they have to provide the museum with a functional workflow supporting the other parts of the museum in an efficient way. The focus here is on maintaining a workflow for the art works coming in and going out of the building.

The guide here is the flow of art that has to be as easy as possible as seen in figure 7.5.1 where it is an almost straight line. This flow is then supported by different functions attaching them selves on different places or functions along this line. The first functions along the line deals with registration of the art, whereas it in the end is supported by functions that are used for preparing the exhibitions. Furthermore it can be seen that the two main functions are the handling areas, and the working areas, both supported by different kinds of storage.

This is a very diagrammatic reading of the functions, but as the case studies showed this is hardly the way things work at small local museums as for example Nordjyllands Art Museum, where the workflow was quite open, and the differentiation between the functions was hard to see in the open and compact plan. This should also be taken into consideration in the design process that certain functions are overlapping.

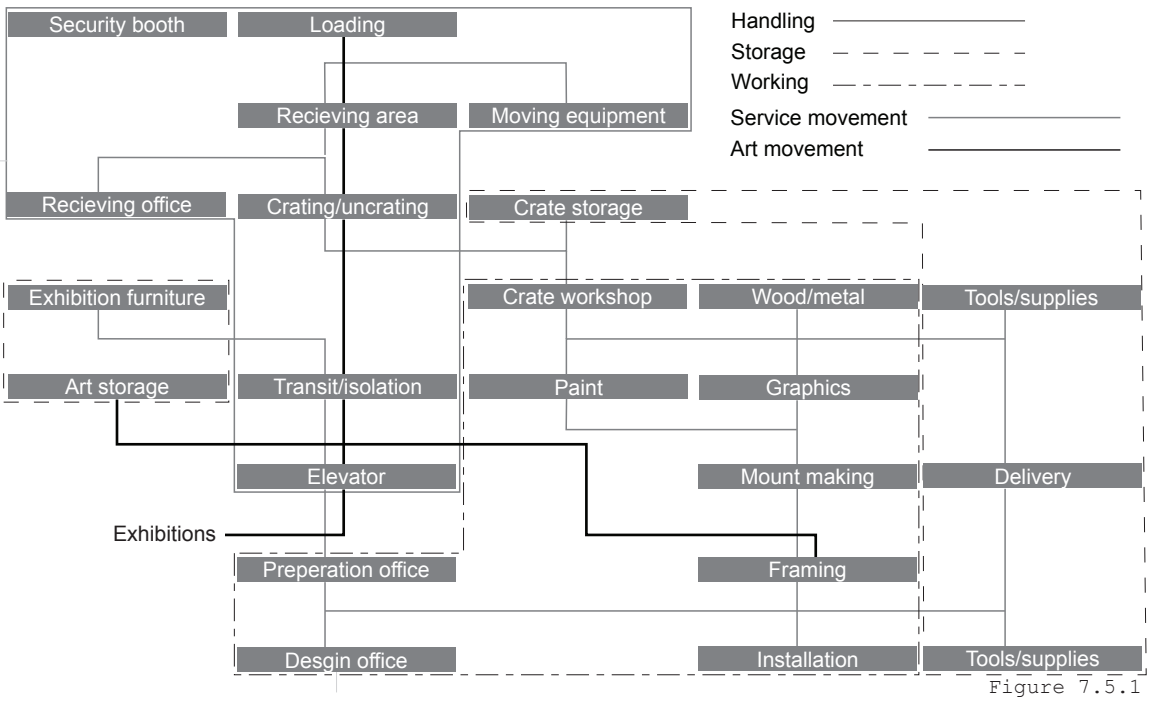


Figure 7.5.1

How can the incorporation of environmentally sustainable thoughts become an active factor in the design of a new art museum for Skive that also challenges the perception of the art museum as being a "temple" for art and instead aims for being a place for interaction?

8. Design

- 8.1 Initial design parameters

The initial steps in the design phase are influenced by two major factors, namely the interpretation of the clients demands and the directions pointed out in the municipalities plans for the area.

One of the most important factors for the client has been to maintain the old museum building. Their aim is to take it back to its original state with white stone facades and its little courtyard in the middle of the building. Furthermore the demands about functionality interaction and materiality as described in chapter five have been important [page 92]. Maintaining the old museum poses a challenge in incorporating it into the extension of the museum, without the building being an appendix. Furthermore the massive increase in area, going from the original approximately 1400 m^2 to about additional 5000 m^2 in the extension poses a challenge in not letting the new museum building dominate the old one completely.

As for the municipalities plans for the area the important factor is the specific site that has been set out for the museum. This site is defined with a small part on the south side of the existing museum extending past it to the north side where the main part of the site is located as it is seen in figure 8.1.1.

This site is challenging first of all because of its relative compactness. It is about 5000 m^2 and on it has to be situated a building of the same size in connection with the old museum. Furthermore the location of the site right next to one of the main roads through Skive poses a challenge in creating a place where people can become immersed in the art or just meet other people for a meeting or a talk. It also provides a logistic dilemma in how the museum is approached by visitors, employees and people delivering different things to the museum in relation to different functions in the museum - for example goods for the café or art for temporary exhibitions. The location on this corner provides a very visible site but also causes difficulties because it is located in an intersection posing possible problems with parking areas

On the other side the small museum park provides the site with a unique recreational space, where sculptures are scattered around the park, creating a stage where people and art interact in an informal way. A fact that is a contradiction to the busy road right next to the site. This contradiction between the quite recreational park already existing and the busy road next to the museum poses and interesting

challenge in connection with the old museum building and the compact site, with only just enough space to accommodate the museum.

By using these two initial design parameters the design has been forced into a strict framework, where the steps taken in the process has to relate and respect to these initial parameters. Furthermore the use of these initial steps provides the project with the possibility to challenge the museum and the municipalities and their approach to the extension of the museum.

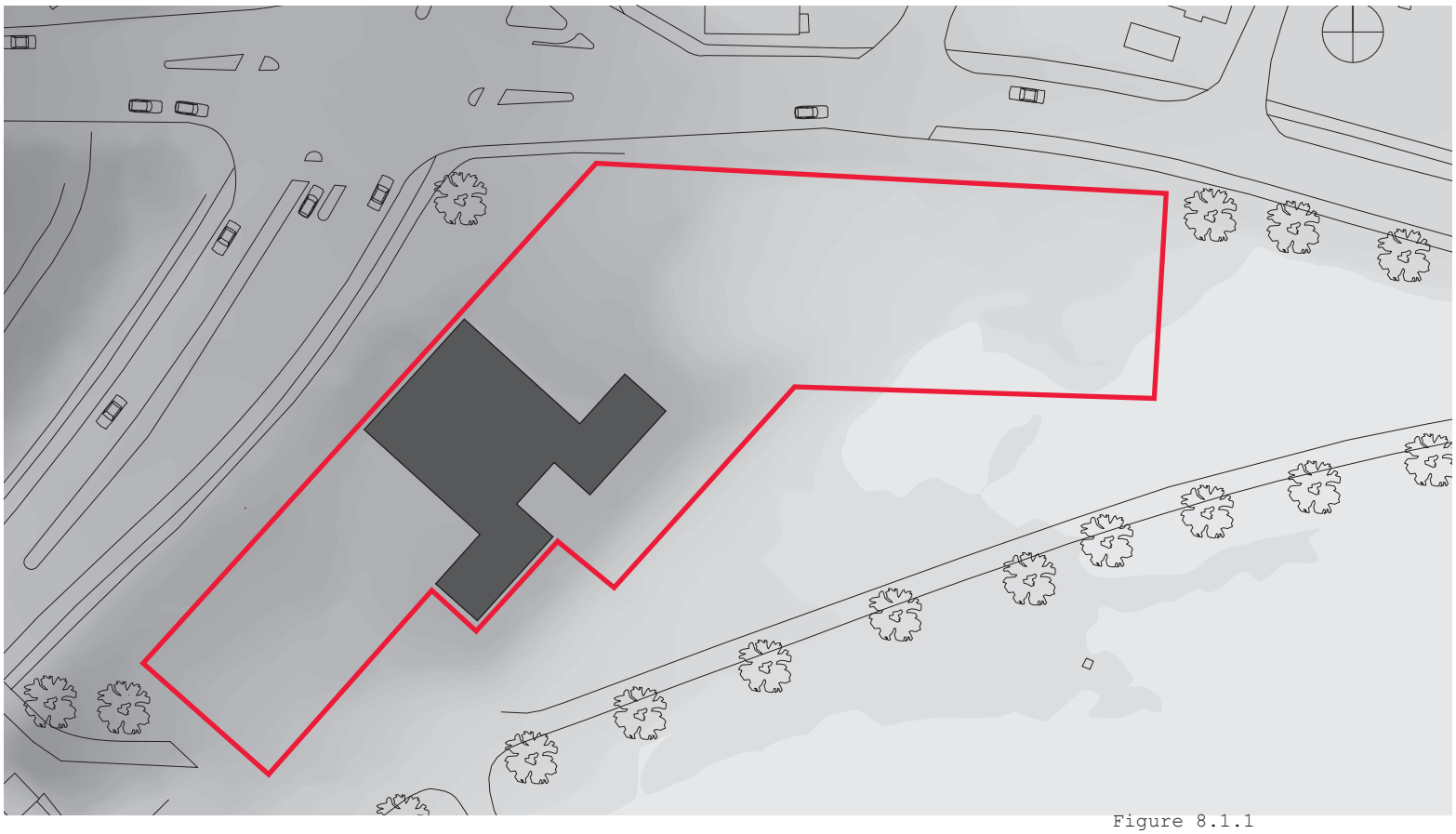


Figure 8.1.1

- 8.2 Concept

From the initial studies made in connection with the museum the concept has been defined from the architectural brief, and evolves around functionality, interaction and materiality.

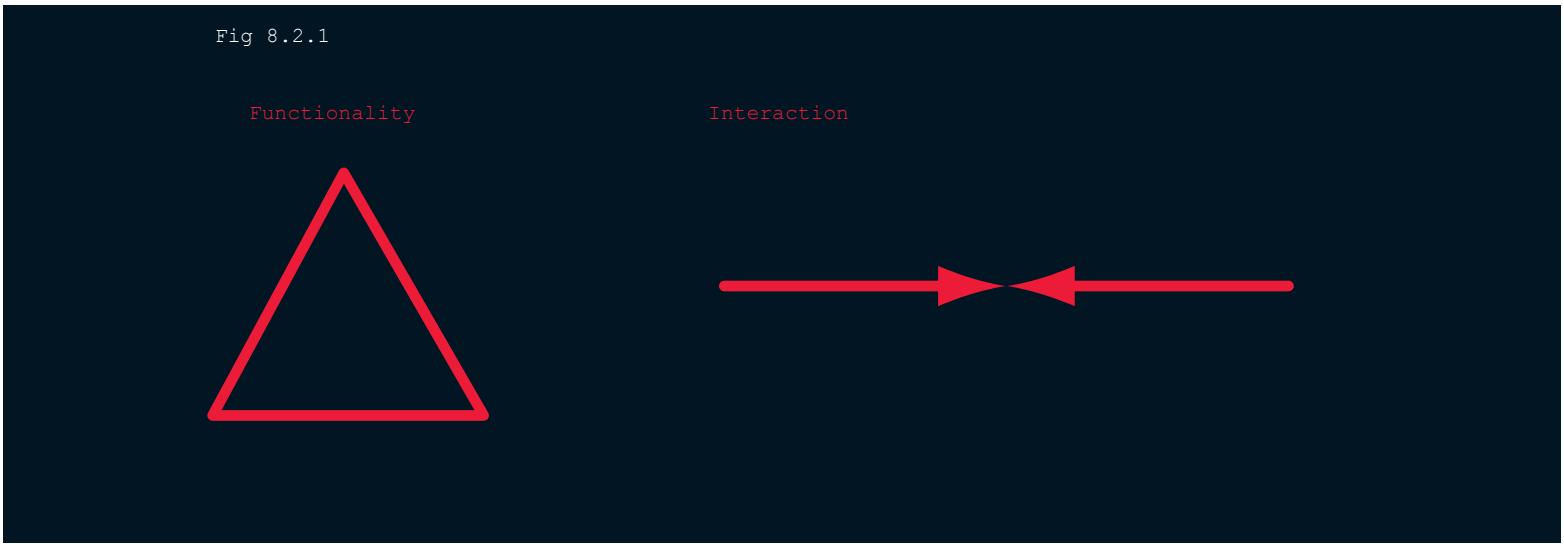
The three principles reflect how these experiences are means to develop an architecture that respects and communicates its function, creating an experience for the visitors.

Functionality is about creating a solution where the logistics has a simple form, creating a natural flow of people and art in the building. It creates a simplicity in the building

Interaction is about creating a building that communicates with the surroundings. It gives people passing it a peek at its inner life, awakening a couriosity

Materiality is about giving the users of the building an experience of the spaces. Creating a feeling of existing in the building, and not drawing attention from the purpose of the building

Fig 8.2.1



- 8.3 Utilizing the site

As mentioned the site poses certain challenges for the design. The first thing here is the traffic on the road right next to the site. This road is one of the main roads through Skive. It provides the site with a distinct edge, and a very visible site for people passing through this part of Skive, as it was seen in the site analysis in chapter six. Having the road and intersection there has led to using this "back side" as a platform for showing interpretations of the life in and around the museum with light. This has been chosen both because of the location next to the road but also because it is a wish from the museum to make a platform where people can get an impression of the inside and through that being teased and challenged to enter the museum.

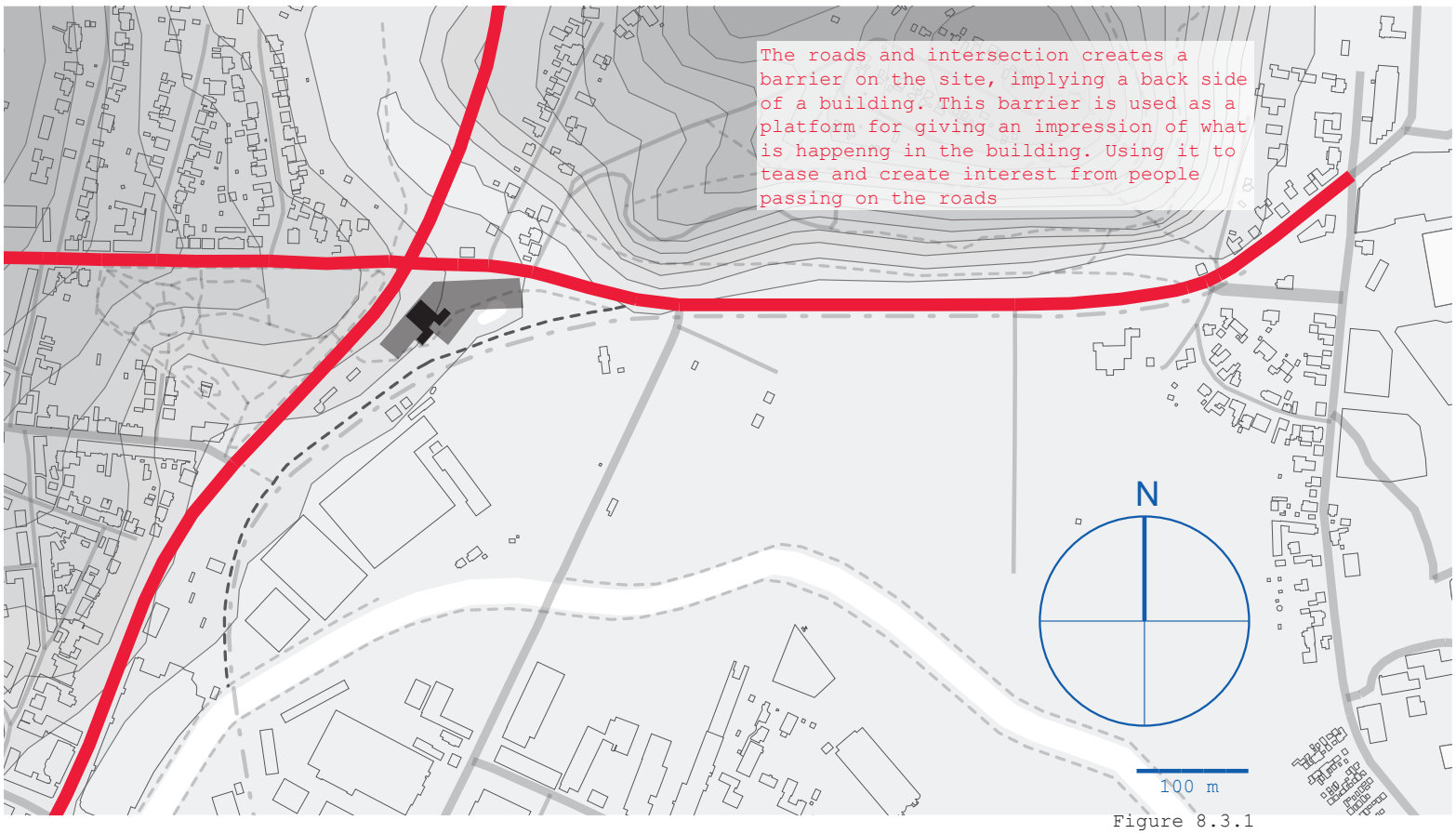


Figure 8.3.1

Zooming in on the site and the flow of pedestrians in the area, it is seen that they are passing the site on the path crossing the road, and from the parking lot located near the shopping center. This flow of people creates a node on the southern corner of the building site. The node on this corner provides a natural entrance, where the flow along the top of the artificial embankment, where the old museum building is placed. Furthermore the flow is connected to the nearby parking lot by the shopping center that will be used for the museum as well. It has been chosen to use these features, because it connects the nearby parking area, with a central node for the different flows in the area and with the end of the building site.

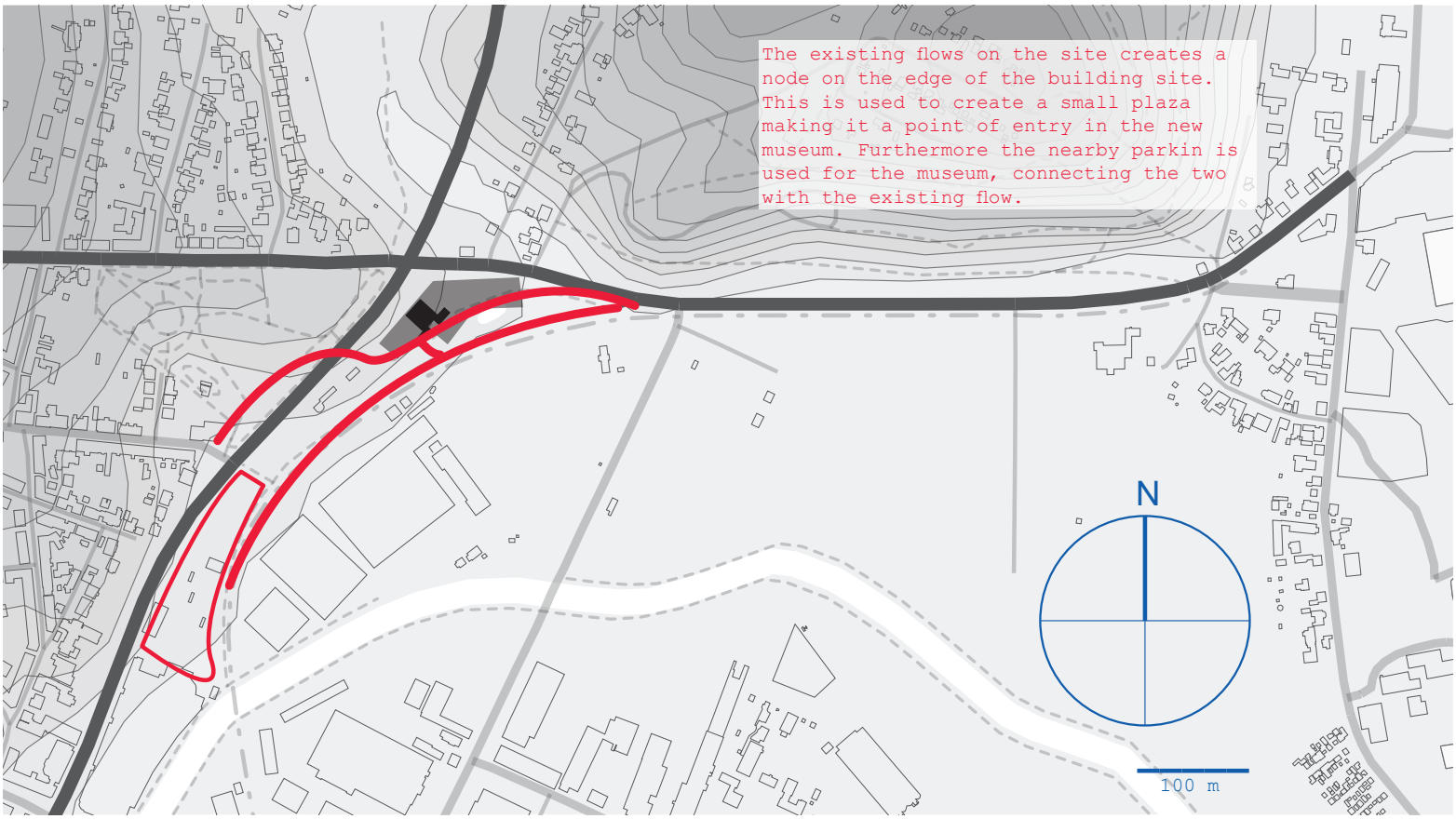


Figure 8.3.2

Zooming further in on the site, and the features here, the decision made about creating a buffer zone towards the road gives the opportunity of creating a path from the before mentioned node along the embankment, where the old museum is placed, and towards the forest and the harbour. This path is facing east and south, creating a path embracing the park, and being able to gain heat from the sun most of the day. Furthermore this path will utilize the views to the small park and the nearby forest. Doing this both utilizes the use of passive solar heating as well as creating a visual connection between the museum and the park. Using the before mentioned path for that purpose also gives a clear definition of the spaces in the museum, where the parts with the visual connection to the outside are breaks from the museum.

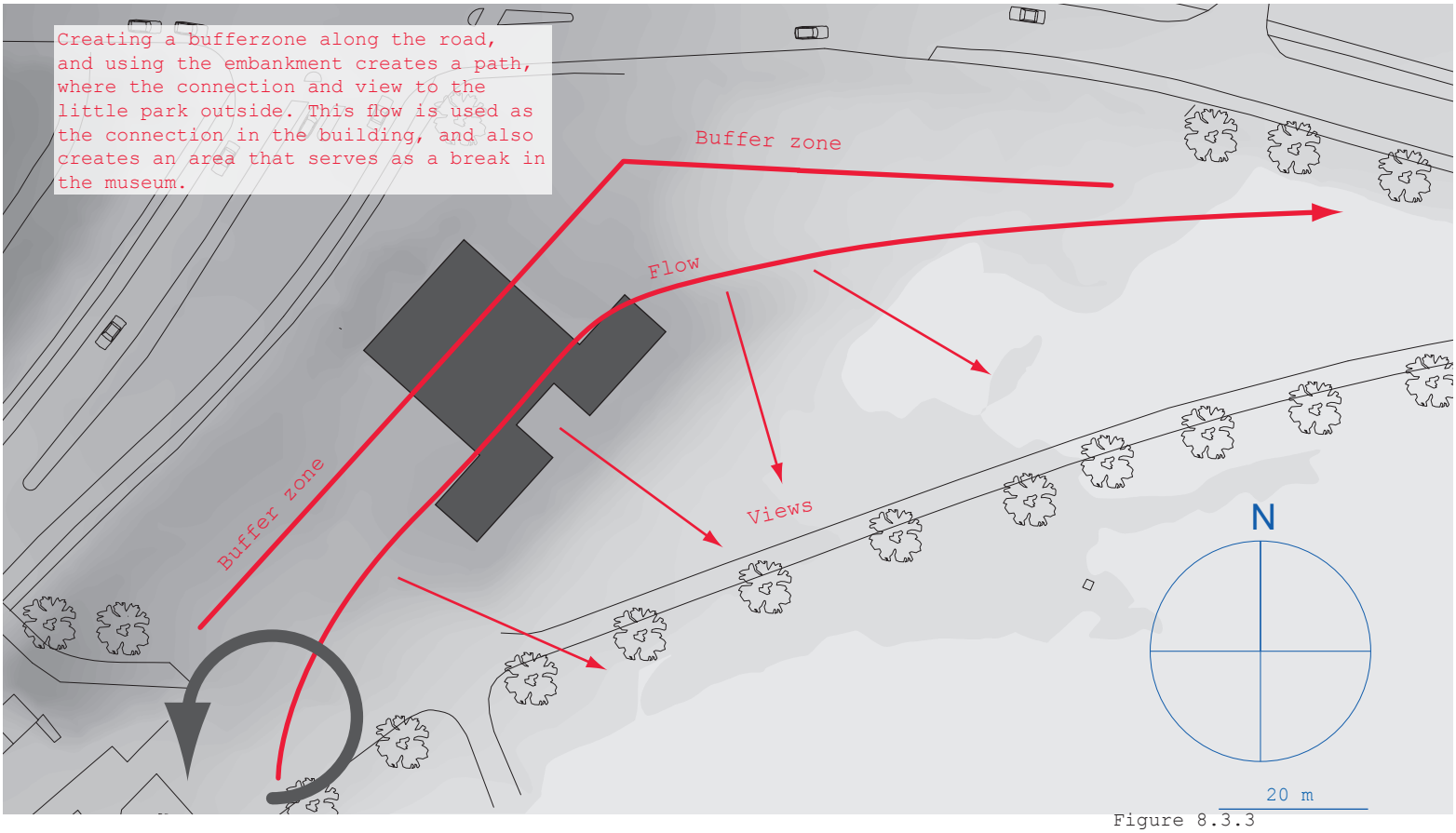


Figure 8.3.3

When the decisions about how the site can be utilized is used in connection with the functions and how they are related discussed in chapter seven the outline of a simple functional plan starts to take shape. As mentioned there is a "back side" to the site towards the road. Placing the functions servicing both the public areas, as well as the exhibition areas towards the road creates a buffer zone and pushes the zones where visitors are towards the park and the views. Doing this also creates easy access between them. Furthermore the shape of the building site together with the path along the embankment starts to dictate a shape. Taking the node mentioned before as the starting point it has been decided to place the public functions in connection with it. By doing this the flow along the embankment can be used as a connection integrating the old museum building as a part of the experience of the museum. Furthermore it separates the public functions from the exhibition areas, and makes it possible to use them outside the museums opening hours without compromising the security of the museum.

