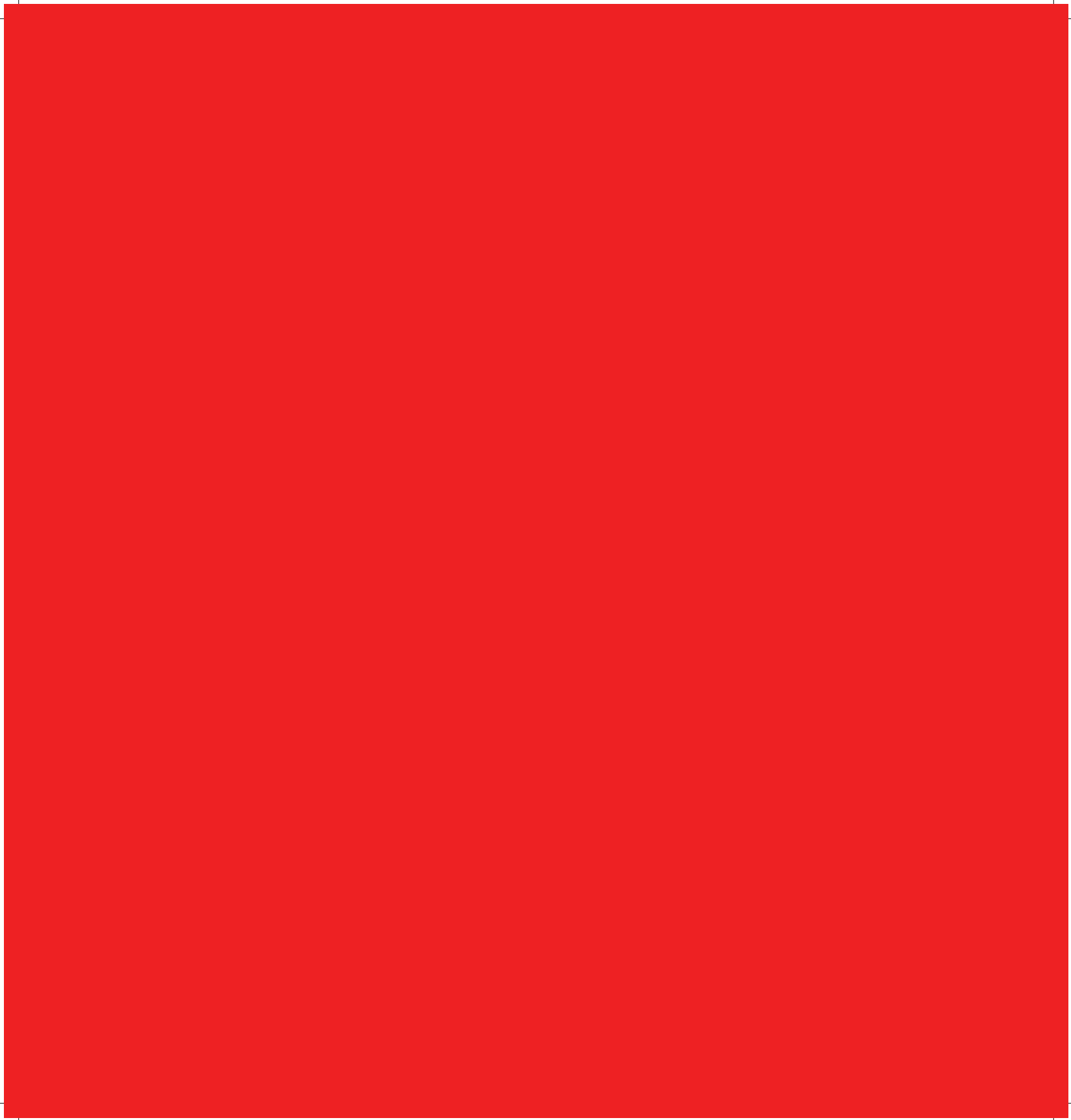


aalborg university mediateque



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abstract

This rapport describes the design process of a new library for Aalborg University, placed in the east part of Aalborg at the university campus. The project aims to create a design proposal for the future library suitable for many generations to come, therefore an analysis of the future libraries is conducted, as well as studies of present and past libraries. The design process have made use of computer added design in combination with rapid prototyping technologies to create physical models.

As the project develops, different aspects of spatial organisation are investigated, resulting in the term 'landscape' which is further developed into the project concept.

topic

This thesis deals with the architectural design of libraries, in particular investigating the potential and changes in functionality following the implementation of new medias in an open-shelves libraries.

In this work, the theoretical research is developed in parallel with a design application of the acquired knowledge, using the actual plans of a new university library as inspiration for the definition of a starting program for a project.

The new proposal is going to replace the present library placed outside the campus, maintaining the existing size of about 10.000 m².

It should be underlined that the boundaries of this project are defined together with the director of the Aalborg University Library (AUB), which therefore could be considered as a real case study. The implicit approach to the architectural design of this project is referring to the Master education in Architecture & Design at Aalborg University, dealing with the topics of Tectonic, Nordic and Sustainable architecture. Nevertheless, the topics of Tectonic are the main focus for the development of the design proposals in the present project.

This thesis aims to explore new design opportunities and solutions for open-shelves libraries, mainly considering the potential of the implementation of new medias when defining new spatial configurations in this kind of buildings from the morphological point of view, as well as from the social one.