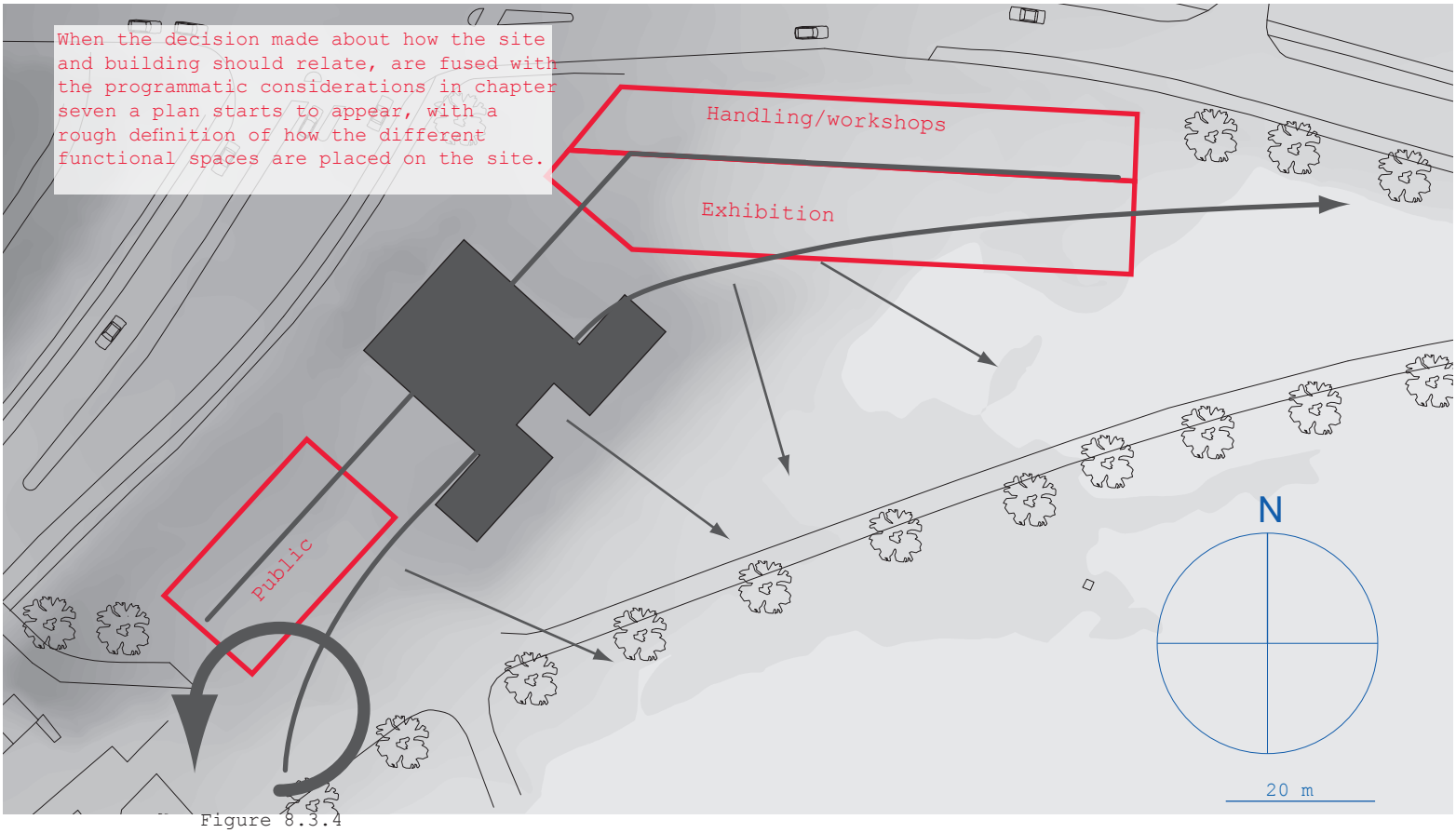


Figure 8.3.4

Zooming a little bit out again, the placement of the functions and the beginning connection between them starts to apply different features to the site. First of all it is seen that the connection between the public building, the old museum building and the new exhibition building is rather long. But between the buildings small courtyards are creating breaks, where small sculpture gardens can be planned, views to the forest and park, and small areas for different exhibitions.

Furthermore the connection to the road and the site makes it possible for trucks delivering art and goods to the museum. By using the contours of the site it is possible to make a secure loading area in close connection the areas servicing the exhibitions. It also provides the possibility for easy access for delivering goods in the public building as well as parking for the employees in close connection to the museum.

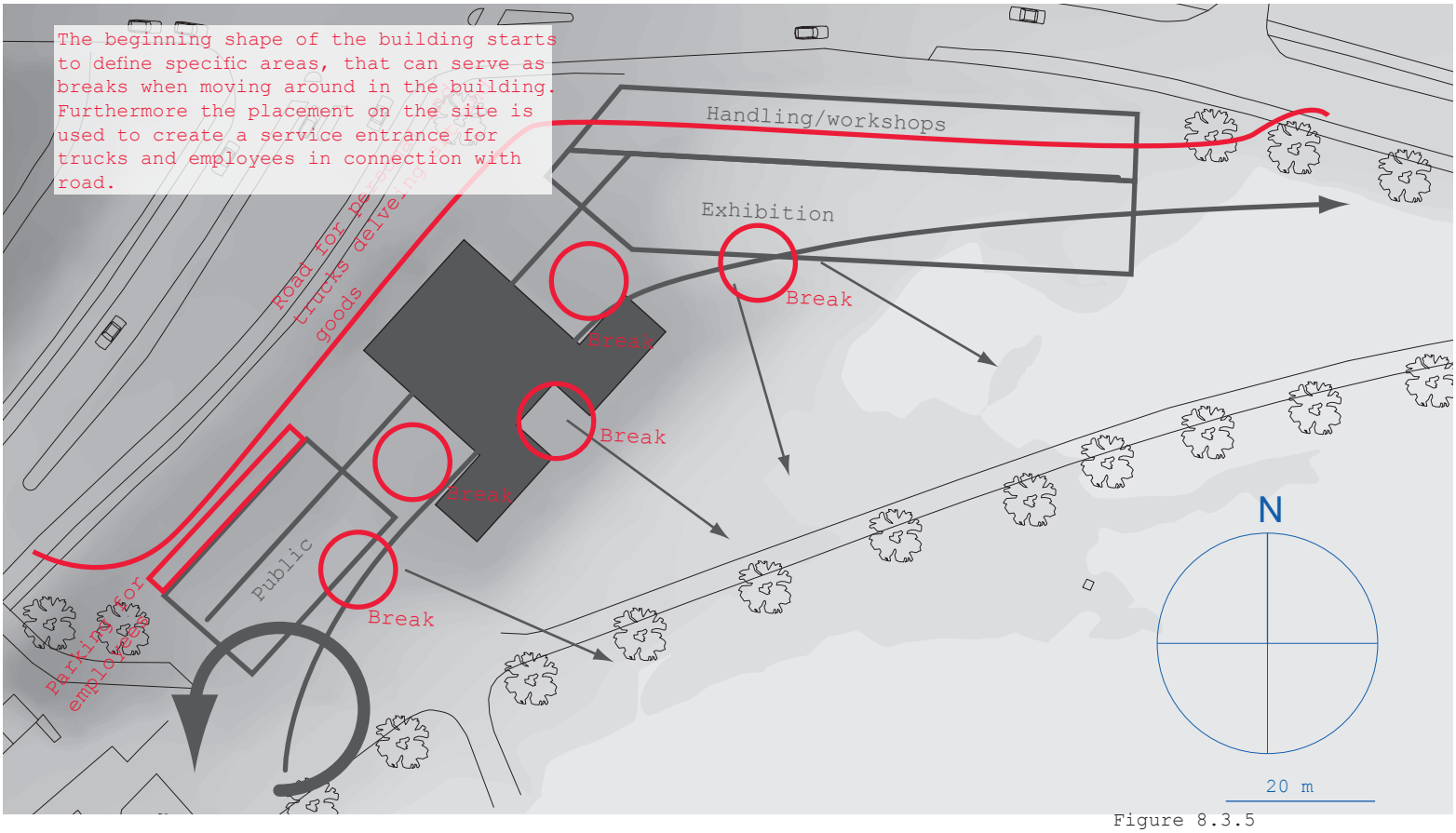
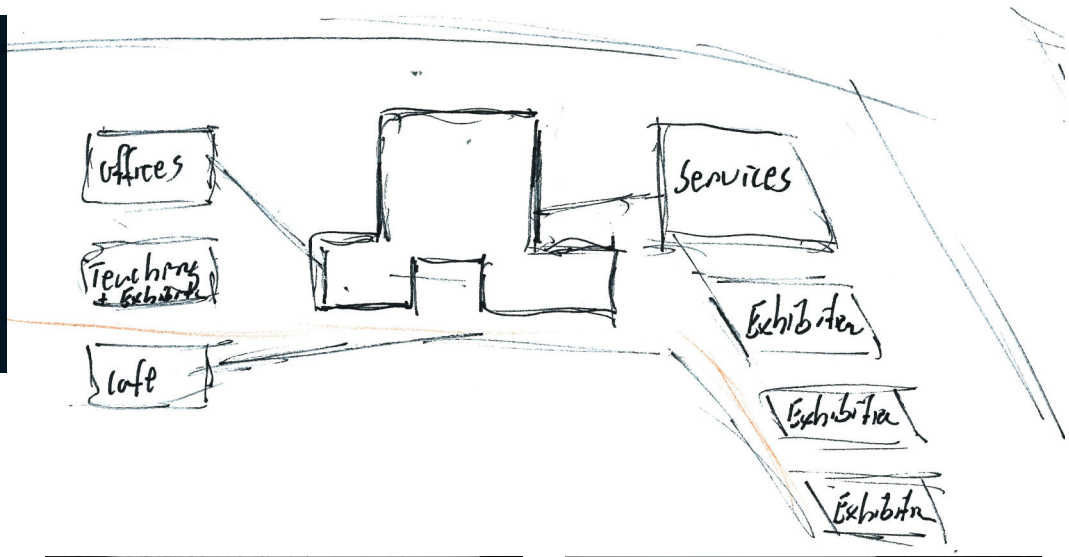
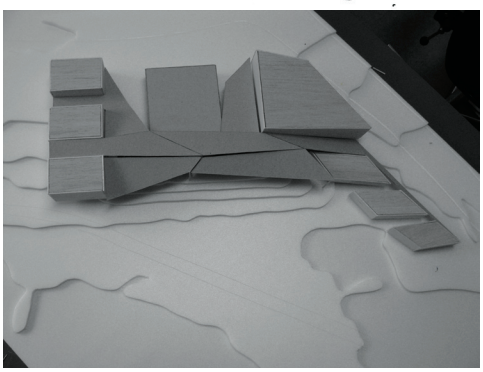
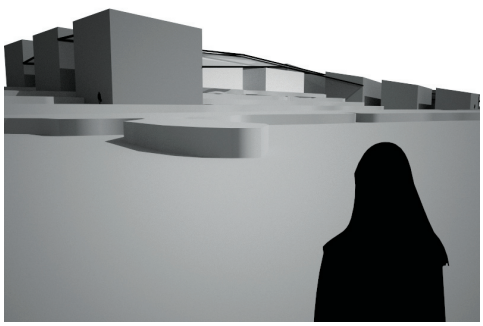


Figure 8.3.5

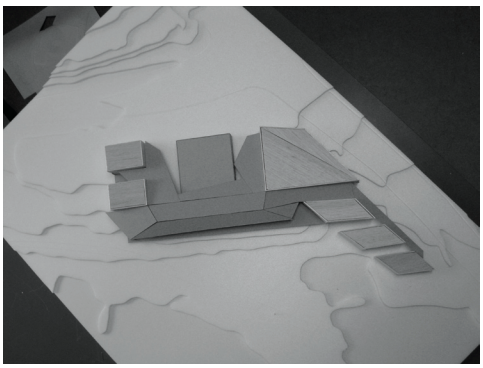
The functions are placed in “pavilions”, allowing the flow to follow the site. At the same time placing the buildings with the services close to the road, and the mediation spaces in the park. At the same time the connection embrases the old museum and exhibits it in the new structure

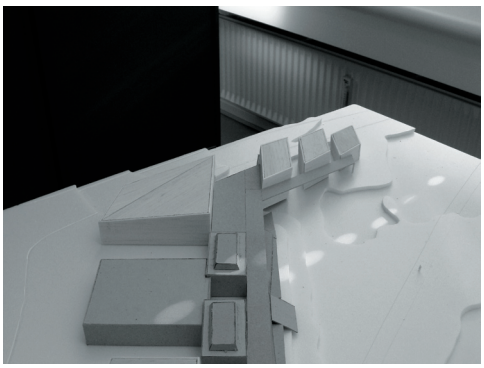


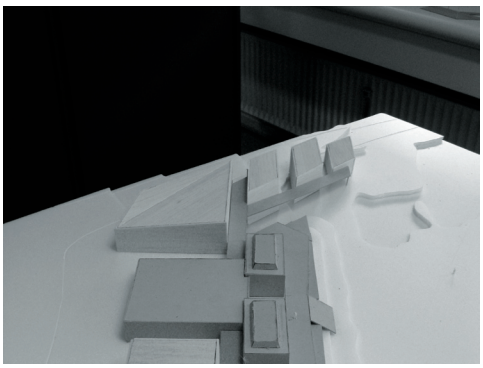


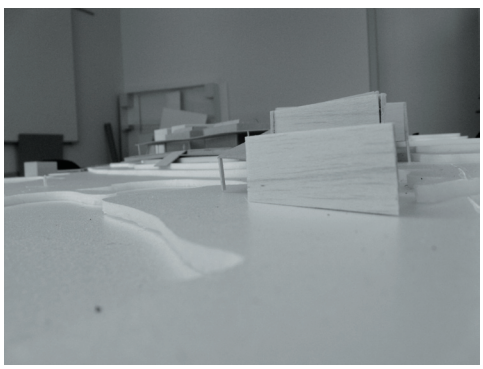


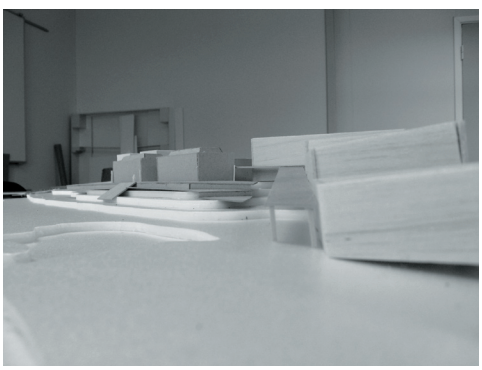
The structure connecting the “pavilions” starts to work its way around the old museum. Instead of embrasing it it starts work with the axis in the museum. Trying to gently connect with it on the old museum buildings premisses. It starts to make use of it as a part of the new museum



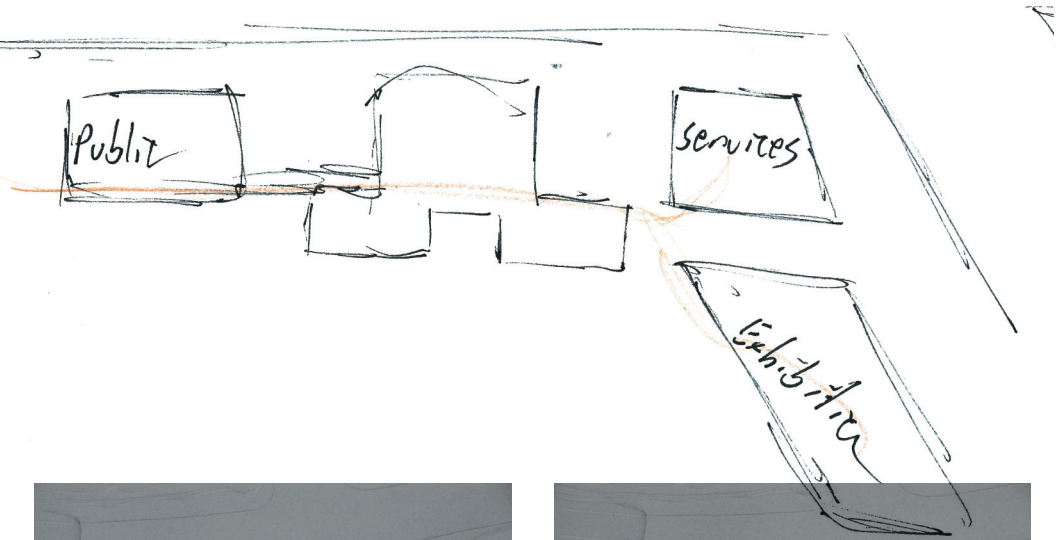


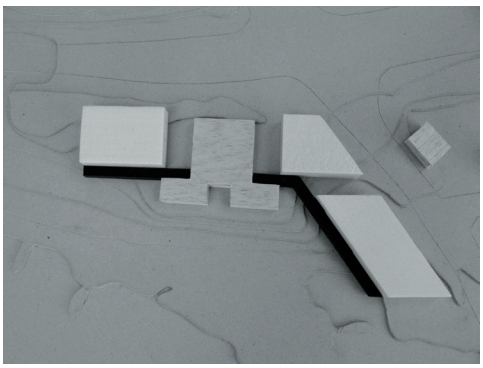


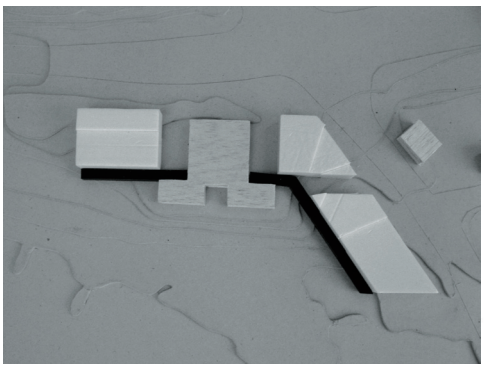


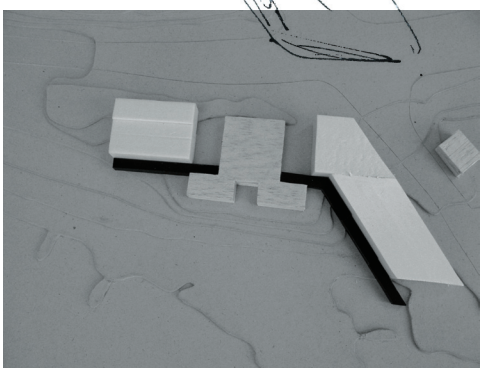


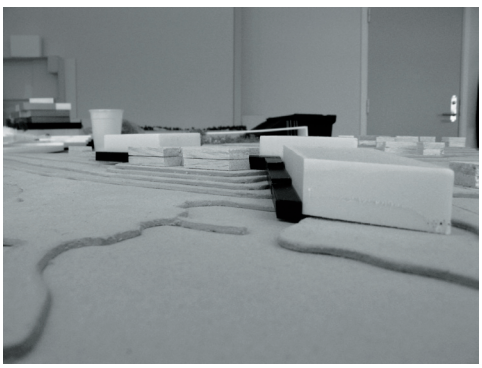
The "pavilions" starts to fuse into bigger regular buildings again. The functions are merging shaping the volume. The landscape starts to affect how the buildings sits. The flow still runs on the park side creating a visual connection between the museum and the park

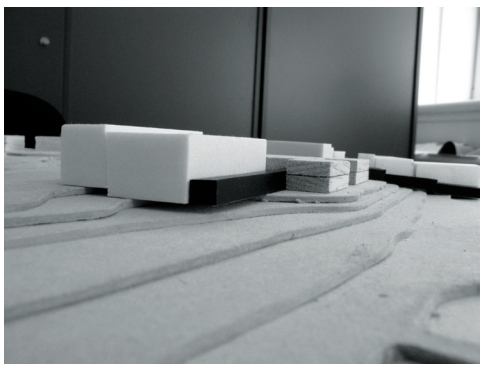




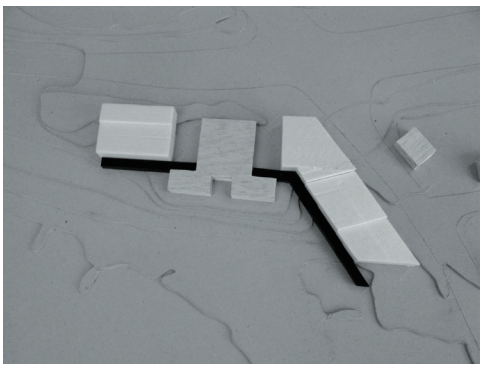


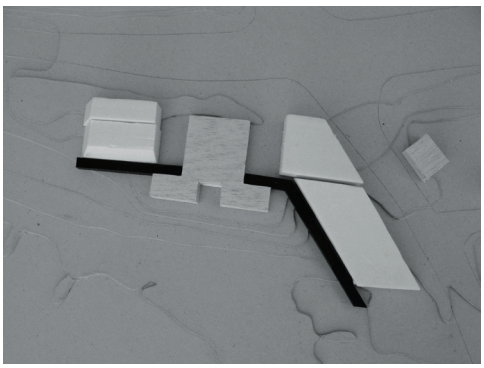


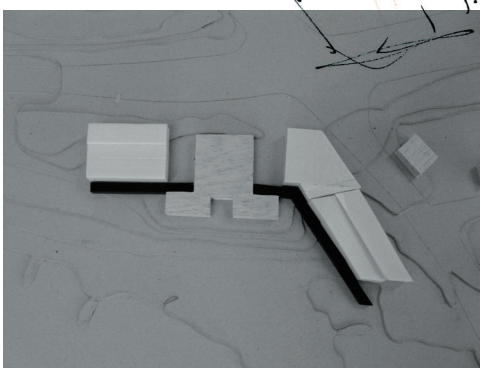


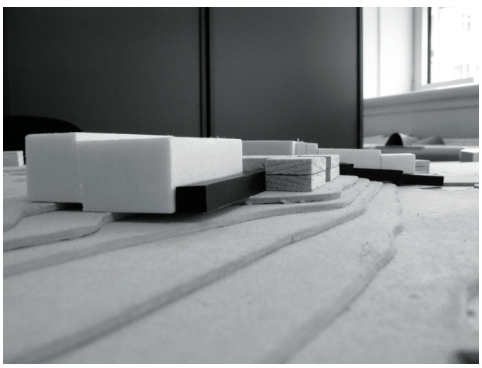


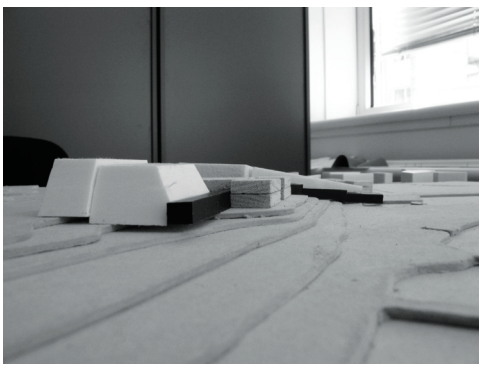
The six "pavilions" have by now been fused into two buildings. The small one containing the public areas that can be accessed without the museum being open and the large one containing exhibition areas, workshops and storage for the museum.