A study about the design of new libraries is therefore provided through the development of a project, based on the real case study of the new plans for AUB.

Title AUM - Aalborg University Mediatheque

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motivation

As the function of libraries date way back into ancient time, the library as an institution, has always had a central position within culture and education. In this way, the libraries have been able to set up and create basis for the knowledge society that we live within today. Libraries themselves have in doing so become the very symbol of knowledge, and have up through time stood out as edifice of prestige – often conducted by the most significant architects and master builders of all times.

The library in some way therefore stands as a footprint of society and the architectural currents of time.

As the Aalborg University campus for many years, has been ordinarily known as a slightly uninteresting area, it now faces a comprehensive alteration, in order to ensure a modern and up-to-date campus.

In this coherence the AUB, as a natural gathering point for the whole university, is going to play a central role within this modernization.

Aalborg University today consists of buildings overall similar in architectural style to each other, and here by finds itself in absence of a landmark or icon, that can promote the university. Here it is evident

that a new university library as a natural gathering point for all faculties will appear as a symbol for the AAU.

The library through the ages has undergone an enormous development, which is why a new library would have to fulfill both present and future tasks, and in this way create the surroundings within learning and educational environments of the future.

The library is a place bound for servicing the vast majority of the population, and it should take care of a wide range of assignments from the search of new knowledge and learning to bringing people together. It is a place where one finds information, gets inspired and draws social bands. Therefore, the library has to withhold all this, while at the same time preparing itself facing the more and more digital aspects of the 21st century, which could be pushing the boundaries of these constitutions.

To be part of creating these physical surroundings of such a building is considered to be a highly interesting task, both because of the strong bands to Aalborg but also in order to create the frame work of a better campus environment for coming fellow students.

At the same time, when working with an assignment, which contains actual future planning in order to be erected, the aspect of realism and the possibility of cooperating with a client as the management of the AUB, interesting and educative ventures are faced.



III. 1 - Aalborg University

foreword

This report is authored by Group 40 within the 10th semester Master of Science in Engineering with speciality in architecture at Aalborg University.

The report is documenting the work flow of an integrated design process combining aesthetic, technical and functional considerations, aims and demands into solutions. This report is addressed to supervisors, fellow-students and similarly correspondents taking interest in the subject area. The reader should be informed that along with the report, a digital copy of the report augmented by digital versions of drawing materials is located on a CD-ROM, placed in the back of the report. The back of the report also contains the drawing material for presentation printed in large-sized paper.

The authors wish to give thanks to the two main supervisors, along with the rest of the supervising team at AD:MT. A special regard goes to Niels-Henrik Gylstorff, director of Aalborg University Library (AUB), whom has personally contributed and served as liaison with the AUB during the entire project phase. Also the rest of the administrative staff at AUB should be pointed out for their accommodating help when regarding questions and library literacy.

The group also wishes to give thanks to vice-inspector Bent Tindahl Pedersen within the Aalborg Emergency Management Center, whom has contributed with expertise inside the field of counteracting fire.

reading guide

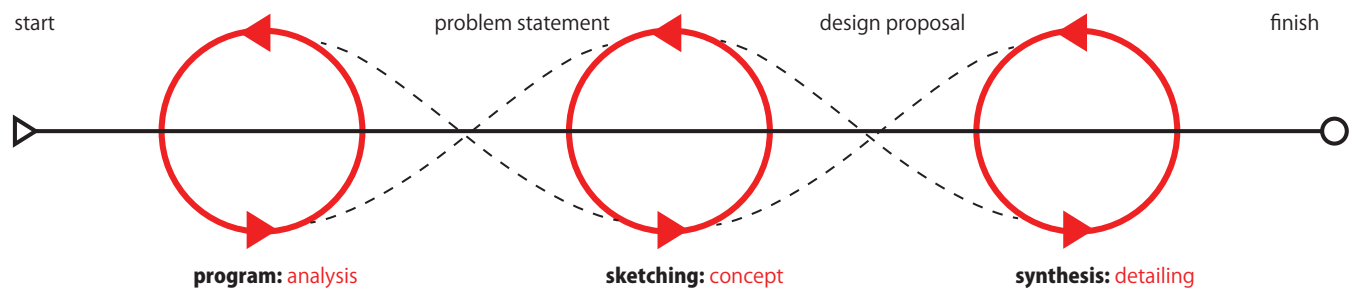
This report uses the Harvard-style author-date information when citations and references are mentioned. Pictures, illustrations and drawings will have a number assigned and as with reference texts, the full source will be provided in the section of references located in the back of this report.

the method

The method used is called Integrated Design Process (IDP). The IDP method is an iterative process, where different phases of the project inter-connect, and relate to each other back and forth. The process consists of five points; Problem, Analysis, Sketching, Synthesis and Presentation. Using the IDP as a backbone of methods, the planning of phases very much underlines this process resulting in a range of different stages within the overall period of design. With the Problem Based Learning method (PBL) used on Aalborg University, the working method is featured by groups working together in order to find plausible solutions to an initial stated problem. To be able to desiccate the problem, the work is divided into these phases. Each phase should be characterized by several so called 'design loops' making iterations of the design until the design until a satisfying result is achieved, preceding the design to a next phase. Should a design on a later stage display lacking in performance of requests and demands additional iteration would be made.