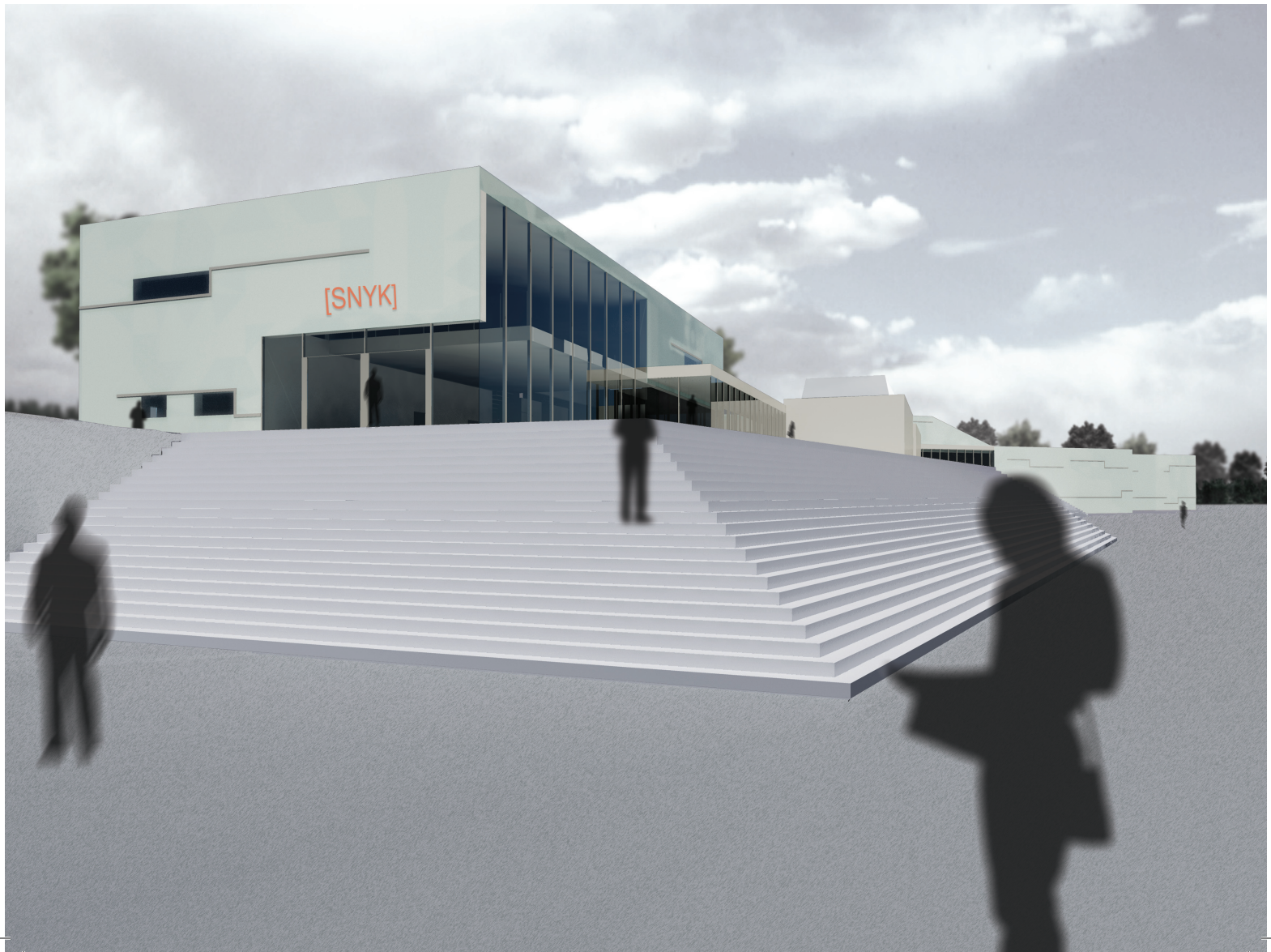








Moving towards the building along the path, it appears as a monolith where the entrance has been carved out in the corner. It rises above the park on its plateau. One is drawn towards the rising stairs. The view towards the nearby forest and towards the harbour slowly appears as one approaches the building on the stairs. Entering the building the light simple room appears. The entrance being in a narrow area with the full height of the room, before moving under the cafe, finally arriving to the foyer area, again with the full height of the room.



- 8.4 Light

Entering the building and experiencing it also plays an important role in the considerations for the design. The focus here has been on using light to create different spatial experiences. The main focus has been the use of natural light where possible, and using the different experiences it can create. As mentioned the light is important in a museum, where direct sunlight on pictures can cause serious damage to them, and the amount of time they are exposed to light is important. Here it has been decided that the only direct light coming into the exhibition areas comes from the pathway connecting the buildings. This creates a light warm entrance space to the exhibition building. Light in the other parts are diffused. The diffused light in the building has different characteristics depending on the direction it comes from. The spaces turned towards the north have a colder feel, whereas the ones towards the south has a warmer feel to them.

Even though the focus has been on natural light, artificial light has also been considered. The artificial light here is used as a supplement the natural light and ensure that there is an even light, creating the best experience of the art. Using this approach the diffused natural light provides the room with a certain feel dependent on the direction of the light, whereas the artificial light is used for providing the arty with the right amount of light.

The museums wish to focus more on digital and interactive art also calls for dark places, without any light, or at least with strict control of the light. Here the focus has been on using areas, where there is no natural light, making the control of the light easier, and emphasizing the experience of this kind of art.

Besides using the light to create different spatial experiences it has also been also been used to create breaks in the rooms. This creates small spots where one can sit down and have a break while still watching the exhibition in the area.

The starting point in the work with natural light has been the amount of windows found in the work with the energy consumption in order to determine how the amount of windows that can be permitted here corresponds with the demands for light in the building and the experience one should have here.

This has been a very functional and pragmatic starting point in the process, where the simulations made have been focused on a single room, and the results from this, has been used as a guide for the rest of the building.

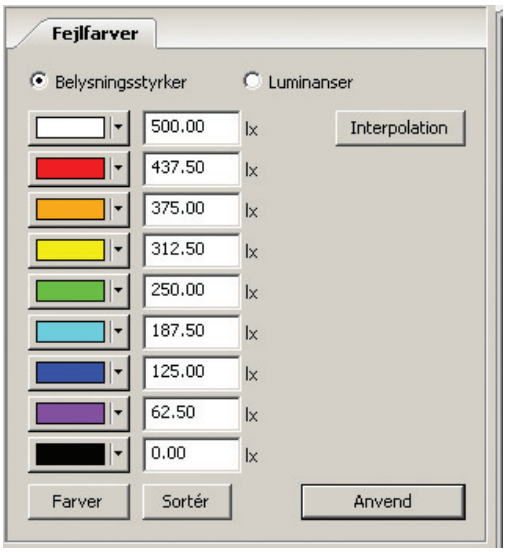
The simulations made are focused on the physical properties of the light, measuring the amount of light and comparing it to the demands of the exhibition areas.

On the following page figure 8.4.1 shows the example as it is taken from BE06 with 10% windows towards south, south-east and south-west. The openings here are vertical.

Figure 8.4.2 shows again with ten percent openings, but here the material is a translucent material and furthermore two roof lights washing the back wall, and a wall placed for dividing the room, and reflecting light.

Figure 8.4.3 shows basically the same as figure 8.4.2 but with the openings horizontally instead of vertically.

Finally figure 8.4.4 is with twenty percent openings and vertically.



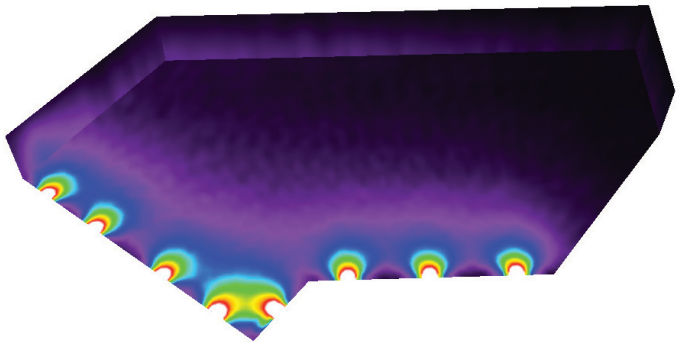


Figure 8.4.1

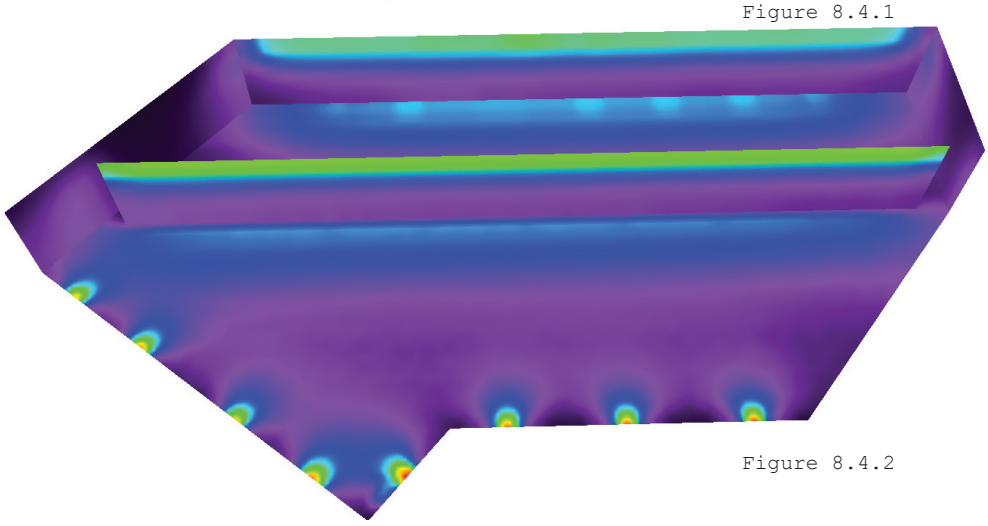


Figure 8.4.2

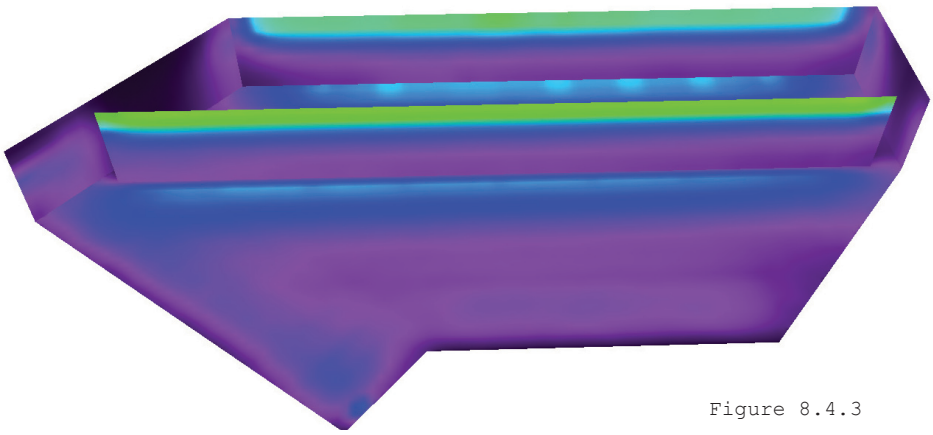


Figure 8.4.3

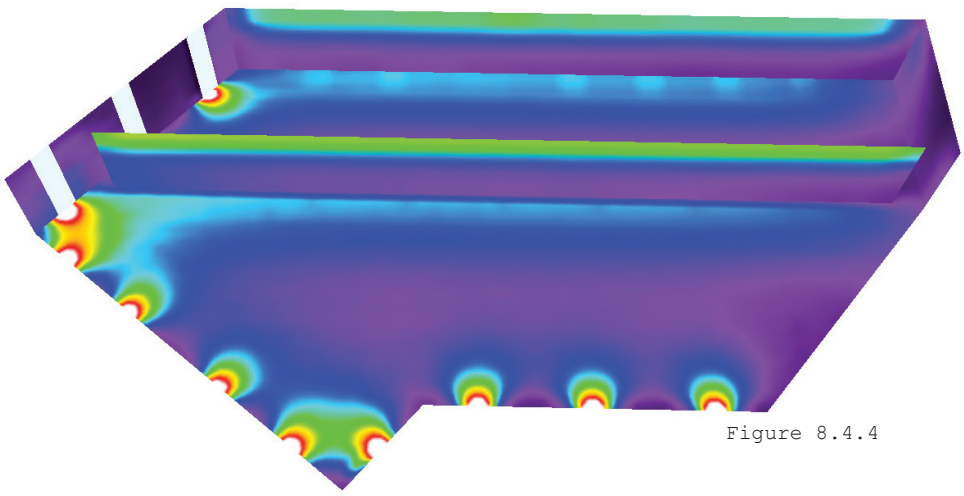


Figure 8.4.4

The experience of the light in the building has been approached in a qualitative way, where models have been used to study the light in the rooms, and how direct, reflected and diffused light affects the spaces. This study has been on a very analogue level, with cardboard models, and different materials used for "glazing", and different scaled models.

By using both the quantitative studies in computer simulations of the space and the analogue models a general idea about the light conditions and the experience they create has been formed. This idea has formed the basis for the light in the other exhibition spaces and the experience they should create.

Figure 8.4.5

- 8.5 Spatiality

The spatial experience of the museum has been an important design factor. It has been focused on creating spaces that complements the art, but also spaces that can challenge the exhibited art. Here the focus has been on creating smaller spaces, that are interconnected, creating a series of different experiences.

As mentioned in the previous section about light, the direction from where the light comes has an influence of the perception of the room. In the museum it has been chosen to use the light as a means to get these different spatial experiences. By using the natural light conditions in the museum as the guide for the spatial experience it becomes possible to create this series of different spaces with different experiences.

Using the natural light in this way will in general create spaces to the south that are perceived as being warmer, whereas the ones facing north will be perceived as having a cooler light. Using the depth of the building also creates a darker and more dense spatial experience towards the middle, where the use of artificial light can help to create different more focused experiences.

An important factor in the series of spaces is that they are not sealed of from each other. They are connected with views from one to another, creating a sense of experiencing pieces of what is happening in the next space, teasing ones curiosity.

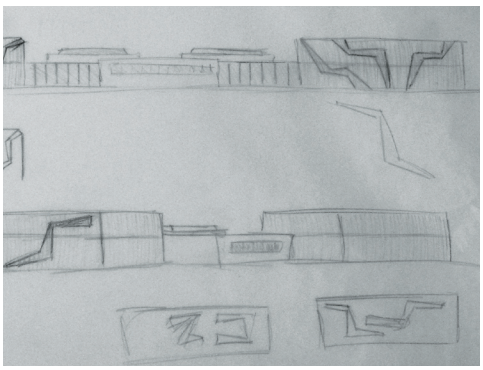
Another important factor in the spatial experience of the building is the breaks and light zones created where the connection between the functions meets the building. The breaks are central to the experience of the building creating a place where it is possible to peek into the exhibition areas, and central to moving around in the different exhibition areas. Furthermore these breaks serves as places where the impressions from the different exhibition areas slowly can settle in ones mind before moving on in the museum.

- 8.6 Facades

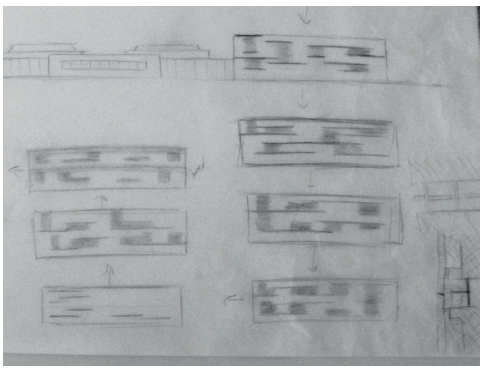
The design of the facades has had two major design parameters as a starting point. First of all it should be possible to use them as a place for communicating what happens in the building, and secondly it is the source of natural light for the building. Furthermore it has been important that the facades reflects the horizontal movement within the building, but still maintain simplistic expression.

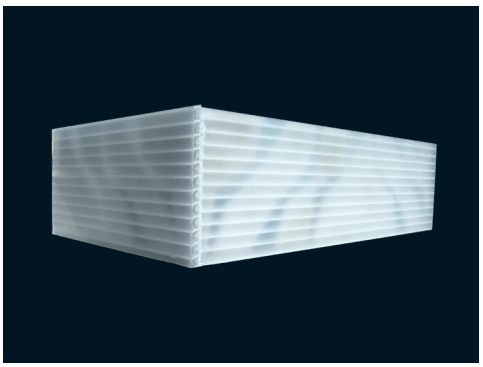
In terms of materials the aim has been to find a material that can fulfil the above mentioned requirements. A material that has a simplicity, that allows the facade to change during the day, and allows diffused light into the building, and at the same time makes it possible to sense what is happing in it, without revealing everything.

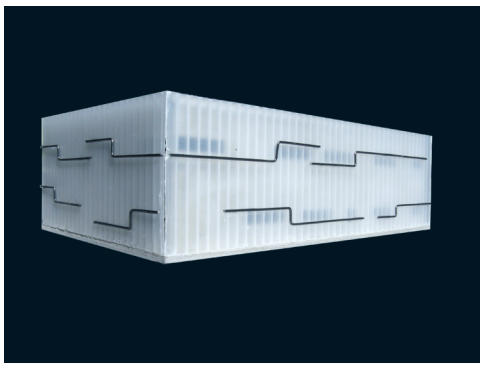
The choice is a u-shaped glass profile allowing for large uniform surfaces. This combined with an acrylic honeycomb structure inside and the internal load bearing walls makes it possible to have, transparency, translucency and an opaque surface by using just one material. Furthermore the articulation of the horizontal joints of the profiles gives the facade a dynamic movement and sets up a system for where the transparent and translucent areas are.

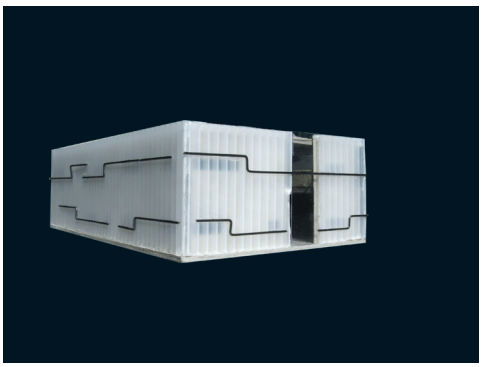


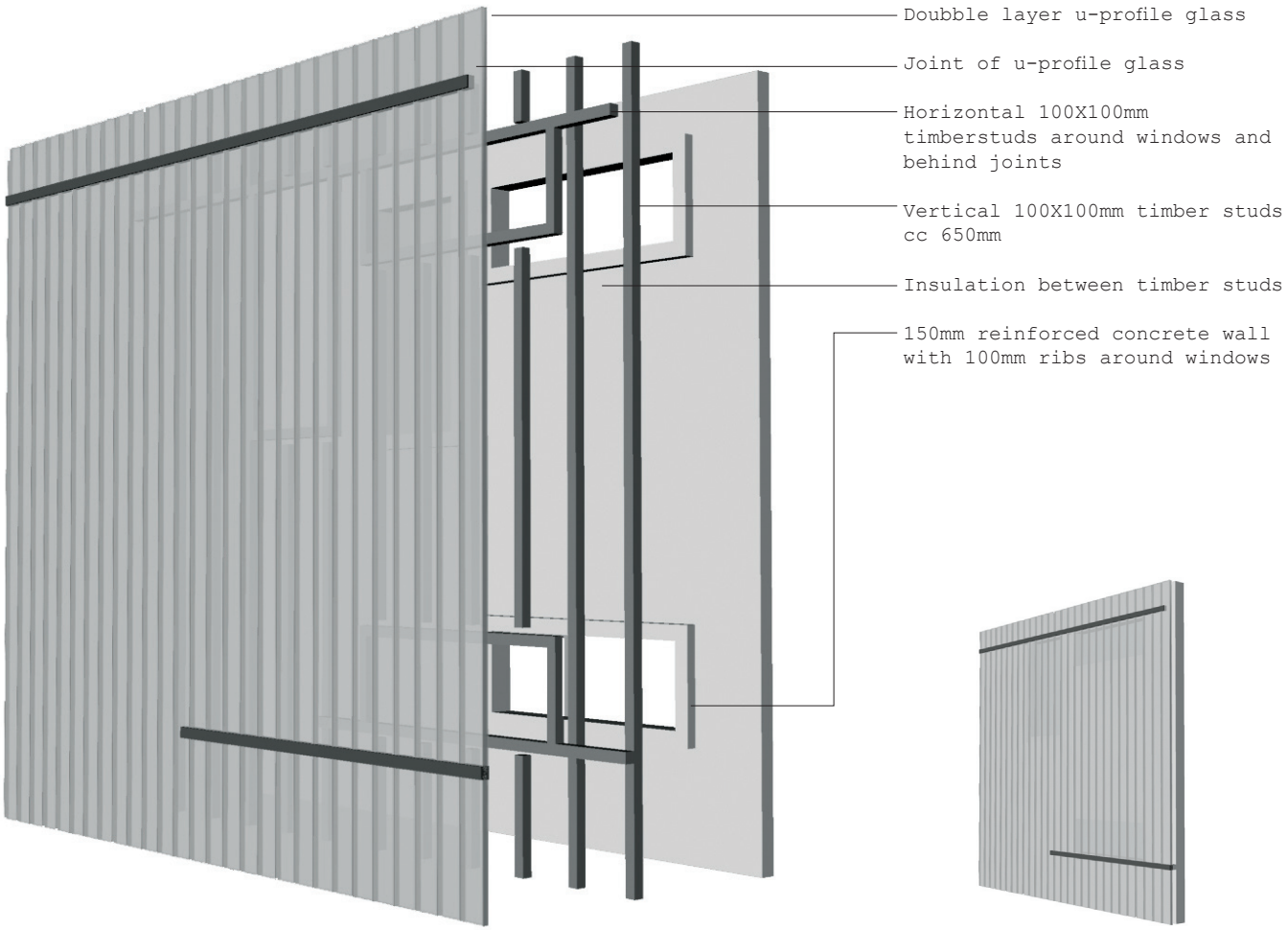
The facades started with an idea of mimicking the trees in the wind, but ended in a calm expression letting the need for light and the functional requirements in the building determining the simple shape keeping the art exhibited in focus. Still maintaing the horizontal dymanics in the building





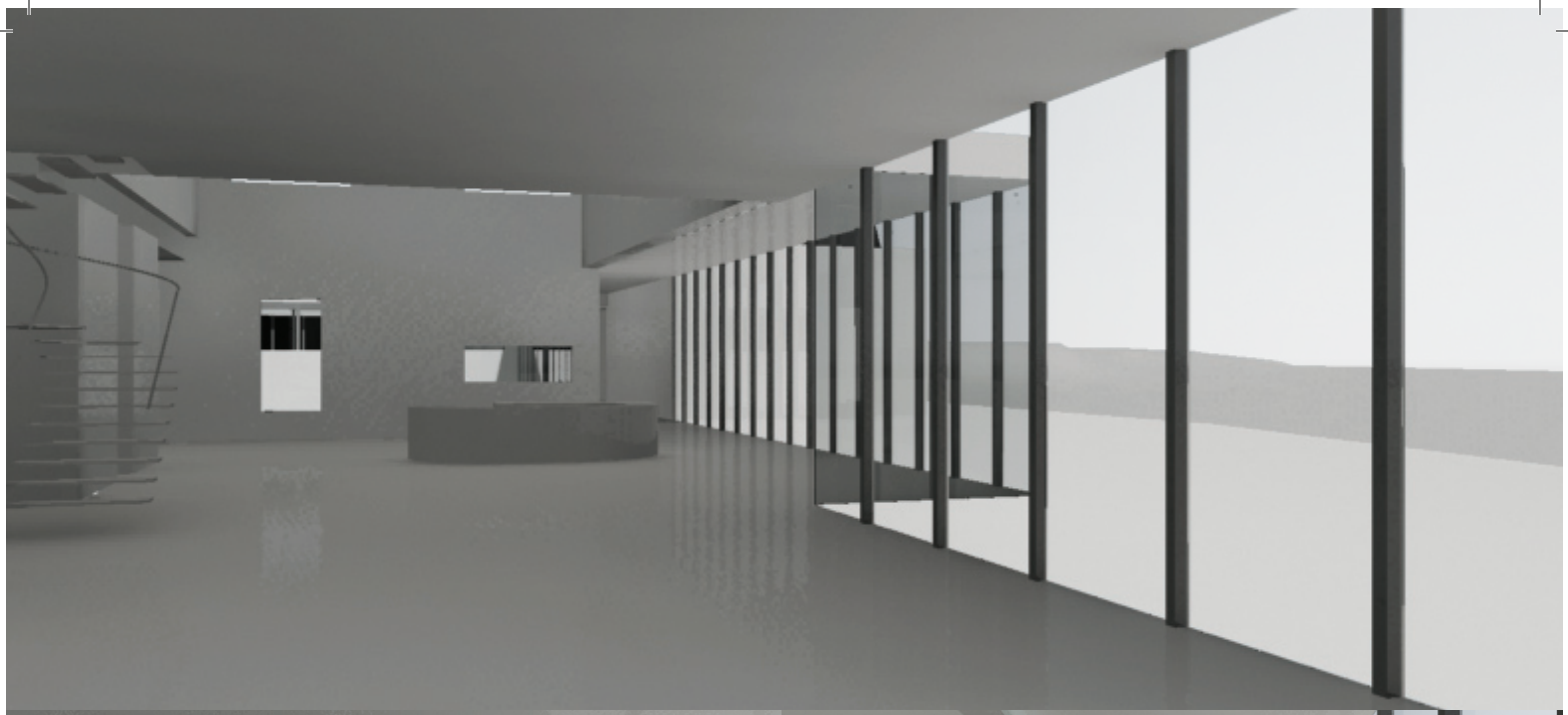






Detail of window openings from the inside

Figure 8.6.1



Moving from the foyer one moves through the narrow path with its view towards the park the first break appears as one passes the old museum building, with its two small rooms for exhibitions. Its little court yard in the center of the building providing a calm and light environment for the exhibitions about local history. Exiting the old building the pathway opens towards the park again, gently turning and the new museum building appears, with views into the different exhibition areas. The light pathway contrasting the darker interior giving full attention to the art.