The IDP process focuses combining technical issues with architectural and functional problems. This is in order to create a unity within a building as where constructive, technical, functional and aesthetical solutions underline each other.

Looking at the different phases, the procedures of IDP first and foremost is to state the problem, which needs to be solved. Within the Analysis the function is to gather the amount of required information and knowledge in order to proceed to the Sketching Phase. Here conceptual proposals and initial technical solutions are tested in order to move on to the Synthesis, where a more complex integration of the overall aspects are assembled resulting in a final design. The last phase in the IDP encompasses the work on producing material for presentation in order to exhibit and display the overall solution. [Knudstrup, 2004]



III. 2 - The method used

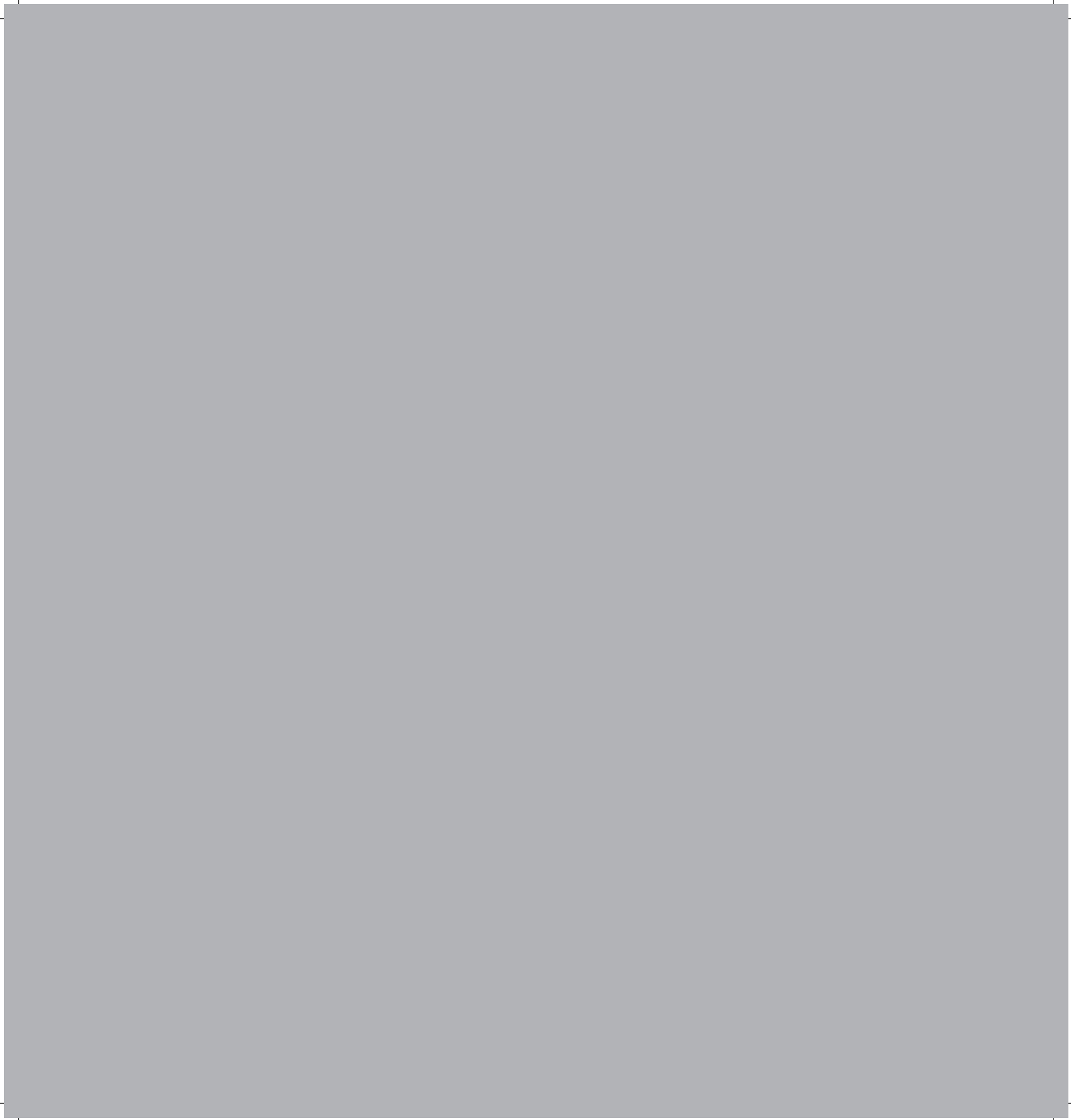


table of content

abstract	3	06 detail phase	76
topic	4	masterplan	78
title	5	public ground floor	80
motivation	6	organization of 'Book Room'	82
foreword	8	administration	84
01 setting	11	facade	86
AAU history and perspectives	13	technical considerations	89
02 investigations	20	structural system	90
the evolution of the library	24	fire verification	96
case studies	34	daylight verification	99
03 context	44	acoustic verification	103
the user	45	07 presentation	106
mapping	46	08 conclusion	132
04 vision	52	reflection	
05 design phase	54	09 appendix	134
phase 1	56	list of references	160
phase 2	66	bibliography	162
phase 3	68	list of illustrations	163
phase 4	74		

AAU history and perspectives

Aalborg University campus was founded in 1974, and today the university administration wants to modernize the campus. This chapter will give a short introduction to the history behind the planning of the campus area, and the plans to build the new university library.

campus

The story about Aalborg University campus goes back about 40 years back, when it after a great debate was decided to situate the university outside of central Aalborg. The competition to design the new campus was won by the architectural office Dall & Lindhardt in 1974, and consists of low university clusters surrounded by housing, commercial buildings and green areas.