- 8.7 Flows in the building

Having considered how the functions in general relates to the site, and the spatial experiences in the building the flows in the building and the connection between the functions starts to define a final shape for the building. In chapter seven a general relation between the functions was established. These general relations now have to be related to the site and the experiences in the building, creating a flow for employees, visitors and the art entering the building. Figure 8.7.1 below shows the three functional flows in the building, and will be described more elaborate on the following pages

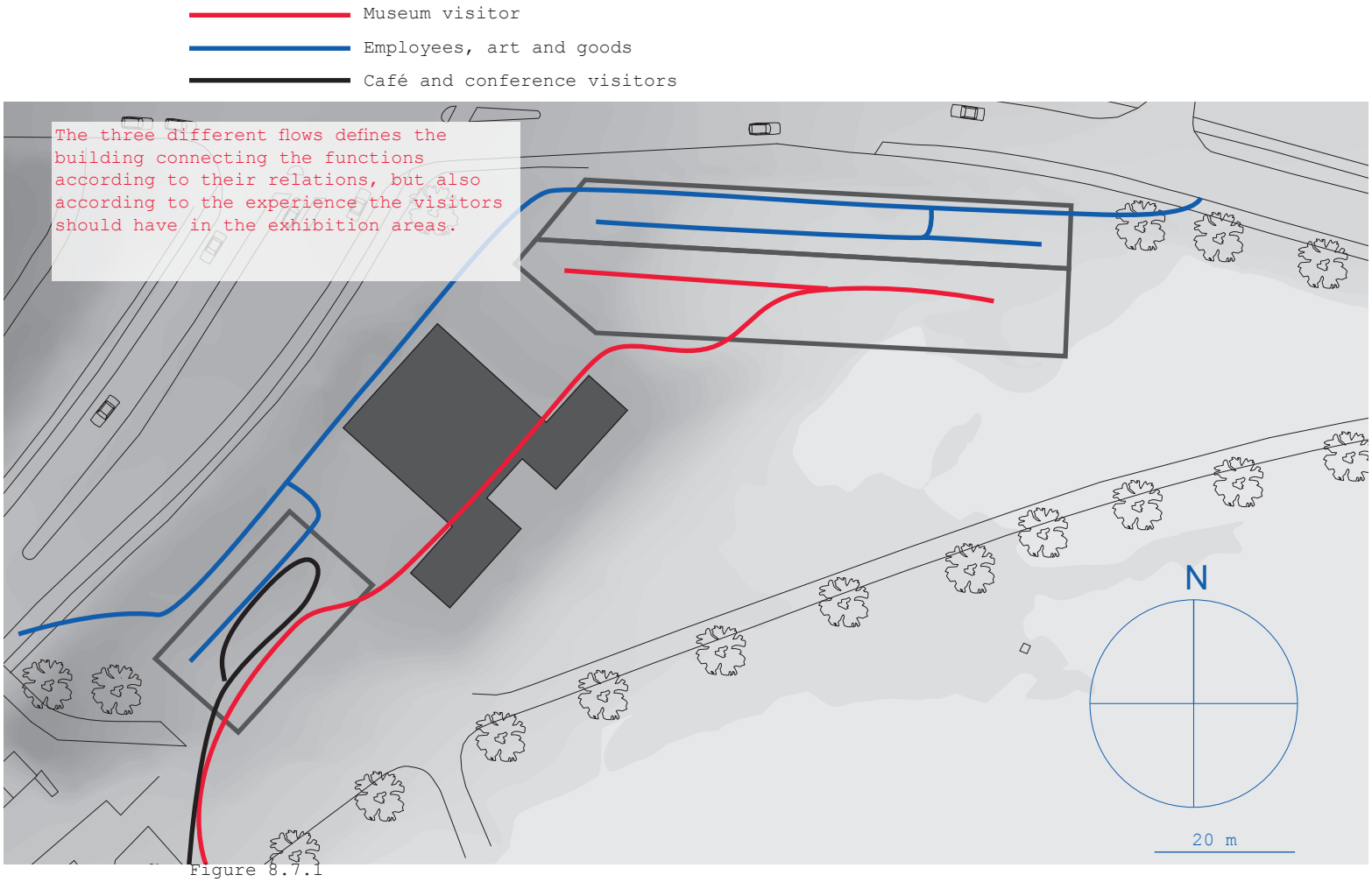
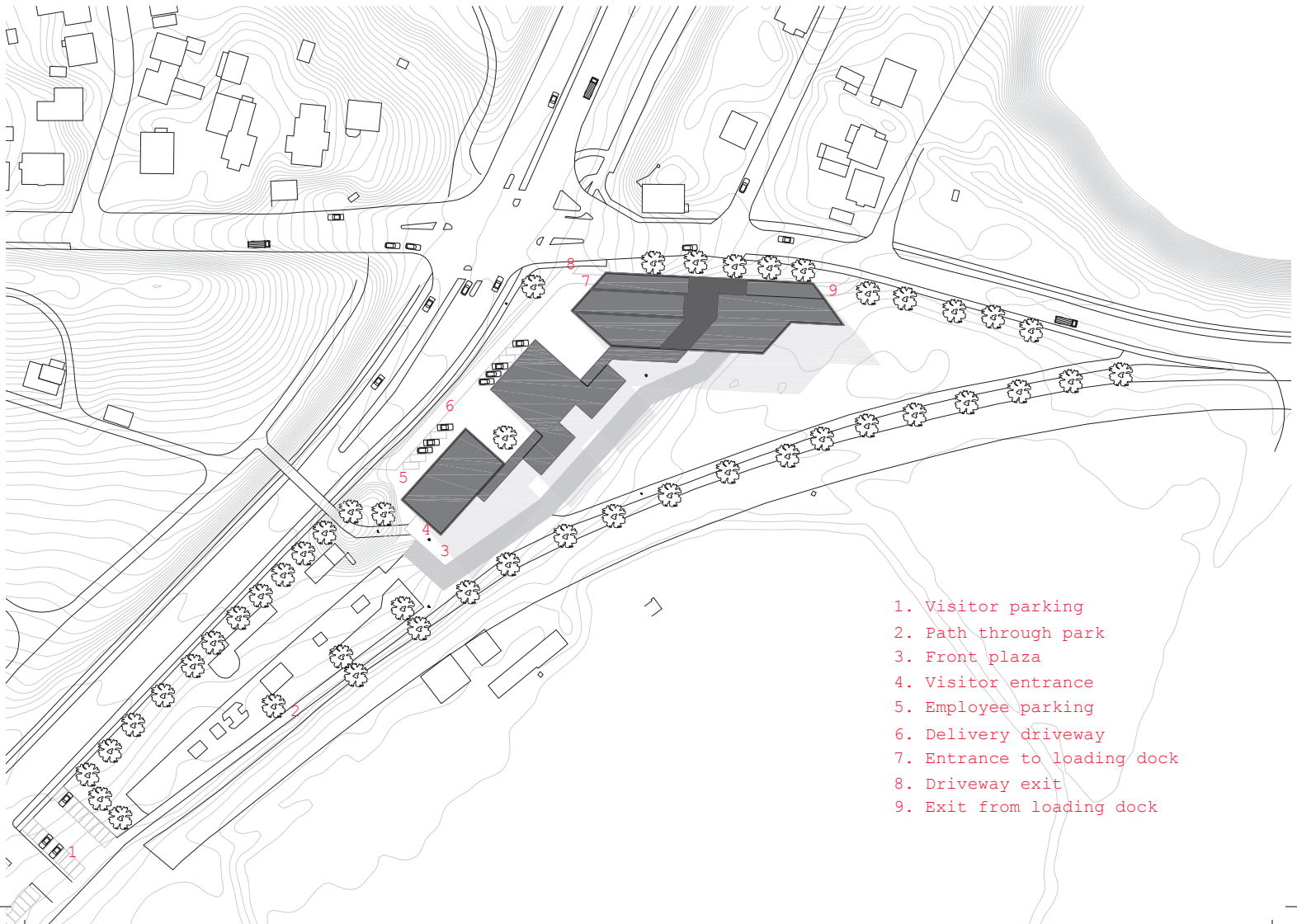


Figure 8.7.1

Approaching the building as a visitor one parks at the parking lot adjacent to the shopping center. From here they move along the path going through the park, and at the southern tip of the park the path meets a small plaza from where stairs leads up to the museum. This plaza emphasizes the node. The stairs leading up to the museum continues around the old embankment emphasizing its function as a plateau raising the museum above the park.

Employees and trucks delivering arts and goods to the museum approaches is from the road on the backside of the museum. Here a driveway is passing the museum providing parking for the employees next to the building containing public functions. Furthermore the driveway makes it possible to drop of things for the café and offices here. The driveway continues past the old building, where it then enters the new exhibition building down a ramp to the loading dock for art, allowing the trucks to pass the museum without having to back up or turn around anywhere.

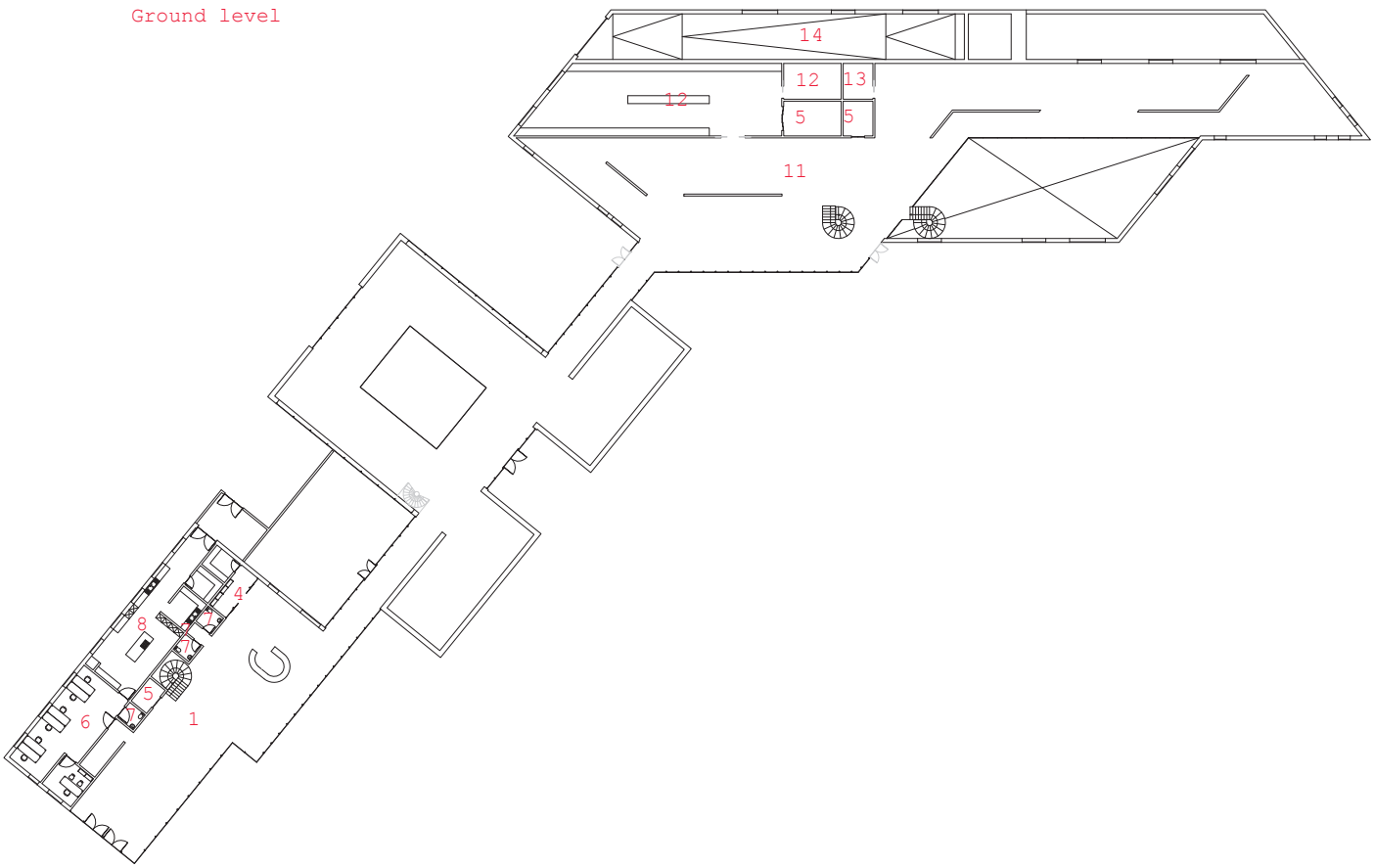


1. Visitor parking
2. Path through park
3. Front plaza
4. Visitor entrance
5. Employee parking
6. Delivery driveway
7. Entrance to loading dock
8. Driveway exit
9. Exit from loading dock

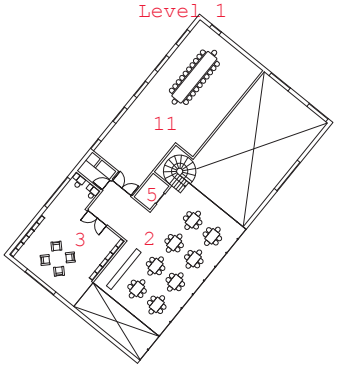
Visitors enters the building from the south-western side, where the double doors marks the entrance. The visitors pass under the balcony with the café, before entering the reception area. The reception area is located at the rear end of the building seen from the entrance and from here it is possible to enter the cafe and conference facilities at the upper level of the public building via the stairs or lift. In the part of the building towards the road the offices and kitchen is located buffering the visitor areas from the traffic on the road.

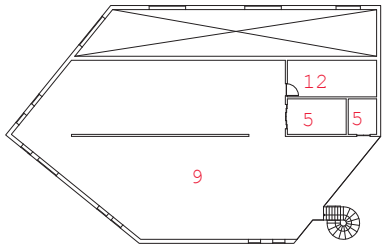
From the reception area the flow to the new exhibition building is through the old museum. This happens via a pathway orientated towards the park. Along this path, which is relatively long, small breaks are created between the buildings, creating different experiences. The old museum is taken back to its original appearance, and here the museum of local history and natural history will be located, making it possible to study these as well. The two small rooms towards the park will still serve as exhibition areas for the art museum, creating the possibility for having small teaser exhibitions or very focused themes here, before entering the new building.

Ground level



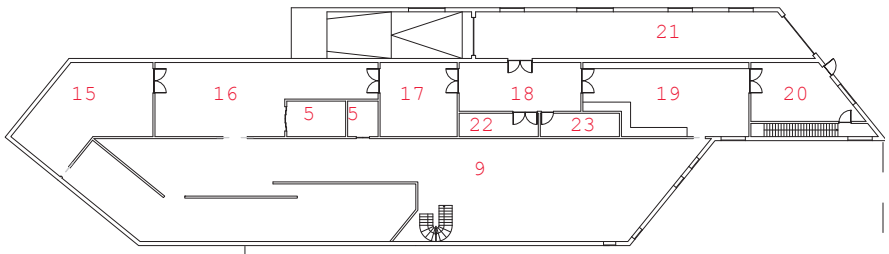
Level 1



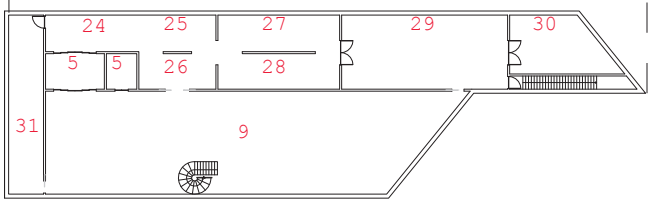


Spaces	Area m²
1. Entrance/foyer	346
2. Cafe	136
3. Library	72
4. Store	20
5. Lift	138
6. Office	78
7. Toilets	16
8. Kitchen	93
9. Exhibitions	2105
10. Art storage	175
11. Conference/teaching	122
12. Duct room	52
13. Exhibition supplies	11
14. Ramp	171
15. Transit storage	96
16. Furniture storage	126
17. Crating/uncrating	55
18. Receiving	58
19. Crate storage	110
20. Delivery	52
21. Loading dock	145
22. Moving equipment	18
23. Receiving office	18
24. Graphics	33
25. Framing	27
26. Exhibition preparation	27
27. Mounting	43
28. Installation	43
29. Workshop	120
30. Paint booth	52
31. Plant room	61

Level -1



Level -2

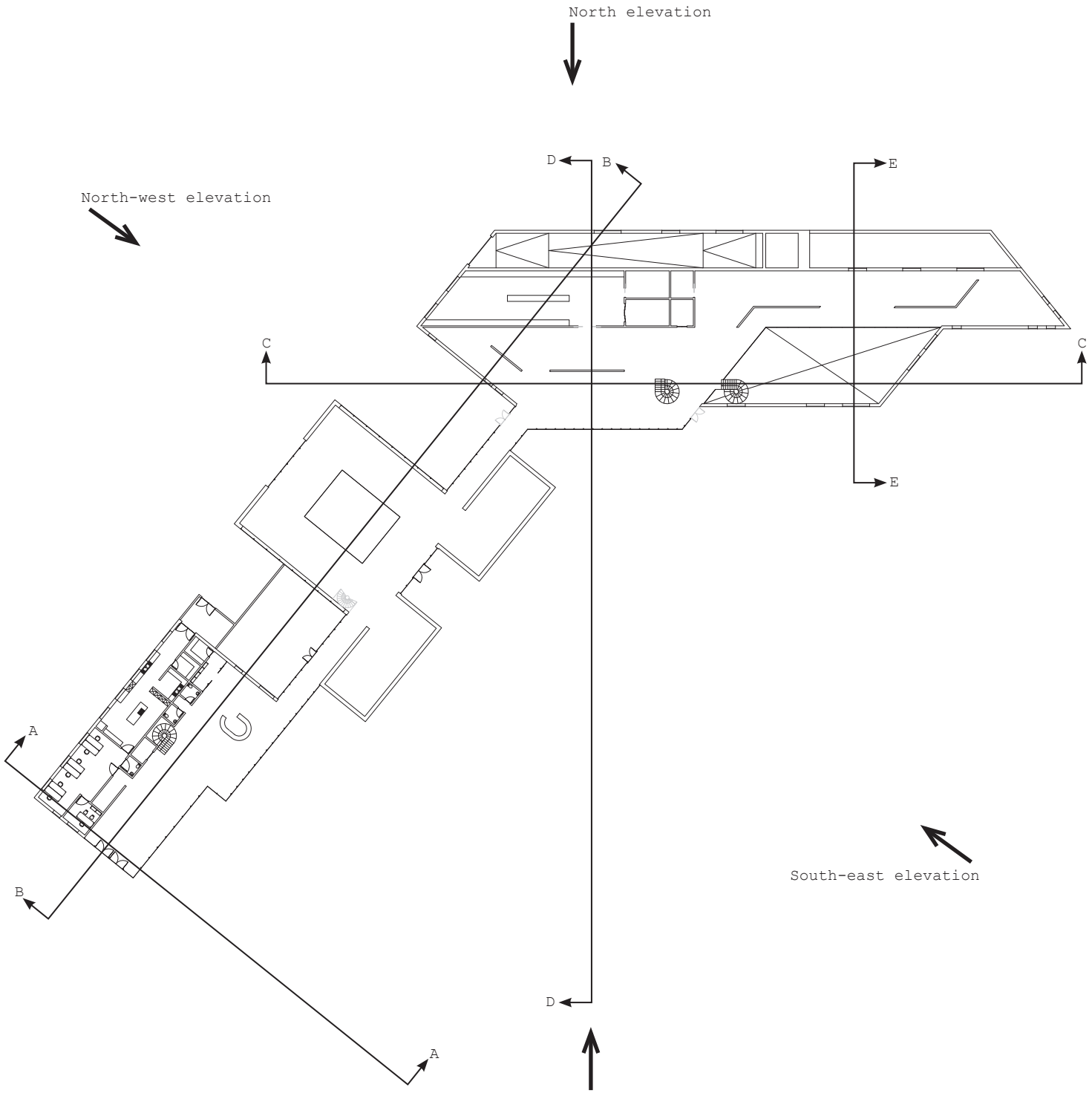


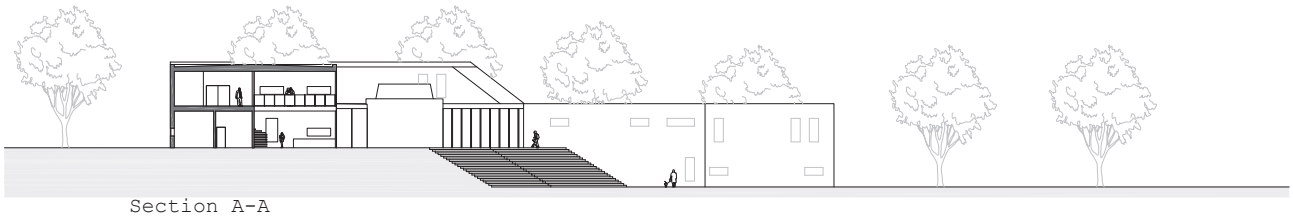
Having passed the old museum building the pathway turns and the entrance to the new museum building appears as the pathway merges into the exhibition building creating a light entrance to it. From here it is possible to sense the different spaces, peaking into them, and it is also from here it is possible to move to the different levels in the building via stairs and lifts. From hear the flow is split into a flow defined by the visitor. It is possible to create an individual path through the building depending on ones interests. Moving on the entry level and the upper level the spaces are focused on creating different spatial experiences through the use of natural light. Moving down into the lower levels of the building one moves down to the darker areas, where the contemporary digital art is located. Along the walls small breaks are located, where it is possible to sit down and reflect upon the experiences.

Employees enters the building from there parking area adjacent to the public building, moving directly into the office. Deliveries to the kitchen happens between the public building and the old museum building entering into a small storage for garbage bins and empty boxes. The same way as the kitchen personnel enters.

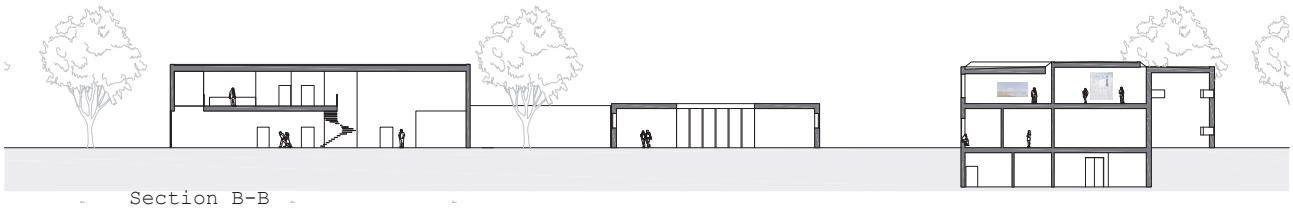
The delivery of art happens through the back of the exhibition building, where the trucks can park in an controlled environment. They follow a ramp down to the level below the entrance level. From here the art enters the building through the loading dock, entering the receiving area, where it is registered and checked before moving further into the building, where it is prepared for the exhibitions ending at the central core with the lift connecting the different exhibition levels with the areas serving them. Moving past this lift the art enters first a furniture storage, before entering a transit storage where art not being exhibited immediately is stored. Back at the lift the flow of art merges with the flow of supplies for the exhibitions from the workshop located at the level below. The workshops supplies the exhibitions with furniture and graphics and also serves as a place for maintaining their permanent collection.

The people working in this section parks with the other employees at the public building. From here they can move through the museum or they can move around the museum and enter it through a service entrance at the tip of the building.

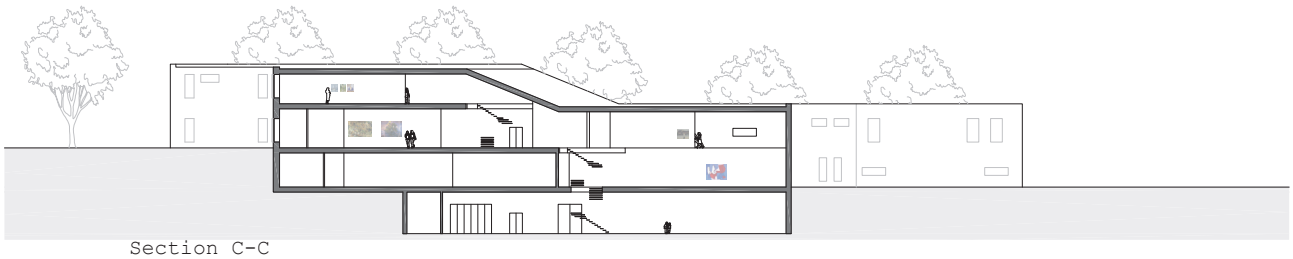




Section A-A



Section B-B



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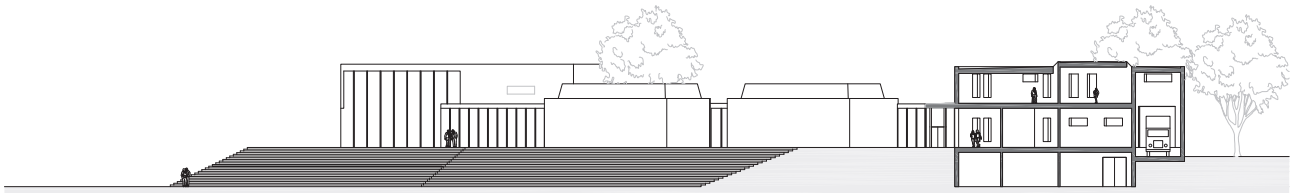

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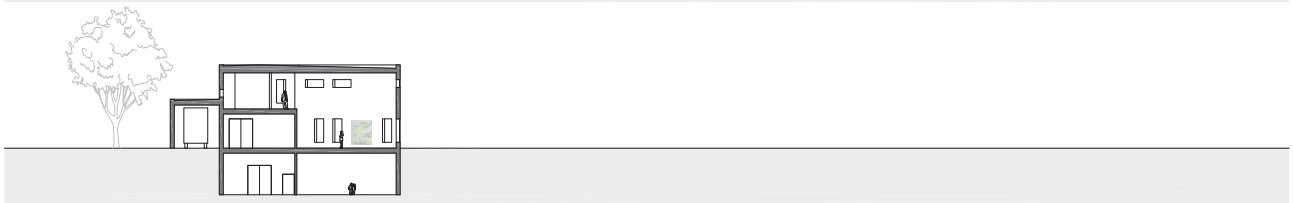
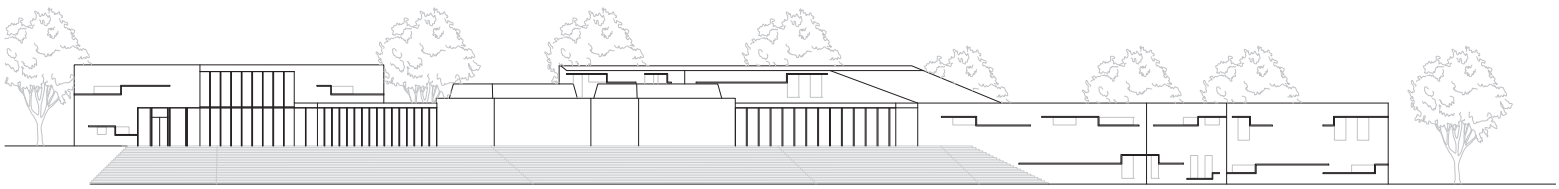
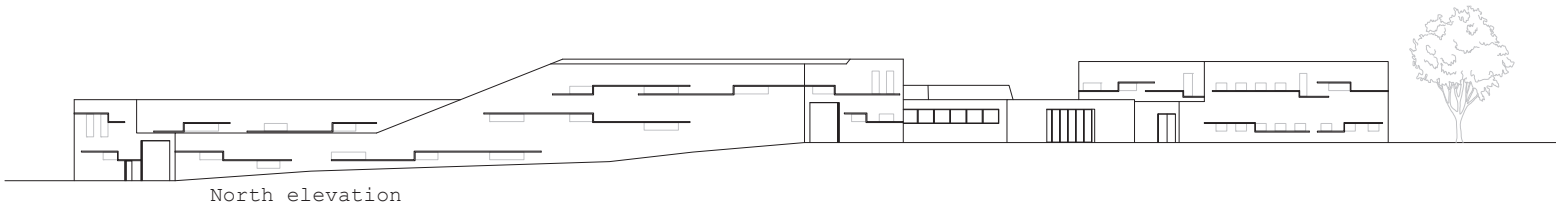


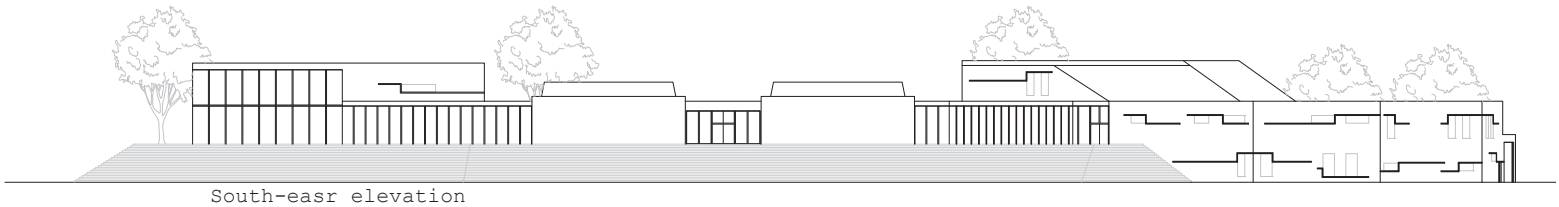
Section E-E



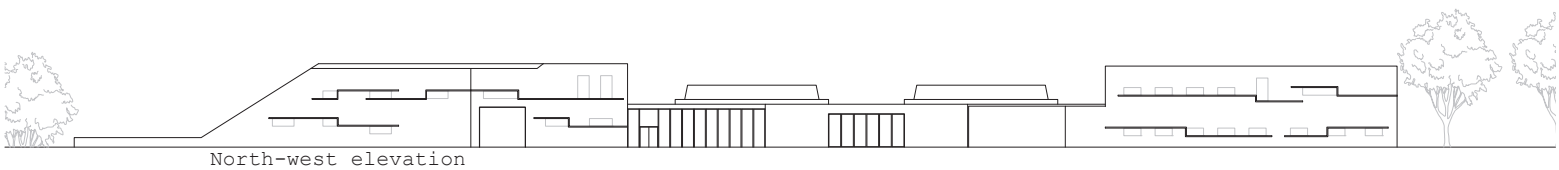
South elevation



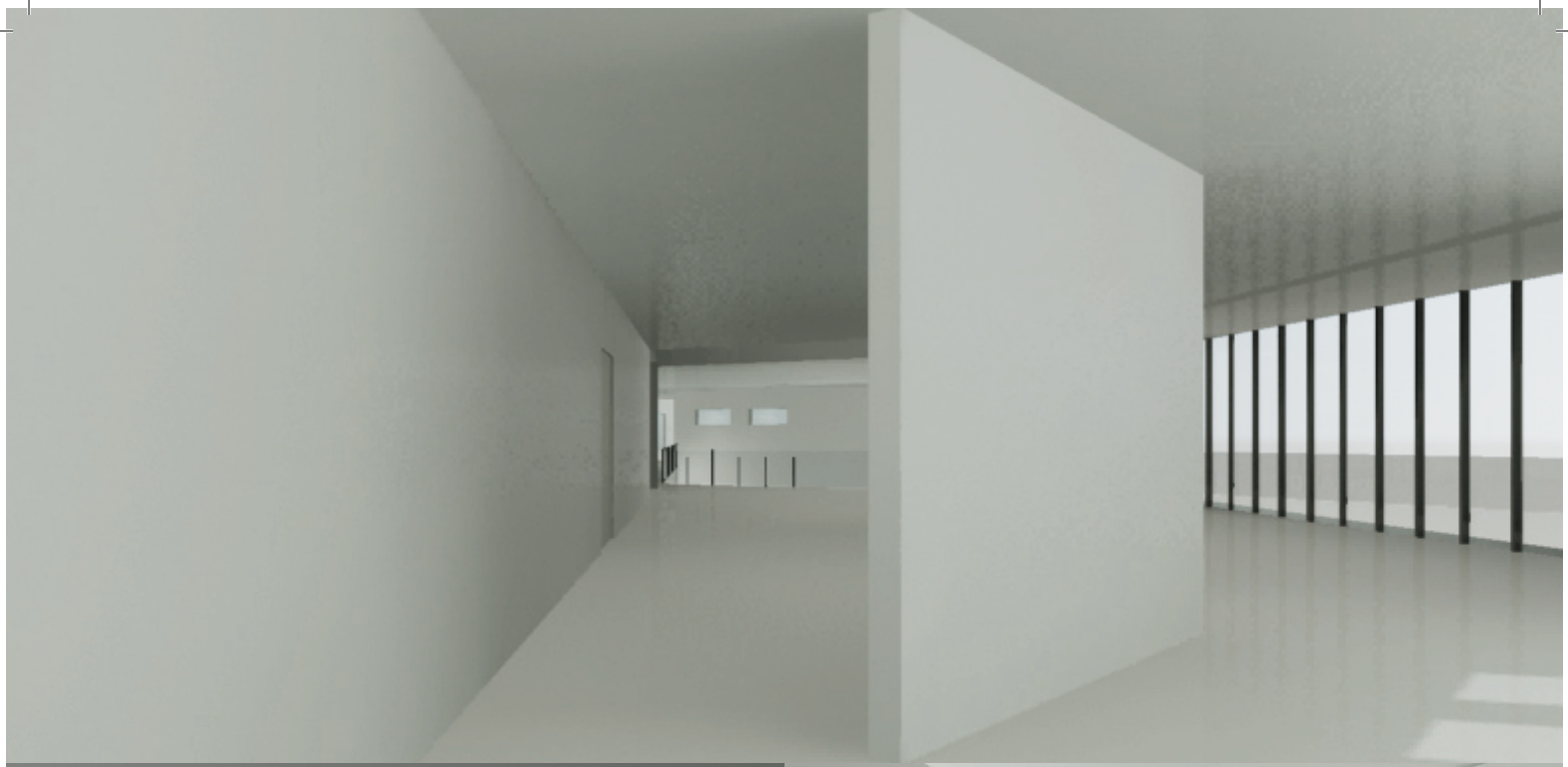
North elevation



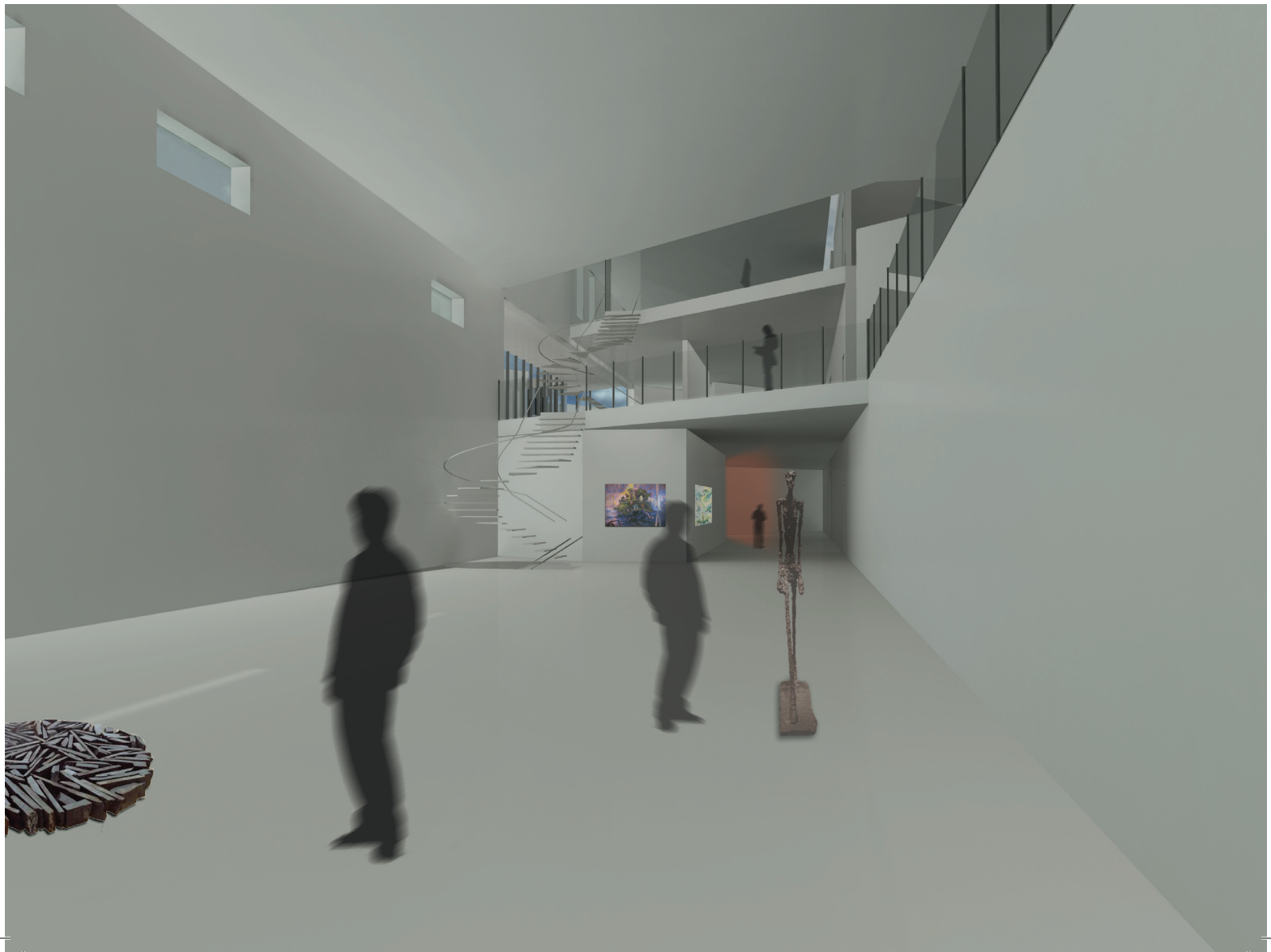
South-easr elevation



North-west elevation



Moving around the museum the exhibition space in double height becomes the center of movements. It connects the different areas both physically and visibly, with the stairs and the light airy feeling it has. Giving room to large sculptures as well as large paintings. At the same time it is possible to sense the other areas and the activities in them



- 8.9 Fire

In terms of fire the building is designed according to the guides in the old building regulations, with two exits placed in opposite sides of the room, and a maximum length of 25 meters to these from any point in the room. These exits leads to the outside or to a different fire cell. The red arrows on figure 8.8.1 is the fire exits or emergency openings and the red dotted line is the division between fire-cells.

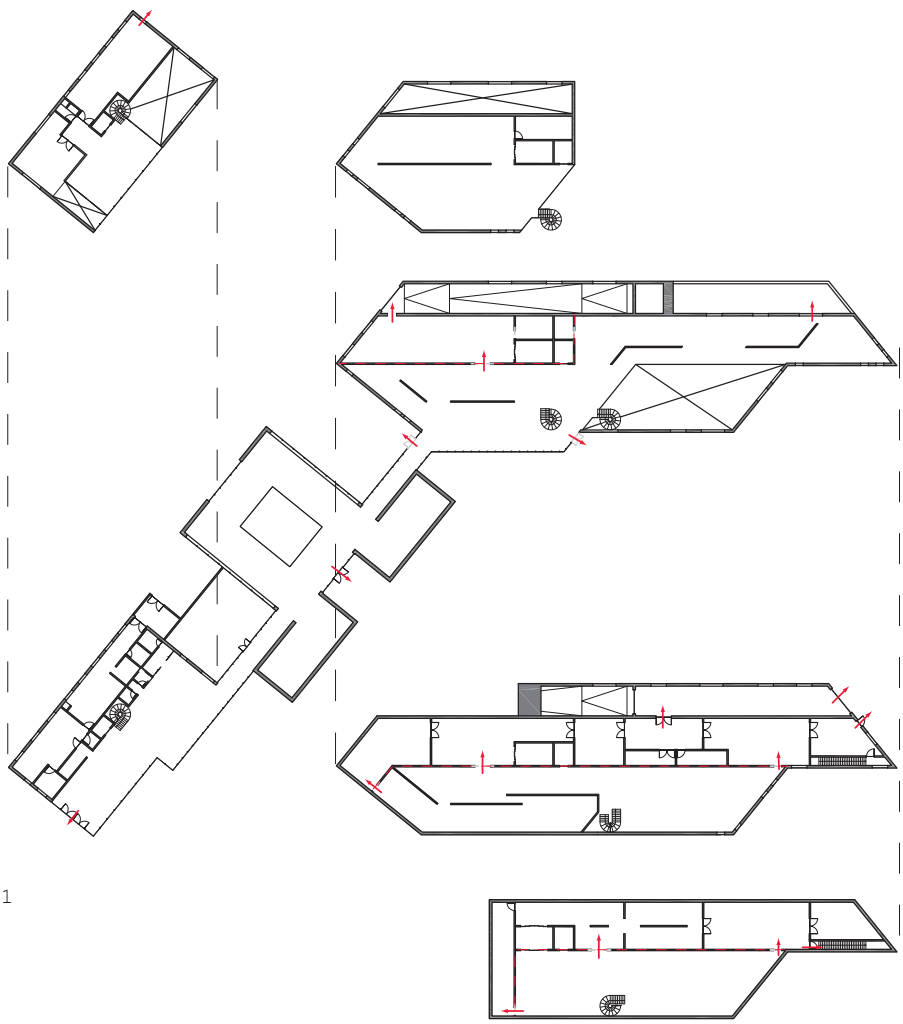


Figure 8.8.1

- 8.9 Ventilation

The ventilation in the building has been split into two separate systems. One for the old and public building that is placed in the plant room in the old museum building, and a system for the new exhibition building and its service areas. It has been chosen to split it into two in order to minimize the distance of the supply pipes in order to try to minimize the energy used to drive the air around. This choice is only based on an assumption. The plant room in the new building is placed in the basement central in the building (figure 8.9.1). The ducts follow the lifts up through the building and from there it spreads out to each floor in the ceilings (figure 8.9.2). The concept behind the ventilation is a mixing ventilation with the inlet at the top of the walls and the outlet at the bottom forcing the polluted air out in the bottom (figure 8.9.3).

Figure 8.10.1

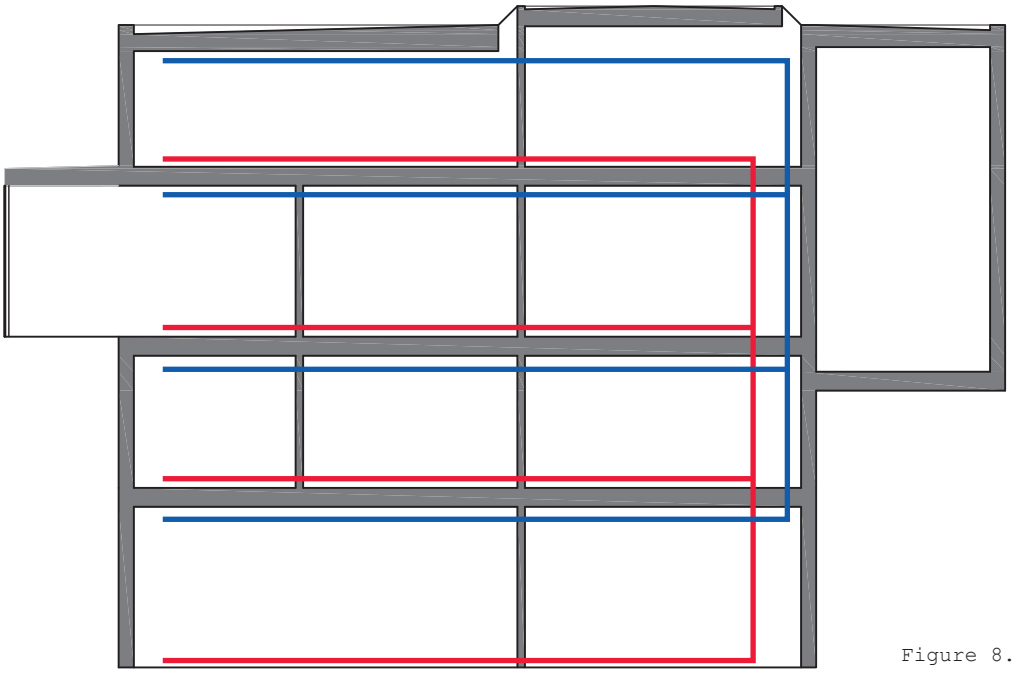


Figure 8.10.2

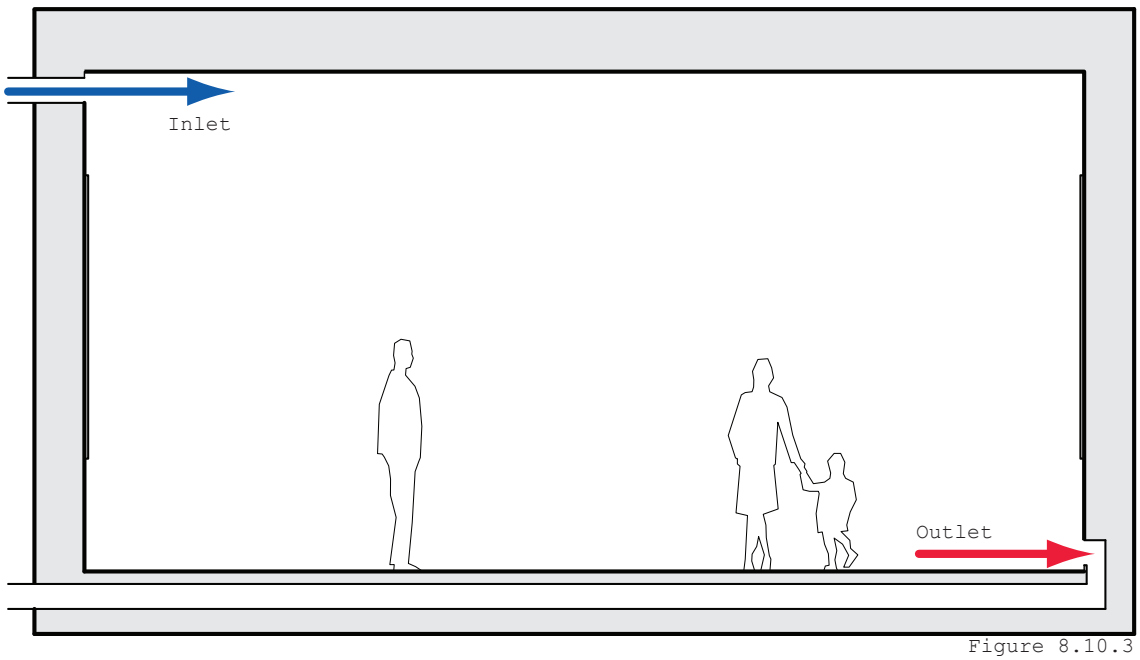


Figure 8.10.3

- 8.10 Energy consumption

During the development of the project there have been a focus on the energy consumption, with a special interest in how the design can be influenced by especially passive technologies. The purpose here is to describe how this focus has been a part of the design phase.

The main themes in relation to these technologies have been zoning, passive heating and cooling and materials and their thermal performance, all of which will be described here, with a focus on how they are related to the architectural idea.

The initial thoughts about the buildings energy consumption was as described, focused on how to minimize it in a building with such specific demands to the indoor climate as a museum has. The architectural idea that evolves around leading people along the flow in the landscape also creates a building with a large surface to volume ratio already making it a difficult building to work with in terms of energy consumption. In order to prevent any other excessive energy consumption the estimated consumption has been tracked through the use of spreadsheets made for calculating the monthly average temperature and later by utilizing BE06. On the following pages it can be seen how these have been used as tools to evaluate and designing the building in connection with the development of the architectural idea.

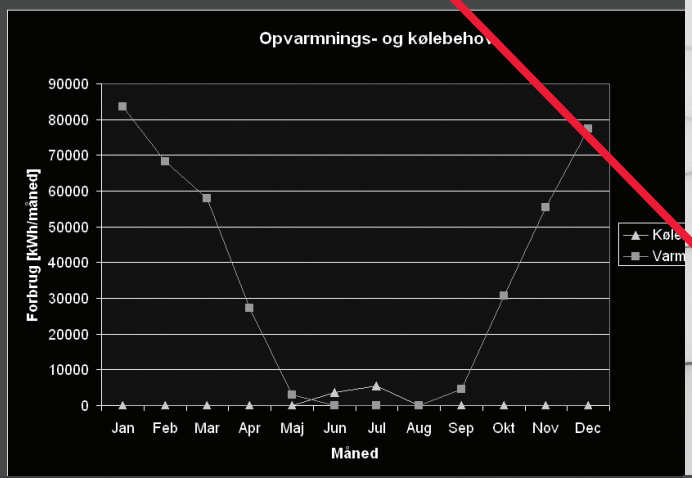
Figure 8.10.1 shows the iterations in spreadsheets whereas figure 8.10.7 shows the iterations made in BE06. In both of these figures the percentage of windows are for the two new buildings and that the connection between them is calculated as a glass construction. In both the spreadsheets and in BE06 the U-values have been set to an estimated level that was considered reasonable. The walls for 0.15 w/m^2K and roofs and floors to 0.1 w/m^2K.