This campus idea with mixed functions, in one or two story similar buildings, has proven to be a unsuccessful idea, and today the campus area tends to be a deserted place. As a consequence of this, the university launched a new competition in 2000, which should attempt to fix the mistakes of the past, and create a modern campus. The competition was won by the architectural firm Kjær & Richter, together with the engineers of Rambøll and the landscape architect Peter Sørensen Aps.

The proposal was to create a 'city strip' going in an east-west direction, running through the entire campus area. This strip should then contain all the vital functions, and thereby act as a life line in the campus area.

A central piece in this strip was the university library, and the planning of the new university library of Aalborg has been on the drawing board for a period of time, starting after the millennium.

[Campussti og uderum] and [Projectfolder Rambøll]



III. 3 - The city of Aalborg and the location of Aalborg University campus



III. 4 - The main AAU building



Antina



III. 7 - The Klingenberg Lake next to the AAU building



III. 5 - Typical building in brick and concrete, the campus area



III. 6 - Aalborg University Library (AUB)



III. 8 - Green banks characterizes AAU campus



III. 9 - The two main colors of AAU campus - red bricks and grey concrete.

Aalborg University Library (AUB)

The AUB today consists of five different departments located around the city of Aalborg. One department supplies the first-year students in central Aalborg together with the Utzon Center department, which holds the volumes for the Architecture and Design. The rest of the departments are situated around the main university campus in eastern Aalborg. Here the main department is located north of the area supported by the two minor departments for law, math, health-care, computer science and medicine respectively.

The main department of AUB was erected in the beginning of the 70's in conjunction with the main campus area. The building is a large industrial building of one floor together with a large basement. The whole building takes up around 10.000m² and is situated around a long atrium creating a main passage going north-south through the building. Today, the library department holds around 70 employees maintaining all the administrative and library service functions. It is constructed in a concrete column/beam system using industrial pitched window rows for roof lights.

The main task for the AUB is to support students, researcher and scientist at Aalborg University, but the functions of AUB are public and

accessible to everyone. The collection of material is wide, covering a large number of topics – but with a focus on specified material used within the specialties of the university branches of the AAU.

The AUB collection holds more than approximately 850.000 volumes and the library annually acquires more than 14.000 new volumes to its collection, whereas most are accessible for public loans. With the use and collaboration on national level the AUB holds licenses to more than 27.000 electronic journals together with more than 160.000 titles of electronic books (2009 numbers). [NHK and AUB]

On a daily basis, the library, apart from providing services to patrons, also acts as a place for study and group work. The main collection is held on open shelves in the eastern side of the atrium together with a more compact collection stored in the basement.

In the atrium hallway the service counter acts as a reception providing services and quick loans. Around the edges of the library rooms for group work, seminars and lectures are located along with tables and computer work stations placed among the collection.

Here students and university staff can come and work Monday to Friday from 8.00 a.m. to 10.00 p.m. The library also accommodates master students from a range of other educations filling the library space in the weekends with up to 90 students at the same time.



III. 10 - Aalborg University Library

AUB in the future

Today the library stands as well-attended – though worn – building, but during the last years, the number of patrons has been falling due to especially digital loans. The digital aspect also concerns the direction of the library, which sees an increasing tendency of patrons making pre-reservations of books followed by picking them up at the reception instead of manual browsing and loans. It has therefore been suggested that a new library should incorporate such tendencies altering the library into a serving more or less closed-shelves library.

With a new and more central location for the library though, it is thought to increase the number of patrons once again, offering easy access for a larger part of the campus area and thereby hopefully resulting in a profiled icon and lively library for the entire university.

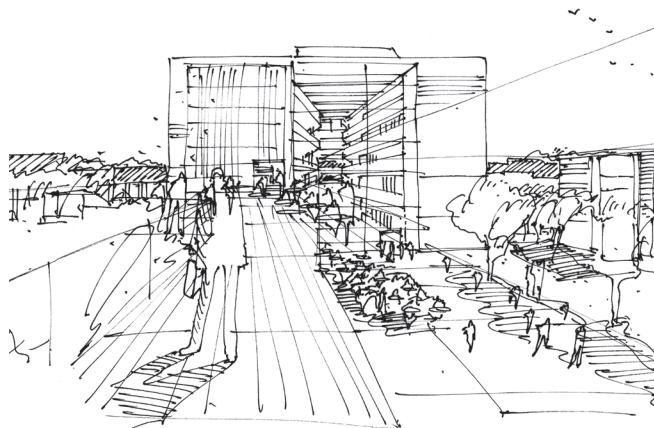
These strategies have not yet been settled but the initial plan to build the new university library took shape already around year 2000. Since then there have been developed two different proposals - on two different locations - but both were rejected in the final phase due to lack of foundations. The location of the existing library is on the other side of 'Universitetsboulevarden' away from the campus area (see page 16 - 17). With a vision of making the library into the natural meeting point, this has been far from ideal, so in the new master plan, the library was placed in the center of the campus area. The visions for a new and modern library were conducted together with the proposals for a new and more concentrated campus downtown – placing the new library in the very heart of the campus.

The first placement of the university library was on the south side of 'Bertil Ohlinsvej', where it crosses 'Fredrik Bajers Vej'. Here the architectural firm Kjær & Richter developed the proposal in 2004. The proposal was to build a six story building, in the shape of a rectangular box. The simple box was cut through by a street-like glass-covered atrium, which divided the building in two parts, and created a big well-lit community space. Even though the project was developed to a great detail, the building was never realized, and in the long process that followed, the location was changed due to expansion of a nearby faculty building.

The new location (which is now the existing proposed location), is on the east side of the rainwater-collecting lake 'Klingenbergssøen', also on the south side of 'Bertil Ohlinsvej', just across the main canteen. This location is on the outskirts of the campus, with a vision of making the university library into a western entrance gate to the campus area. On this new site, the architects of Kjær & Richter developed a new proposal in 2009, consisting of four stocks in different highs, with a mixed glass and perforated metal facade. As a central piece of the design, it continued with the big glass covered atrium, and the well-lit

community space. This is now the newest proposal for the new university library at Aalborg University, but until now the university has not been able to find the necessary founding, and at the moment, the project is on a standstill until the university finds the founding necessary to realize the project. This project takes outset in these present plans of a new university library, with base in the latest proposal for a location.

[Campussti og uderum], [Projectfolder Rambøll], [NHK] and [AUB]



Ill. 11 - The newest Kjær & Richter proposal for a substituting university library





02

INVESTI-
GATION.

introduction

The distance between user and information, is becoming increasingly smaller, and with no sign of this development to stop, the possibility of acquiring knowledge have developed from being attached to physical places, to being accessible everywhere in the modern digital world.

Humans have always had the need to share information, whether it being storytelling, gossiping, news, research etc. Before the introduction of mass communication technologies, this need was fulfilled by social interaction in the city's public spaces. These public spaces could be considered as the internet of that time - a mass communication platform - with all kinds of different information floating around.

With the introduction of technologies like the telegraph, radio and television this changed, and the way both individuals and society communicated took new shapes. As the information technologies evolves, information began to be faster and more dynamic; what happens in one part of the world is news everywhere, making the world 'smaller' and emphasizing phrases like 'connectivity', 'the global village', etc.

In this ever-evolving information age, libraries with its static book collection, seem to become obsolete. But maybe the future libraries main purpose is not the distribution of books, but the provider of an inspiring environment, where sharing and creation of knowledge is taking place. One technology does not make another obsolete, but together they benefit each other, and create better conditions for the user.

In this new agenda the role of the architect is becoming more and more important, the library have changed from being the only solution for knowledge gathering, to one amongst many. The library still have the benefit of being able to provide the technologies at one place, social interaction between users and a well-educated staff. But the creation of an inspiring work environment is becoming more important than ever.





III. 13 - Rolex Learning Center by SANAA, Lausanne, Switzerland

the evolution of the library

The library stands at the brink of a major revolution. At no point in time have there been as many changes in every aspect of the library from the display, over storage of books, to the book itself. In a historical perspective the library as an institution for preserving and contributing information, has undergone a series of changes; both physically and in its role within society, but never at the scale and pace as at the present moment.

To have an understanding about the future of the library this chapter will shortly look into the evolution and thereafter have a look, at what ideas are present for changes the library should undergo in the near future in order to survive the rapidly changing image of the availability of information.

the past

The oldest known libraries dates back and beyond ancient time, and the function of storing writings dates back as early as the city-state of Sumer (4th millennium BC) [W. 1]. But the history of the library as we know it today began in ancient Greece, first with institutional records kept as archives and later with private and personal libraries, which contained both non-fiction and fiction books. These traditions were passed on to Rome, which by the time of Augustus had the first kind of public libraries near the forums. But it was only the very few, who had access to information kept here, even though it was considered public, and there do not seem to have been any direct access to the stacks of books. These libraries of the Roman Empire were in fact not particularly erected for the public, but erected as each succeeding emperor strove to open one which outshone the one of his predecessor as a mean of displaying power and wealth.

The same goes for the private libraries of the aristocrats of the Roman Empire. These libraries often contained documents that were never read by the owner, they were purely for the display of power, wealth and knowledge. The library of that time was mainly a book depository

as the Greek word for library *bibliothèkè*, a combination of *biblion* (book) and *thèkè* (storage place/depository), which literally means book depository, indicates. Secondary it was a mean of withholding and showing the hierarchical structured society. [W. 1]

After the fall of the Western Roman Empire the design of medieval library architecture reflected the fact that the documents kept here were precious possessions. Even though the architecture was developed as a response to the need of security, with the documents chained to the shelves in well-lit rooms, the monastic libraries still lent and borrowed books from each other. This meant not only having another piece to read for the librarians, but also an enrichment of the library's collection, because while the book was in their possession, it could be copied. This is the first time we really see the library function as more than just storage facility, but as the distributor of information and knowledge within the society, even though it was still only the few enlightened people who had devoted their lives to study, write and copy the religious documents. [W. 2]