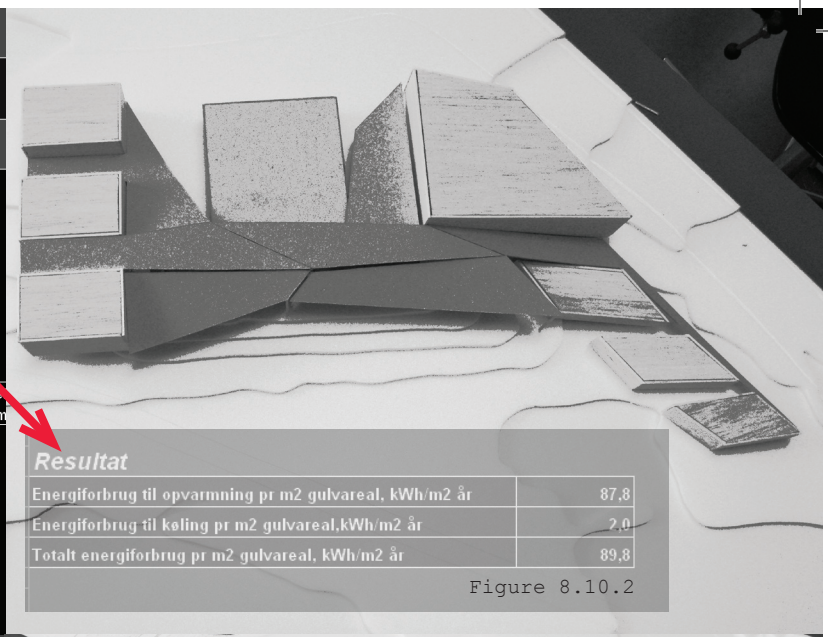
Iteration	Floor area (m^2)	Wall area (m^2)	Roof area (m^2)	Basement walls (m^2)	Build area (m^2)	Window area (m^2)
Fig 8.3.2	4650	1453	2300	1650	2550	1748
Fig 8.3.3	5100	2919	1900	430	1900	508,5
Fig 8.3.4	5100	2316,5	1900	430	1900	1111

Figure 8.10.1

Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	87,8
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	2,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	89,8

Til sammenligning...
Energirammen for boliger
Lavenergi, klasse 2
Lavenergi, klasse 1



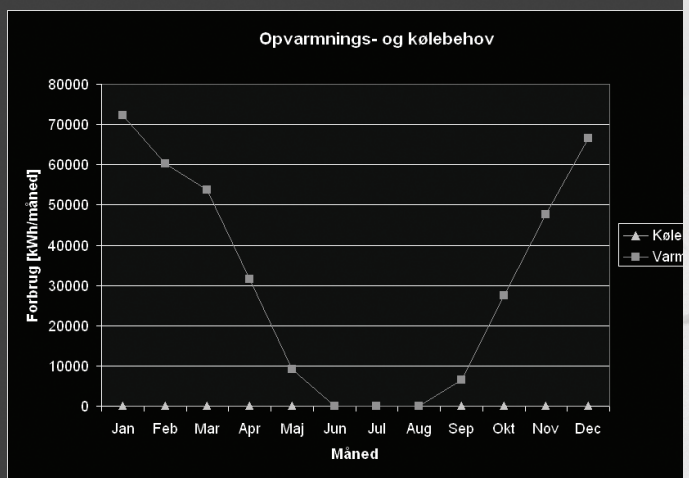


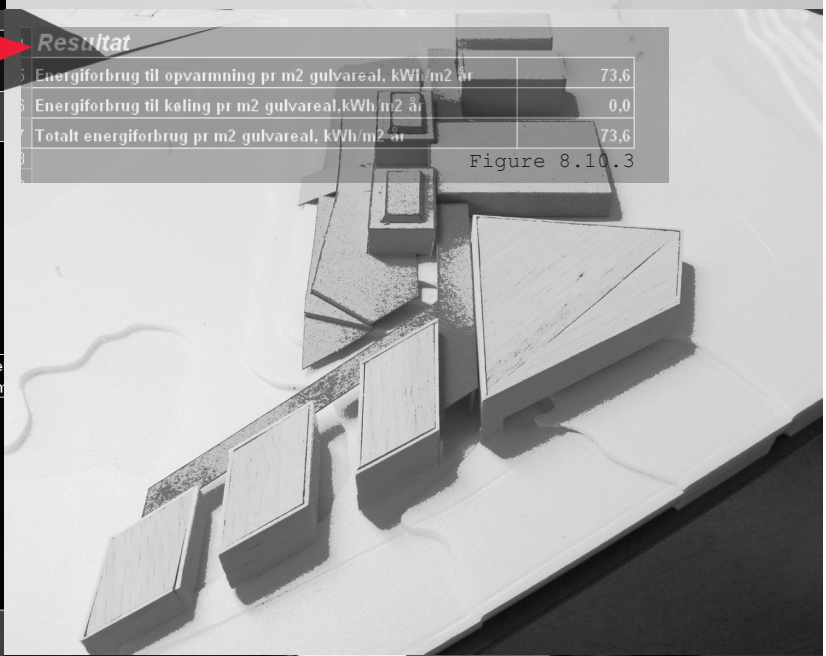
Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	87,8
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	2,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	89,8

Figure 8.10.2

Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	73,6
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	0,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	73,6

Til sammenligning...
Energirammen for boliger
Lavenergi, klasse 2
Lavenergi, klasse 1



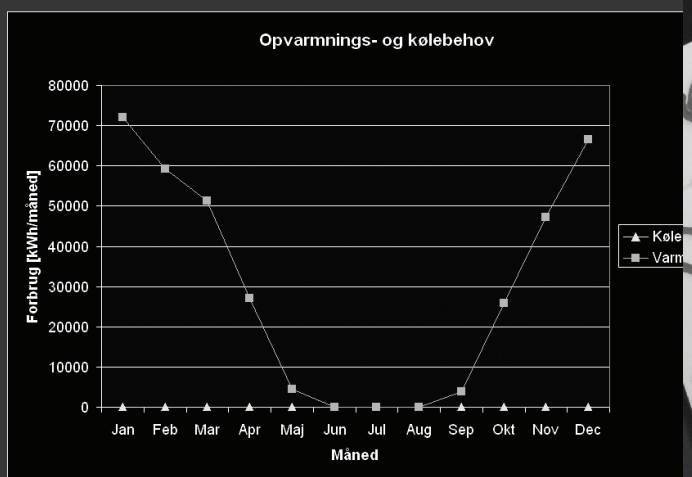


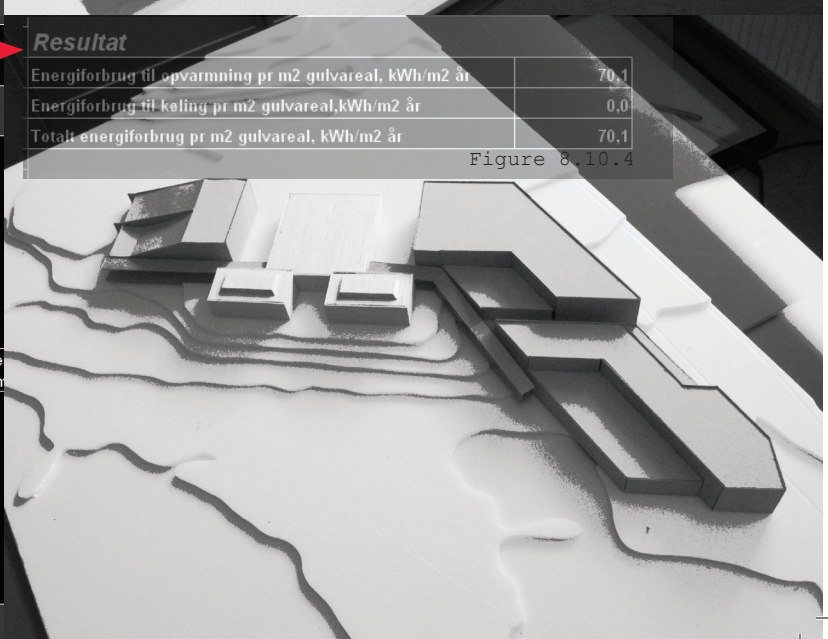
Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	73,6
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	0,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	73,6

Figure 8.10.3

Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	70,1
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	0,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	70,1

Til sammenligning...
Energirammen for boliger
Lavenergi, klasse 1

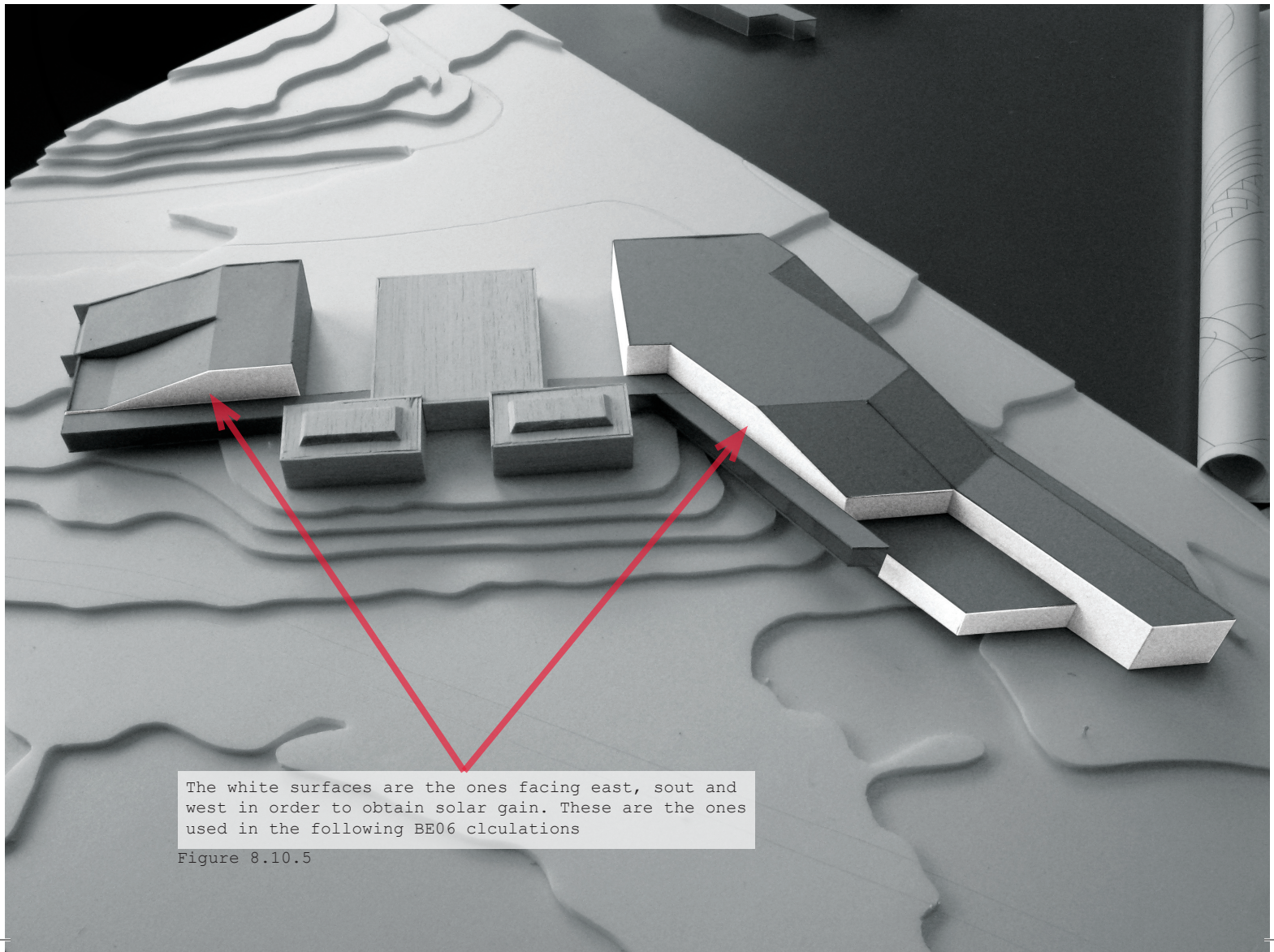




Resultat	
Energiforbrug til opvarmning pr m2 gulvareal, kWh/m2 år	70,1
Energiforbrug til køling pr m2 gulvareal,kWh/m2 år	0,0
Totalt energiforbrug pr m2 gulvareal, kWh/m2 år	70,1

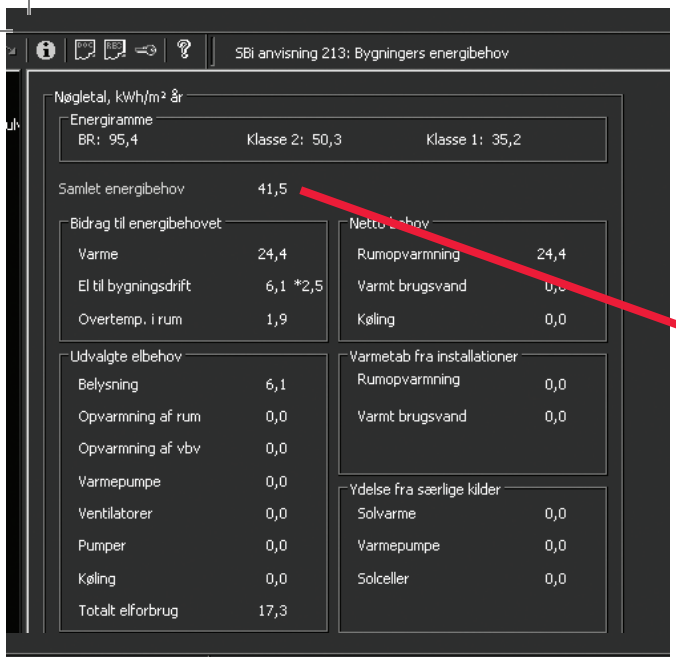
Figure 8.10.4

Where the spreadsheets were mainly concerned with investigating the effect of the building shape on the energy consumption the use of BE06 is heading to a more finalized phase of the project, where the shape of the building is on a more developed level, and the studies of the different aspects of the building begins to be more detailed. The main focus in this study is the impact of window openings on the energy consumption. The study here is based on that as a general rule windows towards north generates an energy loss, whereas windows towards east, south and west generates an energy gain. On figure 8.11.5 the surfaces where windows can be placed in order to provide an energy gain. The results are seen on the figures on the following pages.

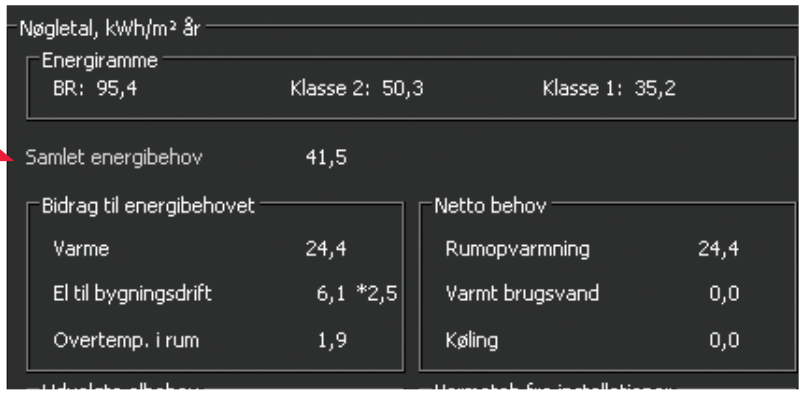


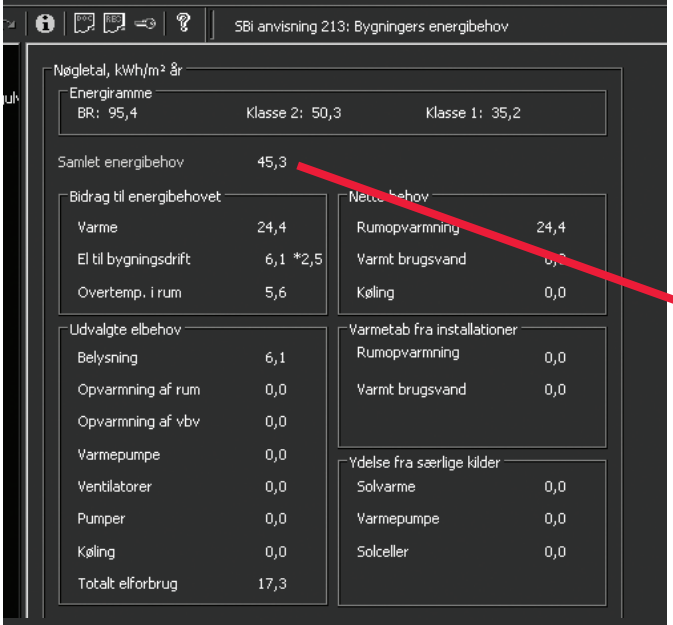
The white surfaces are the ones facing east, sout and west in order to obtain solar gain. These are the ones used in the following BE06 clculations

Figure 8.10.5

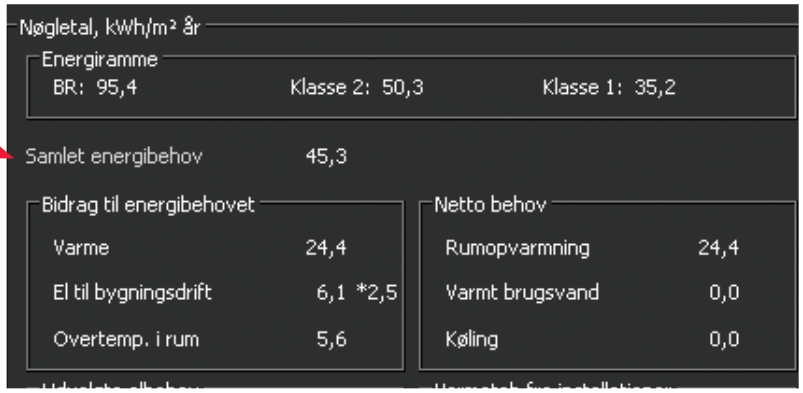


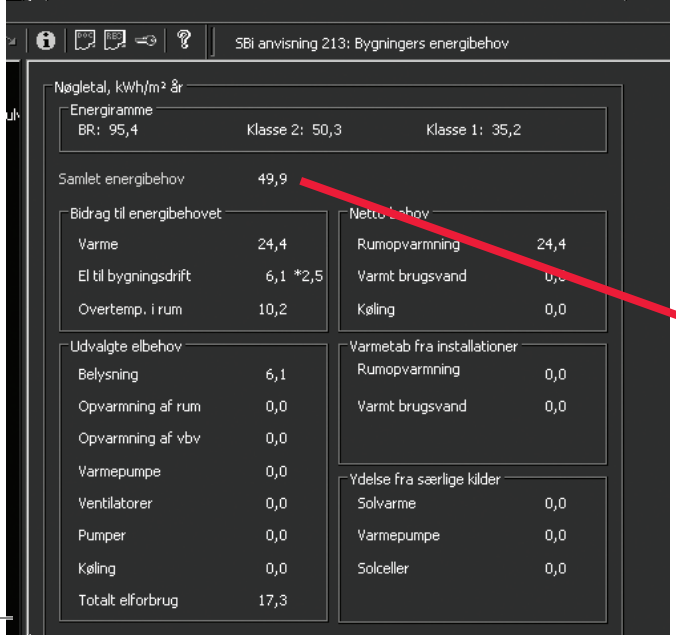
Model with no windows except for in the pathway connecting the buildings



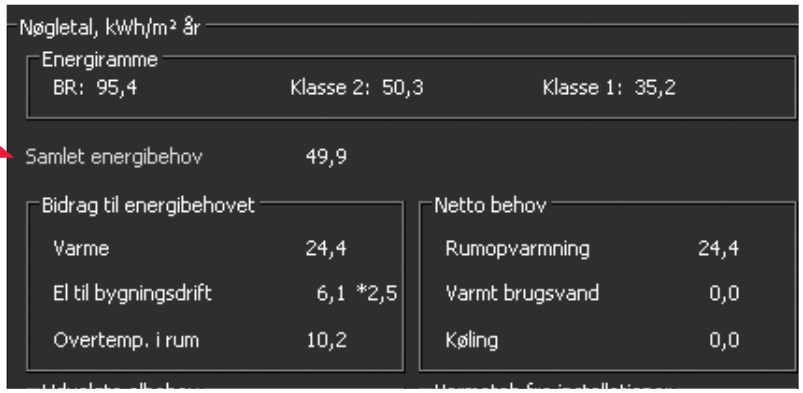


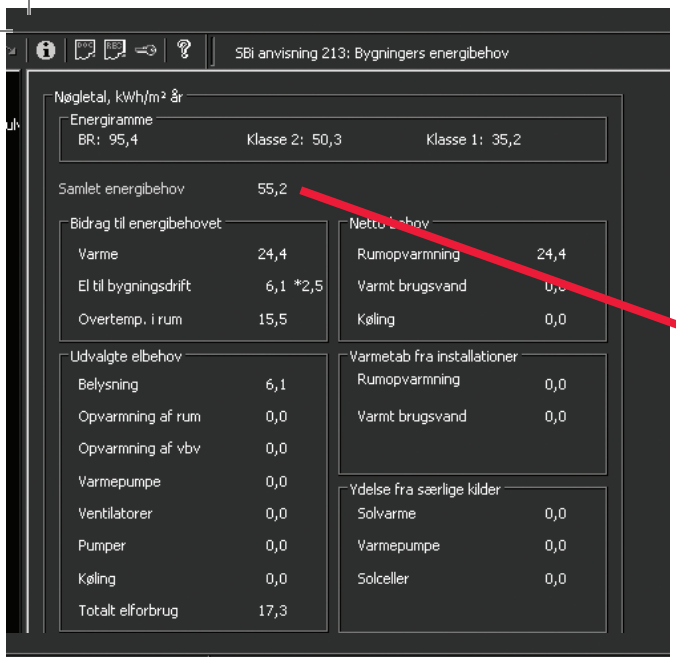
Model with 10% windows except for in the pathway connecting the buildings



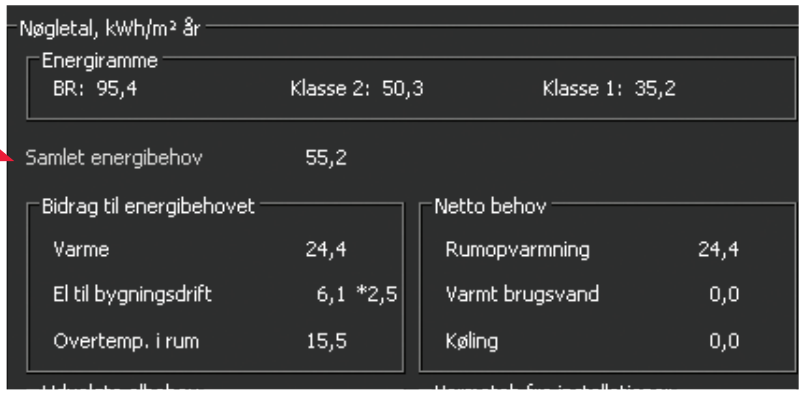


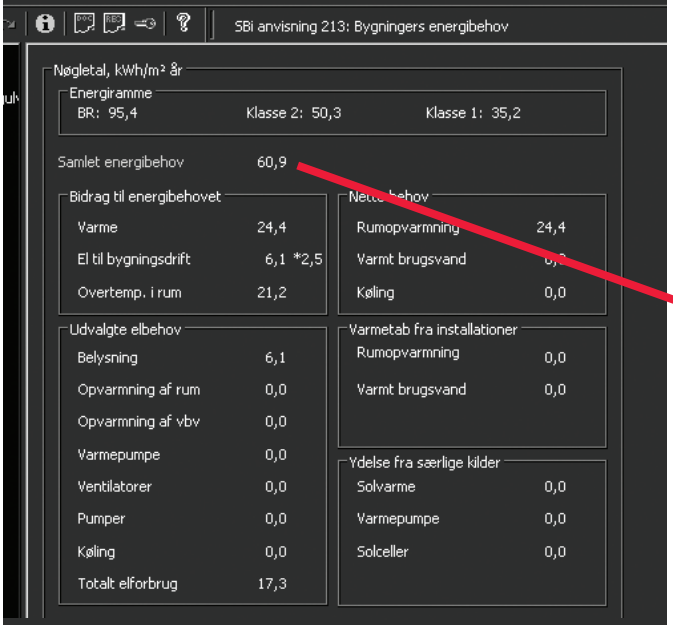
Model with 20% windows except for in the pathway connecting the buildings



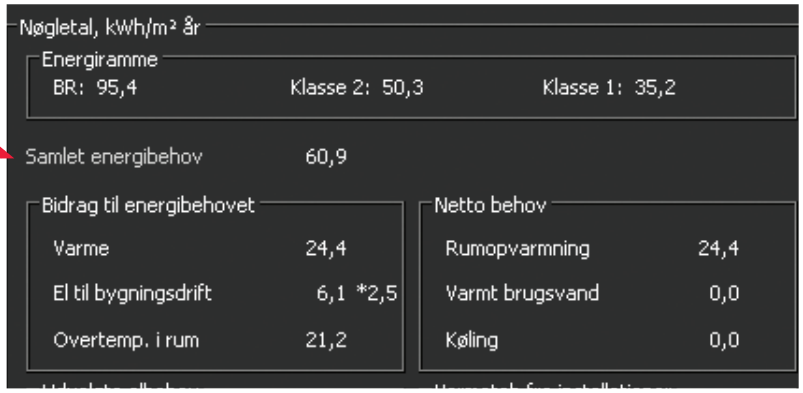


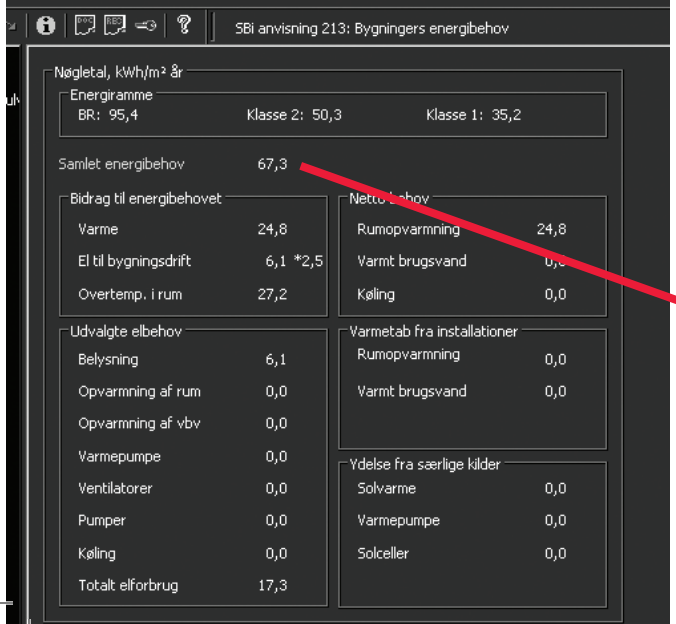
Model with 30% windows except for in the pathway connecting the buildings



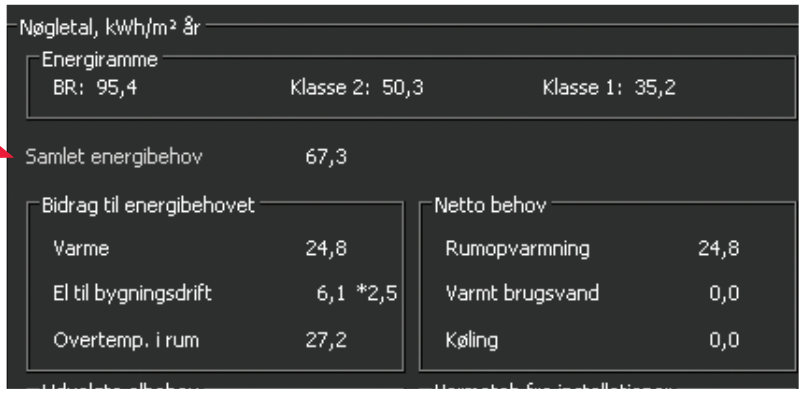


Model with 40% windows except for in the pathway connecting the buildings





Model with 50% windows except for in the pathway connecting the buildings



The aim set up for the energy consumption in the environmental brief was to achieve a low energy level two certification. As seen previously BE06 has been used to document this. The different data for the building has been put in, as it is seen in appendix D [page...].

From the simulation in BE06 it is seen that the building can fulfill the aim to achieve a low energy class two certification. It was anticipated that the shape could create problems in obtaining the low energy class two certification. The long building creates a relatively large surface to volume ratio of the building, making the heat loss through the surfaces bigger than for a more compact building. But the relatively closed facade most of the building have combined with the open connection between the buildings makes it better than expected.

The biggest post in the energy consumption is as it is seen the electricity that is multiplied by 2.5. It is responsible for just below 50% of the buildings energy consumption. Especially the need for light takes a lot of electricity here.

As mentioned these things have been anticipated, and because of the anticipation the use of PV-cells has been considered as a part of the expression of the building. In this case they have not been used in a very visible way, but have been installed on the flat roof, where the large surface area, and the lack of shadows creates a good surface for the PV-cells.