In the 15th century, with the invention of the mechanical movable printing by Johannes Gutenberg, the bookmaking, and thus the accessibility to information, was revolutionized and especially the Gutenberg Bible effected the establishment of new libraries. Up through the 17th century the continuation of the development of bookmaking provided an increase in the accessibility of knowledge similar to what is seen today. The book had become cheaper to produce and thanks to the revival of nationalist and renaissance thinking, this proved to be the golden age for the library, as more cities were inclined to build libraries. But not only the cities build libraries, also cultured upper-class citizens with philanthropic visions build personal libraries. These were also opened for the public, even though it was only to a very selected group of academics and endowed citizens. From the outside, these buildings expressed a communal cultural identity and history by incorporating neo-classicist architecture, while they from the inside acted as symbols of power and potential of society. [W. 2] and [Werf, 2010]

It was not until the late 19th century, that libraries truly became accessible to a wider public. As a result of the Dewey Decimal Classification (DDC) system, books were placed in a universal order and, more importantly, for the first time placed on open shelves. Now, it was possible for the public to access unrestricted materials for a large possible purpose, and especially education benefitted from this. Also important for this period is the fact, that many of these libraries were realized with tax money, which meant, that the ownership now truly

was community-based and their collections could be seen as a reflection of a communal knowledge and culture. The truly free library was born, and access to information bettered and advanced the democratic society. [McCabe & Kennedy, 2003] and [Werf, 2010]

The paradox though was that these immaterial systems of collecting and cataloguing have largely remained the same the last 100 years, while the physical manifestation of libraries has undergone an evolution following the progression of the society from being (neo-) classicist houses of power, over industrially built equalitarian houses of knowledge, to the present-day open houses of cultural diversity. [Werf, 2010]

the present

Today's world witness a second major revolution in accessibility to information allowing infinite access to all information from anywhere through the digital medias. Huib Haye van der Werf says in the introduction to the book 'The Architecture of Knowledge': "These great shifts in the accessibility to tools for location, contemplating and producing information have altered the knowledge landscape from a vertical hierarchy to a more horizontal perspective." [Werf, 2010:11] This brings with it questions about the role of the library in society. It sits in the middle of all these changes, and inevitably plays a role within this evolution. It is not only a symbolic institution that conserves and distributes information, it is also an extension of the public realm. Huib Haye van der Werf says: "Therein lies a task to be responsive and dynamic, because not only is the physical presence as public space questionable, but its immaterial reality is debatable as well, as it either stands at the brink of a new frontier, or at the point of disappearing." [Werf, 2010:11]

The library still acts as a symbol of the power and potential of citizens, and it is still the location where people meet and cultural identity is created, but this is not the exclusive environment for this task of empowerment and enlightenment anymore. At any time in the public realm, everybody can browse through the immense amount of information on the internet. As a consequence of this, the necessity of a physical location could be argued to become less significant. [Wiel & Bey, 2010] and [Werf, 2010]

The public space ventures inside the library, which thereby becomes an extract hereof, and at the same time the functions of the library as



III. 14 - Stockholm Public Library by Erik Gunnar Asplund



III. 15 - Phillips Exeter Academy Library by Louis Kahn, Exeter, New Hampshire, USA

an information distributor expands beyond the library's physical location through the digital medias. This is turning the walls of the library itself into a formality and offers a view of a new frontier.

It could be argued that the physical building is and always should be an important place for public gathering, information and learning, but more and more of the knowledge gathered and produced here expands beyond the walls of the building. This takes the library into a new metaphysical territory of public space, in which information and knowledge collectively is produced and consumed. Nevertheless, such a departure from the physical manifestation of itself without considering the relationship here to makes its function in society questionable. [Werf, 2010]

As Huib Haye van der Werf says: "This shift in production and consumption of knowledge assigns both the architect as well as the commissioning body of a library the task of contemplating alternative architectural programs for the changing function of the public libraries." [Werf, 2010:12-16]

the future

In the present research concerning this issue the discussion about the function of the library in society seems to lead towards a shift – a shift from storing and distributing information and knowledge to the production and curation of information and knowledge. And a shift towards a more versatile institution that focuses more on the public functions like the possibility of random encounters and knowledge transactions between people in the physical public space. But it is also discussed, whether the book as a printed volume of paper and ink is on its way out because of the mass-bombing of digital information or in which way the library should deal with this.

The opinion in the research establishment seems to be that the book is on a retreat as the main source of storage of information and knowledge, but not that this will remove the importance of the library as an institution. The library must embrace the digital era and allow the digital media to be part of the library institution on the same level as books.

In 'The Learning Jungle' the architects Rients Dijkstra and Jason Hilgefort describe the library of the future as such: "The Library of the Future is not a building. It is a concept ... The Library of the Future must be an idea on how to help the book survive the onslaught of the new media; and allow the graceful retreat of the book as the dominant medium for the storage of knowledge, art and fiction. By giving books

"We need a library where the distinction between digital media and books no longer exists."

(Dijkstra & Hilgefort, 2010:69)

a new meaning, they will form a vivid background to the growing offerings of digital media." [Dijkstra & Hilgefort, 2010:67] And they continue: "The biggest threat to the current library is its failure to integrate – i.e. treat the digital section of their offerings in the same way as books. ... We need a library where the distinction between digital media and books no longer exists." [Dijkstra & Hilgefort, 2010:69]

The library must also free the books from the shelves, so they can mingle in the public space like the digital information in the public space of the internet. And by this also free the librarians from organizing books to their natural role as curators of knowledge and learning.

Industrial designers Ester van de Wiel and Jurgen Bey describe, in 'Public space as public library', the role of the librarians as the authority who judges the vast information available in the immeasurable space of the internet: "what we miss here is the critical authority who can tell us how we should judge that information. Real knowledge only becomes available provided someone can formulate the research inquiry precisely and someone can assess which information is worthwhile and which is gratuitous, coincidental, untrue." [Wiel &

Bay, 2010:45] But they still see the qualities of the physical habitat of the library, and describe the library as an enriched environment where instant access to all information is present, while random encounters with others is possible: "In our vision, the library of the future will not just be literally, and certainly not exclusively, a book depository. What will remain is its physical character – a place where encounters can take place – and its symbolic meaning: the democratic right of free access to knowledge for everyone." [Wiel & Bay, 2010:44]

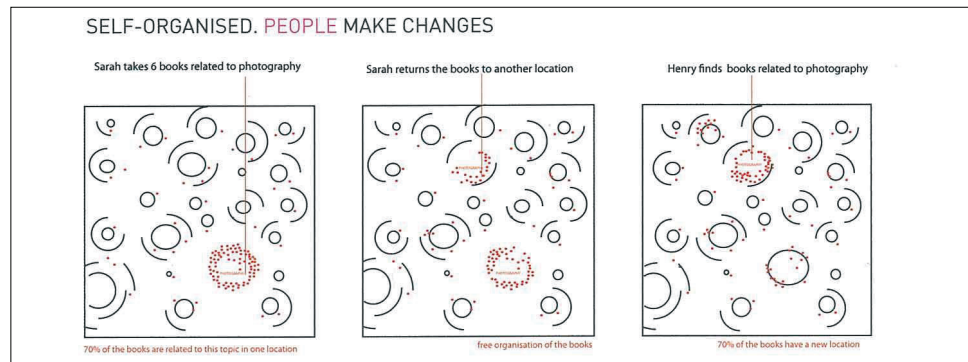
One of the main issues withholding the libraries from embracing the digital era and freeing the library to be a place for discovering, consuming and producing knowledge is the outdated categorization system. The current library is not flexible enough for this to happen. The space is too defined by the tying of books to fixed shelves, the finding of books is often too confusing and as said before the digital and physical information are completely separated. Many are working on implementing digital technologies to make the spaces easier to access, but maybe the implementation of the digital should rather augment an already diverse physical space by making it more playful, challenging and interesting. As the director of the Netherlands Architecture Institution Ole Bouman puts it: "...we see an incredible number of people trying to adopt these new technologies to make new environments smarter, smoother, more neutrals, and capable of being monitored. However, in contrast, there are relatively few trying to use technologies facilitating smart environments to enhance people's experience, to make it more complicated but also more challenging." [4D, 2005:16]

Rients Dijkstra and Jason Hilgefort talk about the idea of replacing the categorization system with a system of RFID chips as the first step in freeing the library to embrace other functions than the depository of books. RFID chips in each book will liberate them from their shelves and let them mingle in the public space of the library by the possibility of locating books digitally. This means that one can enter the library and get instant directions on your cellphone on, where the desired book is at that moment. This frees the librarians from the tiring detective work of locating literature. It also gives opportunity for the embracement of the digital media by for example web-like search, user preferences, user ratings and instant links to other similar information back and forth between digital and physical medias. This opens the availability of a new and more dynamic organization of medias – a self-organizing system that will shift the way organizing is perceived by being adaptable and allow users to change the location of the media. It can for example dynamically adapt itself to reflect

Ill. 16 - Rolex Learning Center by SANAA, Lausanne, Switzerland







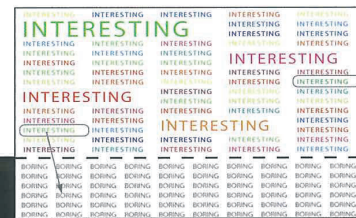
III. 17 - Self-organised library concept

THE LIBRARY FOCUSES ON THE MOST WANTED BOOKS

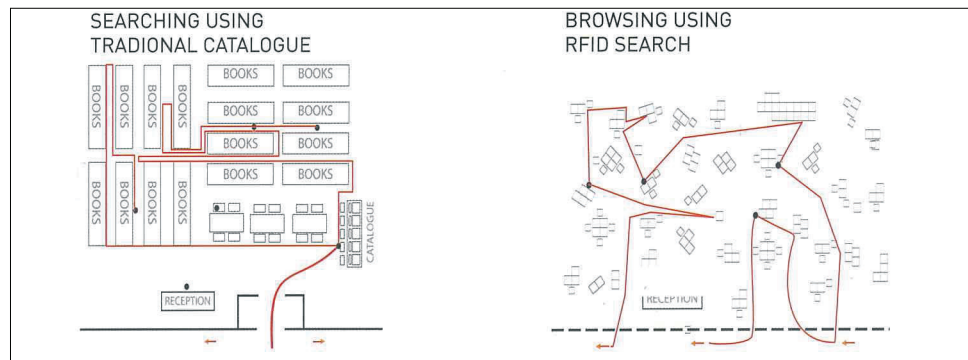
TRADITIONAL



FUTURE



III. 18 - Popular books and medias move forward, and less readen moves to the storage



III. 19 - New ways of programming the library due to RFID

the different media used during different seasons by bringing this to the front of the library while pushing the unused medias to the background. It also provides the opportunity of encounters with others of same interest by the availability of locating books that are in use, and that way provide a better opportunity of the sharing of knowledge between people in the public space of the library – thus creating random social encounters, that might not had happened otherwise.