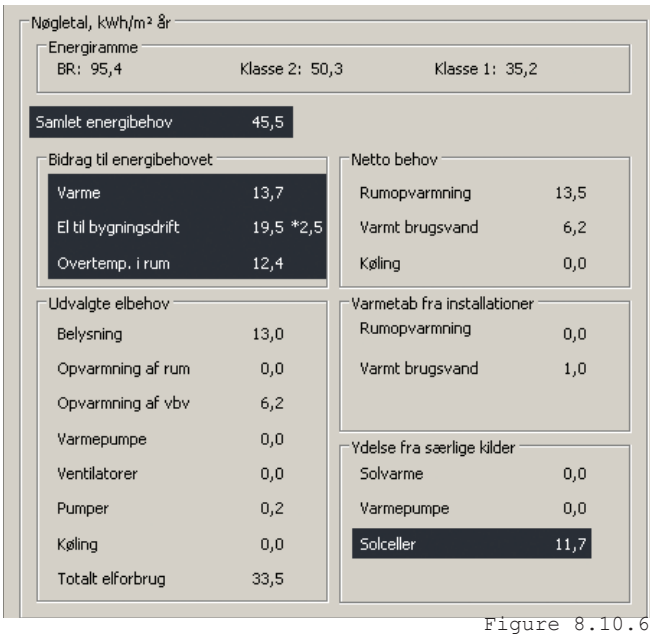


Figure 8.10.6

- 8.12 Thermal comfort

The demands for thermal comfort was defined earlier in chapter seven [page 124], and the need for ventilation has been determined by calculations in appendix B [page???]. Furthermore a simulation has been made in Bsim, where the energy consumption and temperatures has been simulated dynamically. This simulation has just been made in one room of the building. The result serves as a check for the rest and through that the assumption is that the rest of the building is all right. The room used for the simulation is the exhibition room on the top floor

Going through the results of the simulation it is seen that the results are reasonable even though some of them are outside the limits of the demands.

Figure 8.11.1 shows a table of the mean results from Bsim, where the three areas of focus for the comfort in the simulation are high lighted. As it is seen here all of the results stay within the limits setup. In order to analyze these further the level of the different parameters are investigated.

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
tOutdoor me	7,7	-0,5	-1,0	1,7	5,6	11,3	15,0	16,4	16,2	12,5	9,1	4,8	1,5
tOp mean	21,4	21,0	21,0	21,0	21,0	21,3	21,9	22,3	22,6	21,2	21,0	21,0	21,0
AirChange/h	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7
Rel. Moistur	51,5	47,8	46,9	48,1	50,1	50,1	54,7	57,4	54,0	56,2	52,4	51,5	48,7
Co2(ppm)	475,6	475,9	475,9	475,9	475,8	475,6	475,2	474,9	474,9	475,6	475,8	475,9	475,9
PAQ	0,3	0,4	0,4	0,4	0,3	0,3	0,2	0,1	0,1	0,2	0,3	0,3	0,3
Hours > 21	35,5 %	1,5 %	1,5 %	7,8 %	15,0 %	50,0 %	77,2 %	95,0 %	97,4 %	53,6 %	12,1 %	5,7 %	5,8 %
Hours > 26	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %
Hours > 27	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %
Hours < 20	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %

Figure 8.11.1

The first parameter that has been analyzed from the simulation is the temperature, where figure 8.11.2 shows the percent of time, where the temperature is within the zone setup in the demands. What is seen is that the temperature stays within this zone for approximately 95% of the time. The last five percent of the time it rises to just below 26 degrees Celsius. Seen from a point of view where a persons comfort is in focus this is acceptable, but the demands here are set up for the demands for the art. This taken into consideration the amount of time and the temperature is so low that it is not seen as being a problem that requires major changes. This adjustment can be obtained by a small increase in the air change, which is assumed to be within the limits of the ventilation system.

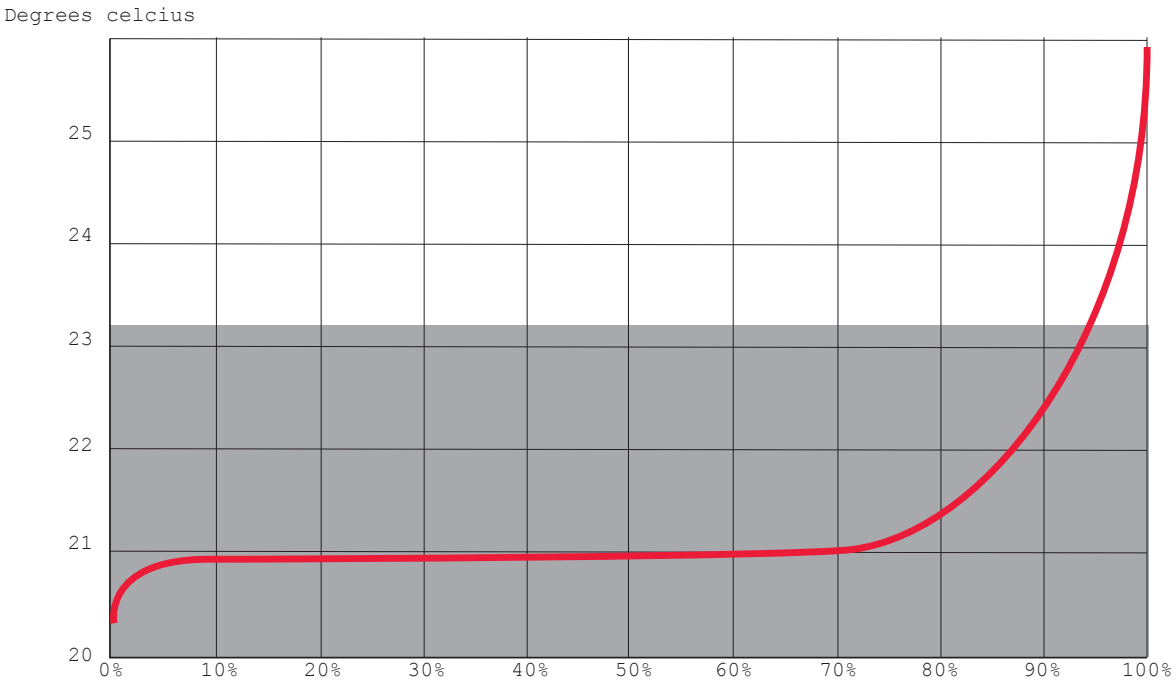


Figure 8.11.2

The second parameter is the relative humidity, where figure 8.11.3 shows the percentage of time the relative humidity is below a certain point. Here it is seen that the relative humidity is within the limits for most of the time. It is below 55% for about 80% of the time, and below 45% for about 10% of the time. Again it is seen that the amount of time and the amount the relative humidity transgress this limit is also limited. As before this can be handled by adjustments of the air change, and by adjusting the humidification and dehumidification of the air, that must be assumed to be within the limits of the ventilation system

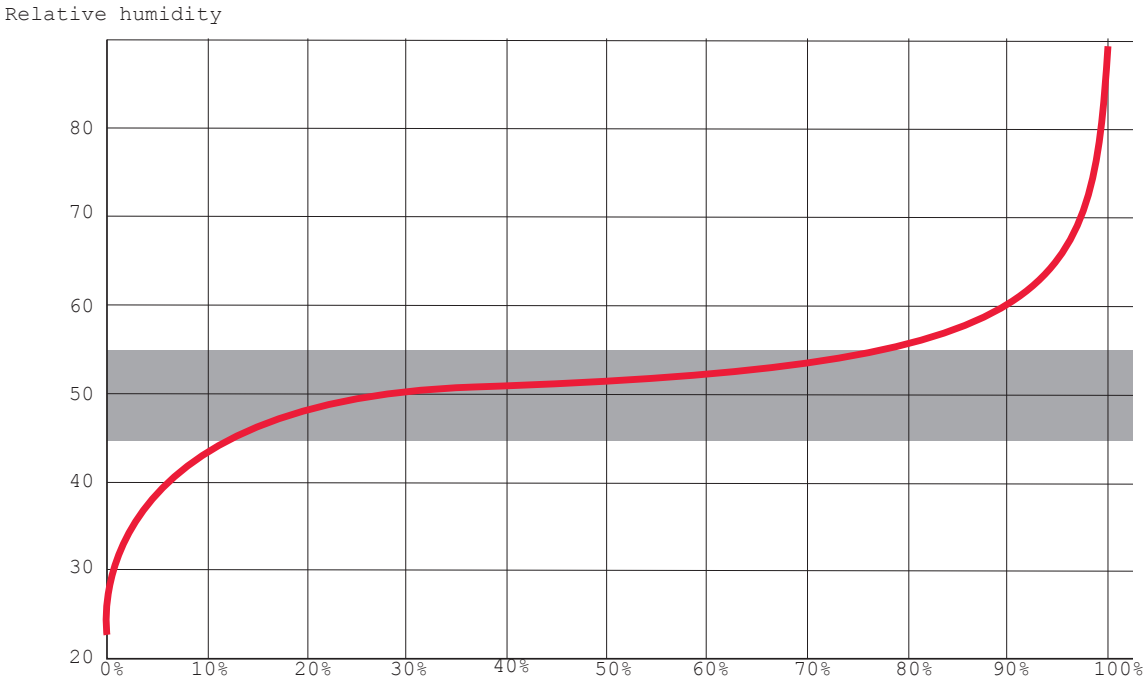


Figure 8.11.3

The third and final parameter is the amount of CO_2 in the air, which is determined mainly by the comfort for the visitors instead of the demands for the art. Here the level has been set to be A in releation to CR 1752, which means that it has to be below 780ppm. As it is seen the CO_2 level stays below this level at all times, and requires no adjsutments to the ventilation.

The adjustments of the ventilation is as mentioned assumed to be within a reasonable limit of the ventilation. Furthermore the ventilation is controlled dynamic, meaning that the levels set here and the loads are maximum levels. By using these it can also be assumed that it is rare they appear, and the simulation confirms that should t happen the ventilation system is able to handle it

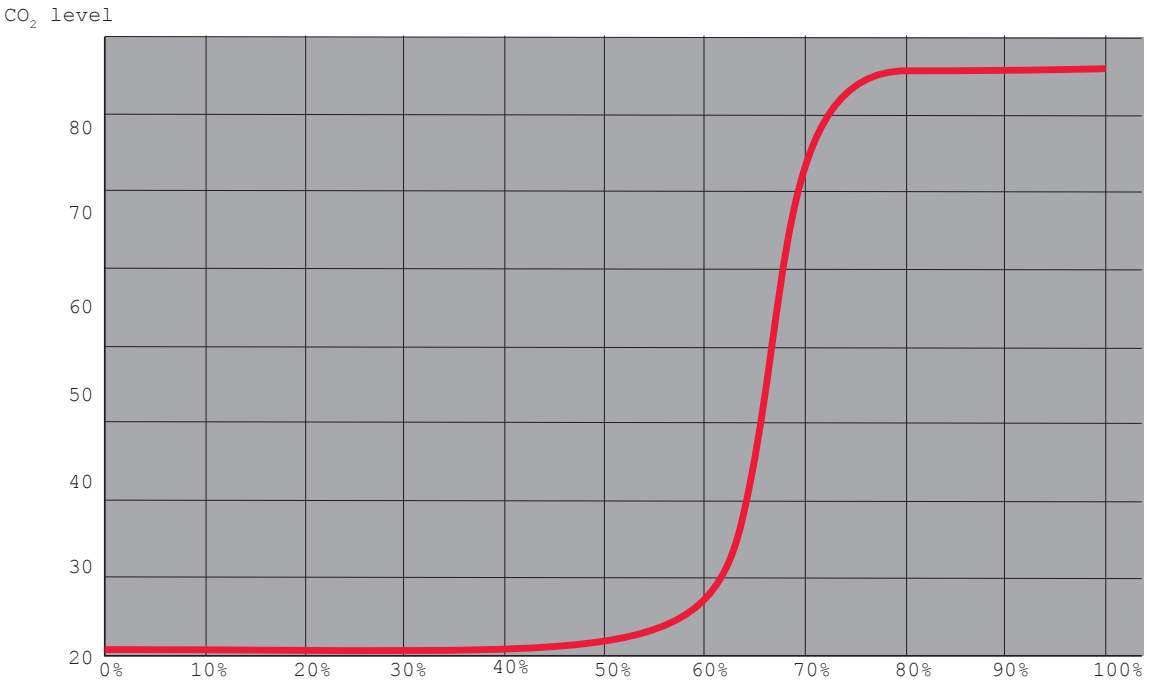


Figure 8.11.4

Moving along the road towards the city centre in the early evening the building subtly glows in the dusk. The light slowly breathes with its light changing and the glow of the building changing. Shadows passing the openings revealing activity in the building. Openings contrasting the otherwise dark building reflecting the light from the moon.

9. Perspective

Starting out with an aim to design an environmental sustainable building and choosing to design a museum has been a challenge. The major question surfacing from time to time is how a building with such specific needs for the indoor climate can possible be perceived as environmental sustainable.

Going back to the theoretical part, where the different methods used in the different approaches to sustainable architecture [page 35], it is seen in figure 9.1.1 that different methods from here have been used. The red bars shows the ones that have been part of the design process, and through that have influenced the design of the building, whereas the blue bars shows factors that could have been assessed as it is seen with the two bars concerning materials, and the two bars concerning energy efficient appliances and renewable energy sources. The last two could be the next step in the process going from a design proposal to a phase where the project is detailed further. In the process these measures have been used in relation to evaluate the performance of the design. Such an evaluation is based mainly on assumptions and therefore the results have to be regarded as a guide showing a tendency not as a final result, making it crucial to be critical towards the figures they give. In the end the aim is to maintain a balance between these tools making a qualitative evaluation

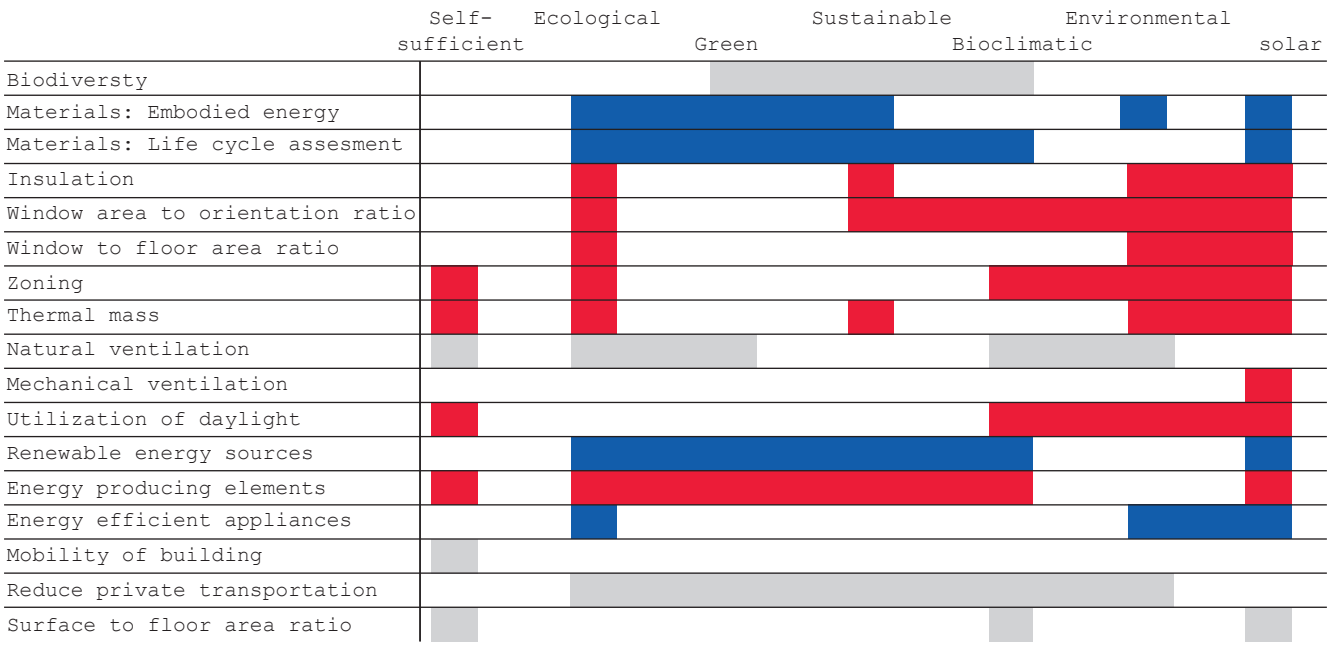


Figure 9.1.1

and the architectural idea. Furthermore it is important to be aware of that these tools only focuses on the enrgy consumption of the building. They do not take materials or the preservation of old buildings into consideration. This means that the focus on attaining a good result in a program like these can remove the focus from other important issues in the discussion.

As it was argued in chapter three environmental sustainable architecture cannot just be seen as a table with methods and numbers for energy consumption. Environmental sustainable architecture is about defining architecture through a discussion of how we as people are in the world - it is a process. At the moment the focus on energy consumption and CO_2 emissions is a part of the process. In fact it is playing a major role in the debate and in architecture today as it was seen in the interviews. But what about the visions for humanity as architecture is about instead of the fixes that is seen in the focus on energy consumption.

In this project it has been chosen to recognize the architectural quality of a present building. If the building had been demolished the design might have ended up in a different place. Furthermore the energy consumption of the building when the old part is included will most likely have a significant increase, and in the end not be able to attain a building permit. Recognizing this is of course also to recognize that the design to some extend has failed according to the environmental brief.

The question then is if the old building with its architectural qualities and the energy embedded in the building materials should have been demolished because the simulations in BE06 showed that the energy consumption was too big? The easy answer is of course yes. It is important to remember though that architecture is not just about energy consumption though. Architecture is about how we relate to the world it is about creating a frame around our lives that creates experiences.

The extension to Skive New Art Museum places itself in this discussion. The extension in itself is environmental sustainable and the architectural idea evolves around using the present qualities of the site and the building. Furthermore the design process reflects that the energy consumption has been considered, and it has played a part in the design. As it was stated in the qote from the Brundtland report sutainable development is not a fixed state but a process of changes in which the development is made consistent with future as well as present needs. In terms of architecture this not just about the energy but also about the quality and experience of architecture. The design

of the museum aims at perceiving architecture and sustainability as two interconnected terms affecting each other. Architecture by definition is sustainable if it has a quality that allows it to be redefined at a later stage. This being said the discussion about energy consumption is important at the moment, but to define a building as sustainable just because of that removes the focus from what architecture is.

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Appendix A - Interviews

In this appendix is the material used for the interviews. On the following pages is an example of the interview guide used. This one is the one used for Grimshaw Architects. The last three guides are similar in the way they have been build up, and only a few specific things about what the different offices work with has been changed.

The interviews can be found on the CD, where they can be heard in full length. They are located in the folder called interviews, where the all the interview guides can be found as well.

Arkitema's interviews:

/Interview/Arkitema/071024 - Interview guide Lars Kvist
/Interview/Arkitema/Lars Kvist

Grimshaw Architect's interviews:

/Interview/Grimshaw/071101 - Interview guide Joy-Anne Fleming
/Interview/Grimshaw/Joy Anne Fleming

BBM - Sustainable Design's interviews:

/Interview/BBM/071101 - Interview guide Ian Mckay
/Interview/BBM/Ian Mckay

VGL CPH interviews:

/Interview/VGL/071109 - Interview guide Vibeke Grupe Larsen
/Interview/VGL/Vibeke Grupe Larsen

Aim of the interview

Present master thesis is about the connection between sustainability and architecture and how that discussion is perceived among practicing architects. The time schedule for the thesis is to have a finished draft of the theoretical part by the middle of December, which will be forwarded to my supervisor as well as the architects who has been interviewed, so it is possible for them to read and comment on the parts to which they have contributed. The theoretical part of the study will then be the starting point for the design process which is starting in the beginning of January and finishing by the first of June 2008.

The aim for the interview is to investigate how you approach sustainability in architecture. The reason for choosing this starting point is the discussions in the medias about sustainability in the building industry, where the focus in this discussion often seem to be focused on the quantitative aspects - a focus which seems to remove the attention from the qualitative aspects of architecture. Furthermore the aim is to investigate how you work with sustainability in your design process, meaning which tools you are using and how you use them.

The interviews will be used to give the theoretical discussion a more practical perspective, where meanings and quotes will be used to underscore points, and to show possible dichotomies between the theoretical and practical aspects in architecture concerning sustainability.
The interview will be recorded and put on a CD as part of the documentation of the project. This can of course be kept confidential, so only the censor and supervisor have access to the full interview, if you request it.

What I would like to talk about here is your interest in sustainable architecture and where your interest for this subject comes from. Let us start to talk about

What you understand by the term sustainable architecture?
Why do you consider it to be relevant?
Can you describe where this interest comes from?
Do you think there is a connection between your interest in sustainability and the reason for your clients choosing you as architects?

Let us try to talk a bit more about the more architectural specific

topics. You write on your home page that you have developed a tool (EVA), which allows you to asses the environmental impact of buildings from the point of conception. Can you try to explain how it works?

Are there any specific parameters it works with?
Can you try to describe a project where you have utilized it?

At what stage in the process do you start to discuss aims about sustainability, and how do you discuss it? Is it among yourself in the office or is with the client or how does it work?

How do you implement it in the process?

Let us talk a bit about the design process. How do you work with consultants, as for example engineers? Can you try to describe the subjects you discuss with them and the way you work with them?

At what stage in the process do you start to work with them? Is it from the beginning or is it just in specific phases of the project?

If any problems occur, how do you then solve them? For example if there is a wish to have big windows towards south and you then end up with overheating? Is such problems solved through a dialog in the process or, to put it a bit bluntly, is it more of damage control in the end?

Can you describe a project where such a thing has occurred, as a result of contradictions in the brief, and where you find the problems have been solved in a good way?

Can you describe the difference between working on a competition and a normal project where a client has appointed you as architects? How does it affect the process?

Then let us try to zoom a bit out again. Can you describe how you develop your work with sustainability?

Would you describe your work with sustainability as a natural part of architecture?

Appendix B - Indoor climate

- B.1 Introduction

This appendix is concerned with the more technical aspects of the indoor climate, where calculations and the full range of tables are present. The tables in the report are all derived from the numbers in this section.

This appendix has been split into three sections. The first one concerning the indoor climate in terms of needs for ventilation, the second one concerned with temperatures and the third one concerned with energy consumption in the building. All of these are of course interrelated, but by splitting them up in these sections, makes the understanding of the different parts easier.

The section about indoor climate is mainly based on the comfort requirements listed in CR 1752 that sets the standard for designing the indoor climate in buildings. Being a museum, which is a highly specialized building these figures has been related to what the Museum design guide sets up as guidelines for museums, where it is important to adjust the indoor climate to a level where the art exhibited and stored are preserved as well as possible.

The section about the temperatures are also concerned with the indoor climate and the comfort of the vísitors. It has been chosen to put this in its own section because it is related closer to the shape of the building and the way it interacts with the surroundings in terms of how it opens and how sun light for example is utilized in the building design. This section is mainly based on spread sheets concerning the subject, and in these the main focus is on overheating during the summer - a state that it should be possible to avoid in a Danish climate.

The third section about energy consumption is the more overall estimate of how the building performs. It is closely related to the two previous sections, summarze the two previous sections in a way that allows us to see how the building performs.

- B.2 Ventilation

As mentioned this section is mainly concerned with the comfort requirements and ventilation based mainly on the requirements stated in CR 1752 combined with those stated in the museum design guide for the exhibition areas. In the following the ventilation requirements in terms of CO2 pollution, sensory pollution and humidity will be

determined for the different rooms in order to investigate what determines the ventilation for these.

In order to calculate the required ventilation the stationary value is determined, where an equilibrium is assumed. The formula is as follows:

$C = q/(n \times V_r) + C_i$ [Steen-Thøde, 1997: 29 formular 1.14], where

C is the maximum allowed concentration
q is the pollution added to the room
n is the airchange (h^{-1})
V_r is the volume of the room (m^3)
C_i is the concentration in the inlet air

In table B.2.1 the requirements for the different rooms are listed.

Ventilation for CO_2 pollution

According to the before mentioned formular the following is seen when using the entrance as an example

C is here the maximum allowed CO_2 level (ppm) = 950ppm
q is the pollution from the visitors (ppm) and is found in the

Space	Comfort level	Area (m^2)	Occupancy (persons)	CO_2 limit[1)] (ppm)	Air quality[2)] (dp)	Relative humidity[3)] (%)
Entrance	B	395	50	1080	1.4	40-60
Cafe	B	395	50	1080	1.4	40-60
Exhibition	A	2090	200	780	1.0	45-55[4)]
Conference	B	143	50	1080	1.4	40-60
Classroom	B	143	28	1080	1.4	40-60
Multimedia	B	85	28	1080	1.4	40-60
Library	B	75	10	1080	1.4	40-60
Office	B	100	10	1080	1.4	40-60
Loading	B	500	8	1080	1.4	40-60
Art storage	A	200	15	780	1.0	45-55[4)]
Workshop	B	650	15	1080	1.4	40-60
Storage	B	450	4	1080	1.4	40-60

[1)] CR 1752 figure A.8 page 24
[2)] CR 1752 table A.5 page 23
[3)] From miijøstyrrelsen
[4)] From The manual of museum exhibitions

following way:

q = occupancy (50persons) X 17 X activity level (3met) = 2550 l/h = 2,55 m^3/h

n is the airchange needed to maintain an acceptabloe CO_2 level
V_r is the volume of the given room (m3) = 1000m^3 (5m room height)
C_i is the concentration in the inlet air (ppm) = 350ppm

n = 2,55m^3/h * 10^6 / (1000m3 X (950ppm - 350ppm))= 4,3 h^{-1} = 5,9 l/s*m^2

Ventilation for sensory pollution

According to the before mentioned formula the following is seen when using the entrance as an example.

C is here the maximum allowed perceived air quality = 1,4 dp
q is the sensory pollution load by visitors and building per square

Activity level[5] (met)	Pollution-load[5] (olf/ person)	Humidity load[5] (g/h)	ventila-tion[6] (l/s*m^2)	Ventila-tion CO_2 (l/s*m^2)	Ventilation sensory (l/s*m^2)	Ventilation humidity (l/s*m^2)
3.0	2	200	3.0	3.0	2.5	1.2
1.2	1	50	5.6	1.2	2.5	0.3
1.2	1	50	1.6	1.4	1.4	0.2
1.2	1	50	4.2	2.0	2.2	0.5
1.2	1	50	4.2	2.0	2.2	0.5
1.2	1	50	4.2	3.1	3.1	0.8
1.2	1	50	1.4	1.3	1.7	0.3
1.2	1	50	1.4	0.9	1.4	0.2
3.0	2	200	8.4	0.4	0.9	0.1
1.2	1	50	1.4	0.9	1.3	0.2
3.0	2	200	8.4	0.5	1.0	0.2
3.0	2	200	8.4	0.2	0.8	0.0

[5] CR 1752 table A.6 page 26
[6] CR 1752 table 1 and 2 page 10 and 11

meter and is calculated as:

q = (occupancy (50persons) X sensory pollution load (2olf/person) + 0.1olf/m^2 * 200m^2)/200m^2 = 0.6 olf/m^2

n is the airchange needed to maintain an acceptabloe air quality
V_r is the volume of the given room (m3) = 1000m^3 (5m room height)
C_i is the concentration in the inlet air (dp) = 0dp

n = 10 l/s * 0.6 olf/m^2 / (1.4dp - 0dp) = 4.3 l/s*m^2

Ventilation for humidity

According to the before mentioned formular the following is seen when using the entrance as an example

C is the allowed concentration of water vapour (g/kg) = 8g/kg
q is the amount of vapour from the visitors = 50g/h*person and is found the following way:

q = 50persons * 50g/h*person = 2500g/h

n is the airchange needed to maintain the humidity
V_r is the volume of the room (m^3) = 1000m^3
C_i is the concentration in the inlet air (g/kg) = 13g/kg

The maximum concentration and the concentration in the inlet air is found from the relative humidity which in the max concentration is in a 21 dgrees celcius warm room with 50% relative humidity as is the requirements for the exhibition areas. The inlet air concentration is found in a similar way, where the air is assumed to be from the outside on a summerday where the temperature is 24 degrees celcius and and the relative humidity is 70% like a summerday.

n = 2500g/h / (1000m^3 * 1.2kg/m^3 * (13g/kg - 8g/kg) = 1.7 h^{-1} = 2.3 l/s*m^2

1,2kg/m^3 is the density of the air and is used to calculate the amount of water vapour per cubic meter

Appendix C - Structural considerations

- C.1 Introduction

Present appendix is focused on the different structural parts and their level of insulation. It creates a basis for the evaluations in the later chapters and therefore are important. Furthermore they are important for the understanding of the building and their have to be a coherence between the different structural parts and the architectural expression of the building

- C.2 U-values

This part will be focused on determining the U-values for walls, roofs, foundations, floors to terrain, loadbearing inner walls and basement walls. Furthermore the lineloss for foundations, windows and doors will be determined.

U-values for thestructural elements are determined by the following formular from DS418.

$1/U' = R_{si} + R_{se} + \sum R_i$ (1), where

U' is the uncorrected heat transmission coefficient
R_{si} is the internal insulation factor
R_{se} is the external insulation factor
$\sum$ is the insulation factor for the different layers

R_{si} and R_{se} are determined from DS 418 table 6.2 and are as follows

R_{si} = 0.13 m^2K/W
R_{se} = 0.04 m^2K/W

This U-value has to be corrected because of gaps in the insulation layer and this correction is made as stated in DS 418 annex A.

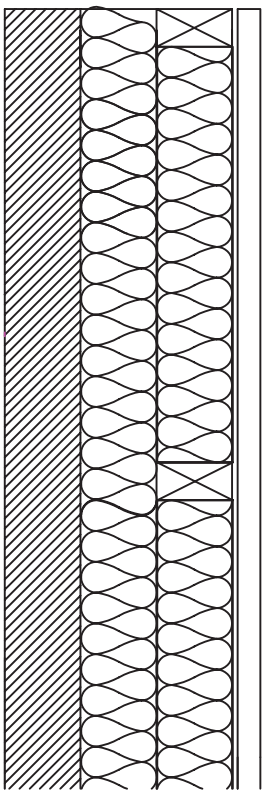
$U = U' + \Delta U$

The insulation for a homogene material is:

$R = d/\lambda$, where

d is the thickness in meters
λ is the ability to transfer heat.

Walls



The wall structure is as follows:

Facade cladding 60 mm okapane
Insulation layer 1 100 mm Rockwool A-Batts
Insulation layer 2 100 mm Rockwool A-Batts
Concrete Back wall 150 mm

Formular 1 gives

$1/U' = R_{si} + R_{se} + \sum R_h + \sum d/\lambda'$ (2), where
$\lambda' = (A_a\lambda_a + A_b\lambda_b + ...)/(A_a + A_b + ...)$ (3), where

R_h is the insulation value for the homogene layer
λ' is the average value for the inhomogene layers ability to transfer heat
A_a, A_b, ... are the areas of the parts of the inhomogene layers
λ_a, λ_b, ... are the value of the ability to tranfer heat in the inhomogene layers

Inhomogene layers

Area of vertical studs A_a	39.9 m^2
Area of horizontal studs B_a	6.6 m^2
Insulation value λ_a	0.14 W/mK
Area of insulation A_b	220.1 m^2
Area of insulation B_b	253.4 m^2
Insulation value λ_b	0.034 W/mk

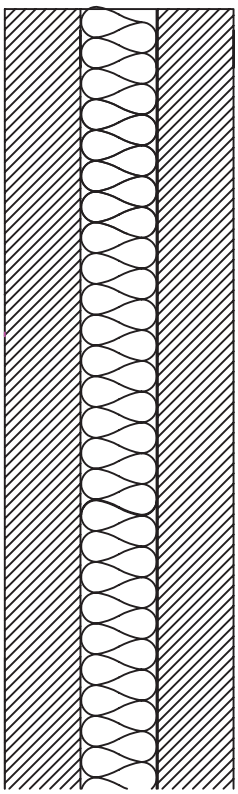
By inserting in formular 3
$\lambda A' = 0,05$ w/mK
$\lambda B' = 0,036$ w/mK

By inserting in formular 2 the following is seen

$1/U' = 0.04 + 0.83 + 2 + 2.8 + 0.088 + 0.13 = 5.9$

$U' = 0.18$ W/m^2K

From DS418 Annex A ΔU is set to be 0.00 W/m^2K because the two insulation layers are crossing each other



Basement Walls

The wall structure is as follows:

External concrete layer 100 mm
Insulation layer 150 mm Rockwool A-Batts
Internal concrete 150 mm

For the basement walls two cases are present. One for basement walls between 0 meters and 2 meters depth and one for walls deeper than 2 meters.

This gives the following insulation for the external insulation layer.

Between 0 m and 2 m R_{si} = 0.2 + 0.3 x h = 0.8 m^2K/W
Below 2 m R_{si} = 2 m^2K/W

By inserting in formular the resualts are as follows.

Between 0 meters and 2 meters

$1/U' = 0.8 + 0.067 + 4.1 + 0.1 + 0.13 = 5.2\ m^2K/W$

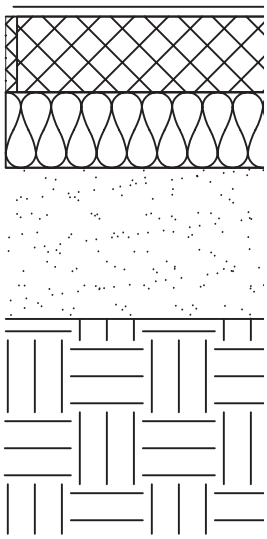
$U' = 0.2\ W/m^2K$

Below 2 meters

$1/U' = 2 + 0.067 + 4.1 + 0.1 + 0.13 = 6.4\ m^2K/W$

$U' = 0.16\ W/m^2K$

Terrain deck



The terrain deck structure is as follows:

Capillary layer 200 mm Leca
Insulation layer 200 mm Rockwool Terrain-Batts
Cocrete 100 mm

The insulation value for the external layer here is 1,5 m^2K/W

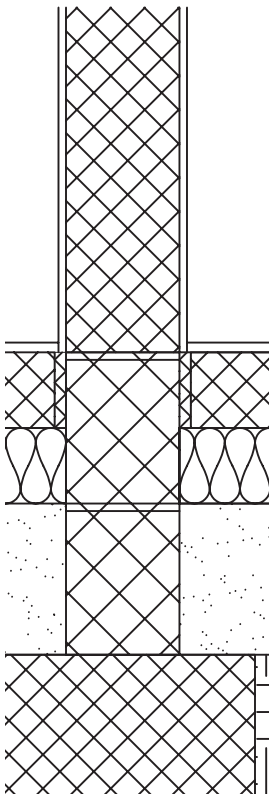
Formular 1 gives

$1/U' = 1.5 + 2.5 + 5.26 + 0.059 + 0.13 = 5.9\ m^2K/W$

$U' = 0.11\ W/m^2K$

Internal load bearing walls

Becuase the internal loadbearing walls penetrates the insulation layer of the terrain deck they have to be integrated into the calculation of the terrain deck.



The structure here is as follows

Capillary layer 400 mm Leca
Concrete 400 mm

By inserting in formular 1 the result is as follows

$1/U' = 1.5 + 1.74 + 0.24 + 0.13 = 3.6\ m^2K/W$

$U' = 0.28\ W/m^2K$

This result has to be incorporated in the calculation of the u/value for the terraindeck.

Area terrain deck A_a	2033.1 m^2
Area internal walls A_b	37.9 m^2

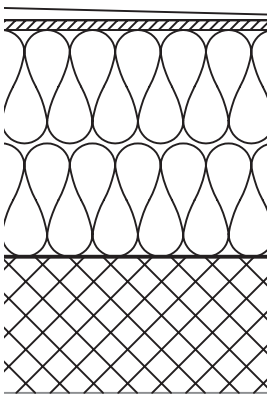
The weighted result is then found as follows

$$U' = (A_a \times U'_{terrain} + A_b \times U'_{internal}) / (A_a + A_b)$$

$U' = 0.11\ W/m^2K$

Roof

Being a flat roof, there is a minimum pitch of 1:40 meaning that it has to rise at least 2,5 cm for every meter. The pitch is stretching over 10 m meaning that the roof structure is as follows



Insulation minimum 250 mm Rockwool Hardkile
Insulation maximum 500 mm Rockwool Hardkile
Concrete 200 mm

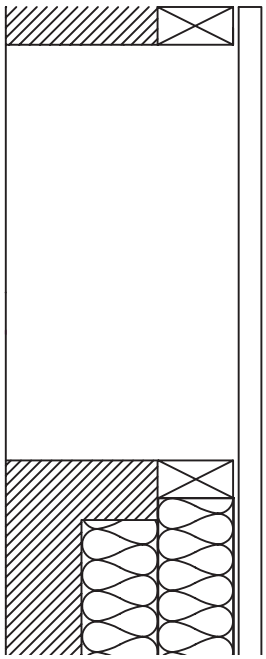
Because the insulation is changing the insulation value for both the maximum and the minimum thickness has to be calculated and then adjusted to make a weighted value.

For the minimum insulation thickness the result is as follows:

$1/U' = 0.04 + 6.25 + 0.12 + 0.13 = 6.54\ m^2K/W$

For the maximum insulation thickness the result is as follows:

$1/U' = 0.04 + 12.5 + 0.12 + 0.13 = 12.79\ m^2K/W$



In DS418 the following is given to calculate a weigthed value

$U = 1/(R_{max} - R_{min})\ x\ ln(R_{max} / R_{min}) = 0.11\ W/m^2K$

Lineloss for windows

The lineloss for windows is assumed to be 0,18 W/mK. This assumption is based on the wall being a heavy innerwall in concrete and a light shielding wall on the outside. The window structure is unusual because it is the openeings in the backwall creating the windiw, and nothing penetrates the outer wall. From this assumption the lineloss is set to 0,02 W/mK from table 6.7.1 DS148

Lineloss for doors is set to 0.09 W/mK from DS418 table 6.12.1b

Appendix D - Simulations

- D.1 Introduction

Present appendix focuses on utilizing the calculations in the former appendixes in two different programs for assessing how the building performs in terms of its use of energy.

The first program used is BE06, which is used for calculating the energy use in the building, and through that determine the energy-class of the building.

The second program is Bsim, which is a program for dynamic building simulations. Here the aim is to asses how the building performs both in terms of the energy use, but more importantly how the indoor climate is. Through the use of the program the temperatures, humidity and need for ventialtion can be determined. This allows one to see if the building fullfils the requirements set up in the beginning. Only one of the exhibition rooms has been chosen for this simulation.

- D.2 BE06

The focus here is to explain where the different inputs comes from in the program. This will be done in accordance with the structure of the program.

General inputs

In this section the general inputs for the building are stated. This is the heated floor area measured on the drawings, the buildings ability to accumulate heat which is found in DS418 and is based on the fact that it is a heavy building, with mainly concrete structures and finally the hours of use per week, which is based on the demands set up in the design brief.

Parameter	Input	Source
Heated floor area	4890 m^2	Drawings
Heat accumulation	160 Wh/Km^2	
Time of Use	45 h	Opening hours

Building envelope

The building envelope can be divided into four smaller sections.Namely one concerning walls, floors and roofs and their level of insulation, one concerning the joints between the different buildingparts and

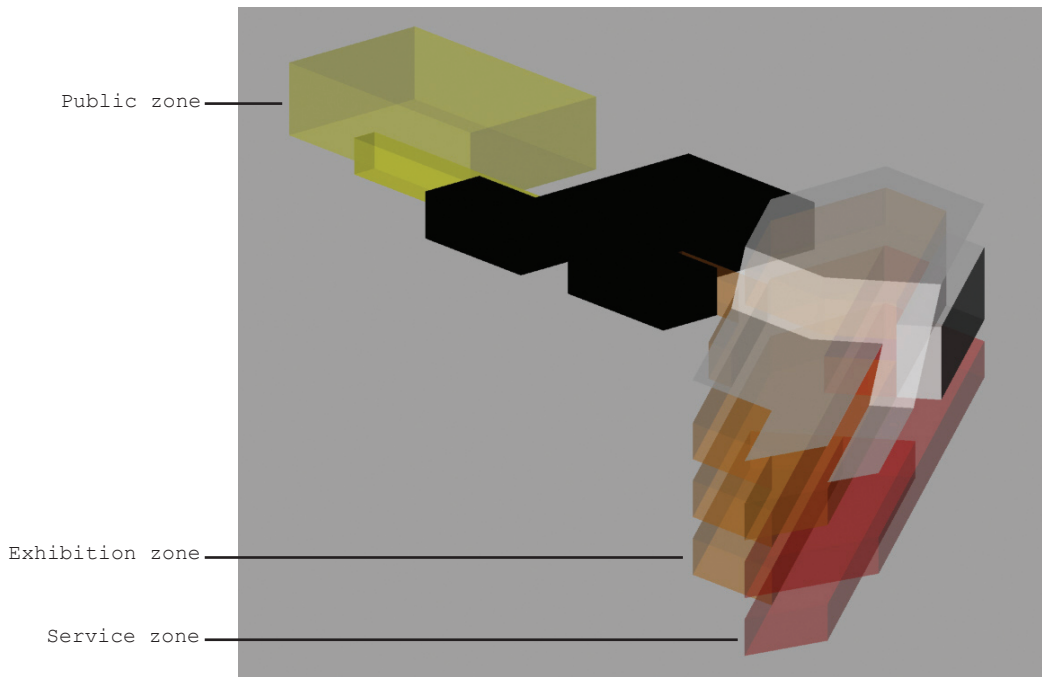
the line losses, one concerning windows and the last one concerning unheated rooms. The three first sections are based on the values calculated in appendix C, and the areas used in the calculations are based on the drawings

Parameter	Input	Source
Wall area	2017.63 m^2	Drawings
Wall U-value	0.18 W/m^2K	Appendix C
Floor area	2180 m^2	Drawings
Floor U-value	0.11 W/m^2K	Appendix C
Roof area	2180 m^2	Drawings
Roof U-value	0.11 W/m^2K	Appendix C
Basement 0m - 2m area	360 m^2	Drawings
Basemnt 0m - 2m U-value	0.20 W/m^2K	Appendix C
Basement -2m area	683 m^2	Drawings
Basement -2m U-value	0.16 W/m^2K	Appendix C
Foundation length	361 m	Drawings
Foundation line loss	0.12 W/mK	Appendix C
Windows length	318.1 m	Drawings
Windows line loss	0.02 W/mK	Appendix C
Skylights length	138.13 m	Drawings
Skylights line loss	0.02 W/mK	Appendix C
Doors length		Drawings
Doors line loss	0.18 W/mK	Appendix C
Windows clear area	381.8 m^2	Drawings
Windows clear U-value	1.0 W/m^2K	Appendix C
Windows transparent area	139.77 m^2	Drawings
Windows transparent U-value	1.2 W/m^2K	Appendix C

Ventilation

The third section in the program deals with the ventilation. For this pupose has been split into three zones. One for public spaces, one for exhibition areas and one for services. The air change in each of these zones has been determined by making an avareage of the air changes found in appendix B. The average is based on the different functions and the area related to the different zones. The areas here are based on the drawwings

Parameter	Input	Source
Public area	915 m^2	Drawings
Public vent. winther	2.0 l/s m^2	Appendix B
Public vent. summer	2.0 l/s m^2	Appendix B
Public vent. night	0 l/s m^2	Appendix B
Public temp. inlet	18 degrees celcius	Appendix B
Exhibition area	2595 m^2	Drawings
Exhibition vent. winther	1.4 l/s m^2	Appendix B
Exhibition vent. summer	1.4 l/s m^2	Appendix B
Exhibition vent. night	0.2 l/s m^2	Appendix B
Exhibition temp. inlet	20 degrees celcius	Appendix B
Services area	1380 m^2	Drawings
Services vent. winther	0.9 l/s m^2	Appendix B
Services vent. summer	0.9 l/s m^2	Appendix B
Services vent. night	0 l/s m^2	Appendix B
Services temp. inlet	18 degrees celcius	Appendix B
Degree of reuse of heat	0.85	



Internal loads

As with the ventilation the internal loads have been split into three zones following the same criterias as before. Namely the public zones, exhibition zone and service zone. The numbers used in this part are from the suggetions made in the progrmas userguide. These values has been chosen because they are an expression of the avarage building.

Parameter	Input	Source
Public area	915 m^2	Drawings
Exhibition area	2595 m^2	Drawings
Service area	1380 m^2	Drawings
People load	4 W/m^2	BE06
Apparature load	6 W/m^2	BE06

Lighting

In terms of lighting the building has been split into a different system of zones from the previous two sections with internal loads and ventilation. Here the system is based on how the zones are laced in relation to the windows and walls. The drawing below shows the different zones.

Parameter	Input	Source
Exhibition		
- Basement area	700 m^2	Drawings
- Inside area	345 m^2	Drawings
- Outside area	625 m^2	Drawings
- Top area	475 m^2	Drawings
Services		
- Basement area	810 m^2	Drawings
- Groundlevel area	920 m^2	Drawings
Connections	190 m^2	Drawings
Public	825 m^2	Drawings
Lightlevel general	200 lux	Requirements
Lightlevel connections	50 lux	Requirements
Minimum light effect	2 W/m^2	BE06
Installed light effect	6 W/m^2	BE06
Work light public/service	1 W/m^2	BE06

Heat distribution

The heat distribution plant is assumed to have a 125 kW effect and it is a 2 stringed distribution system

Heated water

The heated water is assumed to be fulfil the the following requirements

Parameter	Input	Source
Consumption	100 l/m^2 year	Assumption
Heatloss from heater	2 W/K	Assumption
Length to public	180 m	Drawings
Length to exhibition	24 m	Drawings
Apparature load	6 W/m^2	BE06

District heating exchanger

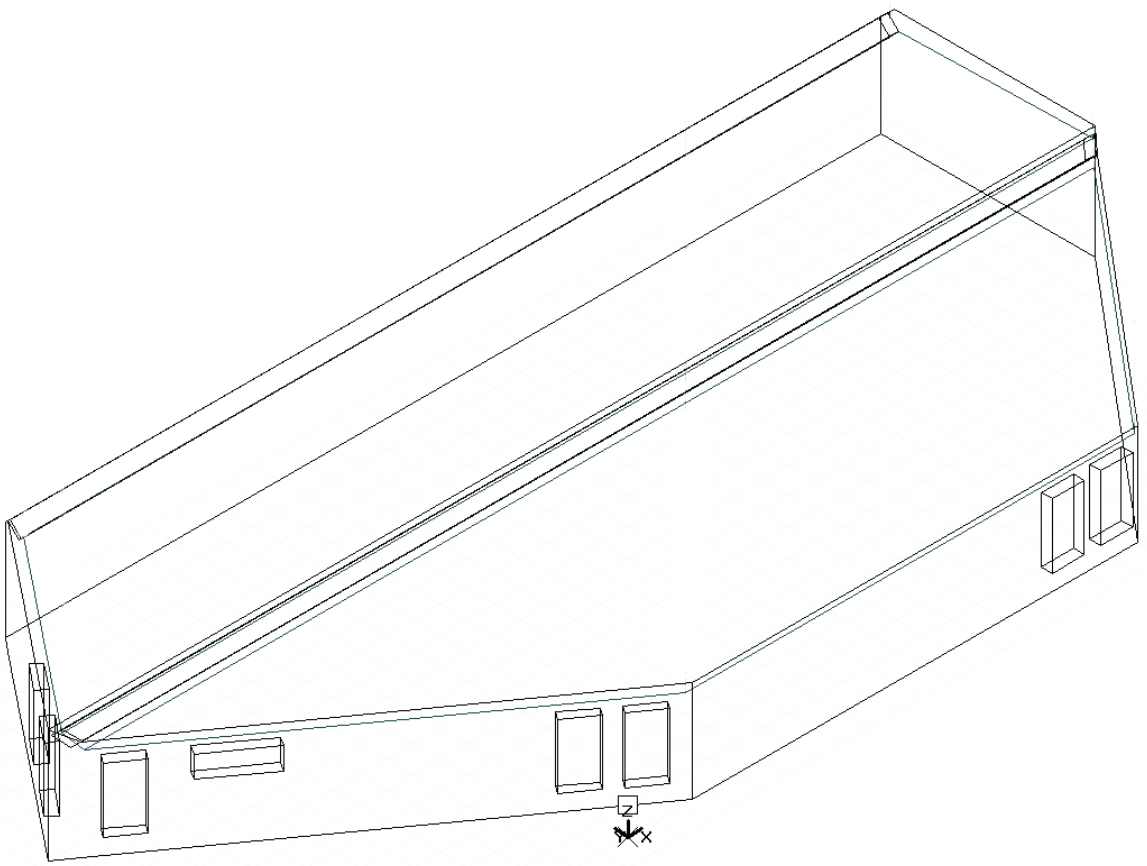
Parameter	Input	Source
Effect	150 kW	Assumption
Heatloss	2 W/K	Assumption

PV cells

Parameter	Input	Source
Area	2100 m^2	Drawings
Peak power	0.21 kW/m^2	Assumption
Efficincy	13%	Assumption

- D.3 Bsim

The focus here is to explain the different inputs to the program. As mentioned in the introduction only obe room in the building is being evaluated here, namely the exhibition area on the top floor as shown in figure D.3.1, where the numbers corresponds to the surfaces used later



Geometry

Parameter	Input	Source
Floor (1)	564 m^2	Bsim
Wall (2)	122 m^2	Bsim
Wall (3)	34 m^2	Bsim
Wall (4)	49 m^2	Bsim
Wall (5)	62 m^2	Bsim
Wall (6)	65 m^2	Bsim
Wall (7)	44 m^2	Bsim
Ceiling (7)	564 m^2	Bsim

Orientation

Parameter	Input	Source
Floor (1)	Thermal zone	Drawings
Wall (2)	Thermal zone	Drawings
Wall (3)	Thermal zone	Drawings
Wall (4)	Thermal zone	Drawings
Wall (5)	Outdoor	Drawings
Wall (6)	Outdoor	Drawings
Wall (7)	Outdoor	Drawings
Ceiling (7)	Outdoor	Drawings

The surfaces orientated against a thermal zone are orientated towards another room, here being defined as a thermal zone similar to itself. This can be assumed because the surrounding rooms are exhibition rooms as well, therefore having the same specifications.

People load

Parameter	Input	Source
People	100	Demands
People	normal activity	Demands

The people load in the room is here set to 100 people having a normal activity level this generates the following input.

Ventilation

The ventilation in this room is determined by the demands and the internal loads. The internal loads here detrmined by the people load and the lighting as it is the only loads in the room.

Parameter	Input	Source
Supply air	0.95 m^3/s	Appendix B
Return air	0.95 m^3/s	Appendix B
Heat recovery	85%	Assumption
Heating coil	2 kW	Standard
Cooling surface	5 degrees celcius	Standard
Schedule	Allways	Demands
VAV control min. inlet temp	15 degrees celcius	Assumption
VAV control min. inlet temp	26 degrees celcius	Demands
VAV control setpoint indoor	21 degrees celcius	Demnads
VAV control setpoint cooling	26 degrees celcius	Assumption

Infiltration

The infiltration is the natural airchange in the building due to small gaps in the joints in the construction. Here it has been set to 0,2 times per hour. The number is made from the assumption that it is a relatively tight building.

Heating

Parameter	Input	Source
Max power	15 kW	Assumption
Schedule	Nov - Mar	Assumption
Set point	21 degrees celcius	Assumption
Design temperature	-12 degrees celcius	DS418
Minimum temperature	18.8 degrees celcius	Demands

Lighting

Parameter	Input	Source
General lighting	6.5 kW	BE06
General lighting level	200 lux	Demands
Schedule	allways	Assumption
Max temperature	23.2 degrees celcius	Demands