What Rients Dijkstra and Jason Hilgefort propose is a library with the desired qualities of a park environment with assorted media lying around, and where users may chat, lounge, read, listen and stroll freely among knowledge and each other. A library of, what they call, the micro shelf, which would allow for a variety of media, flexible of both storage and space, and can be adapted to the wishes of the users and the demands of space. This could take form ranging from series of shelves in the background to user-organized piles of books and ever-changing small enclosures. [Dijkstra & Hilgefort, 2010]

Another approach to the library of the future could be to look in to the places in which reading occurs, especially public reading. Both because this is the all-important act that congregates the library and also the fact that books do not possess the inherent and intrinsic capacity to cause publicness, as many had assumed. [Velden, 2010] Like philosopher and professor Bart Verschaffel expresses it: "Let us therefore consider the library, not as a place where books are stored and borrowed from, but, first of all, as a place and an environment for reading." [Verschaffel, 2010:86]

In his article 'Guessing the Future of the Library' he investigates the places in which reading occurs, and he considers under which mental stage what kind of reading occurs in different environments. His conclusion to guessing the library of the future is that of a 'reading palace', where people will visit to read like if they go to a music concert. An environment with different reading situations from café, bookshop, scholar room, sitting room with a fireplace and piano music, study cells, to a roof garden to read while walking or sitting next to the fountain, etc. He writes: "The Palace can provide the conditions for an intense, concentrated, rich, and diversified reading experience. What is even more important, however, is that in this way the form of the 'vita contemplativa' remains publically represented in the modern city as a possibility." [Verschaffel, 2010:93]



Ill. 20 - People 'hanging' out in a park



Ill. 21 - The qualities of the park are drawn into the library

“What will remain is its physical character – a place where encounters can take place – and its symbolic meaning: the democratic right of free access to knowledge for everyone.”

[Wiel & Bay, 2010:44]

conclusion

From this it appears that the library through evolution has been a representation of the society and values within. Therefore, a change in the organization and functions of the library is inevitable, if it is to survive. The library must embrace the digital era and entangle itself within, so no difference in digital media and books are present. It appears that the library as an institution for distribution and storage of knowledge will move in the background for the functions of producing and managing the vast amount of information and knowledge in any form of media. The library will still be the main function of storing and exchanging knowledge and thereby fabricating culture in the modern society. The physical presence of the library will still be important, but it will move from being the caretakers of knowledge to being a public place for producing knowledge and for mingling and browsing through both the digital and physical knowledge of the internet and the society, and very importantly existing in society as a public space for the possibility of human encounters and sharing. The book will probably remain as the main source of knowledge, but will still be considered equally with the digital knowledge. And more importantly it will always act as the representative of knowledge, culture and history in the physical world. One could imagine that with the digitalization of literature, books will gain the same appreciation as vinyl records have after the digitalization of music.

The architecture of the future library should allow flexibility and dynamic changes where the possibilities of publicness and random encounters are present while at the same time allowing concentration and privacy for the consumption of knowledge .

case studies

In this chapter the aim is to investigate the main developments in the architectural design of libraries, focusing on master references with a particular attention to the more recent experiments within the 20th and 21st century. The selection of libraries will consist of a compilation of recognized libraries from around the world. The purpose of this chapter is to present both the typology of the selected libraries, and the architectural aspects behind the spatial organization.

The Stockholm Public library (1928) by Gunnar Asplund is chosen because of its interesting combination of neo-classicism and beginning contemporary approaches both inside and outside along with being one of the first open-shelves public library within the Nordic. The Philips Exeter Academy Library (1971) by Louis Kahn is represented due to its recognized and famous dramatic atrium and tectonic use of materials. The TU Delft University library (1998) by Mecanoo is chosen due to its innovative form and arrangement. As two eastern representatives the Mediatheque (2001) and the Tama Art Library (2007), both by Toyo Ito, is selected to distinct a Japanese approach of libraries. Also from a present approach the Seattle Public Library (2004) by OMA is selected to represent a pragmatic and contemporary Dutch architecture. As the newest example the Rolex Learning Centre (2009) by SANAA is chosen due to innovative thoughts of library design mixed with different functions, which is also the case with the Multimedia House by Schmidt-Hammar-Lassen Architects dated for 2014.

As to follow up on the previous discussion on the future of the library, the selected libraries pictured in the following text has been subjectively chosen based on both new solutions and by the forward looking perspectives on, how the future libraries are going to function. As an attempt to rationalize the complexity of the library buildings, the functions of the libraries have been dissected into smaller fractions in order to help compare different typologies and designs. The classification and comparison can then be described on the basis of their main differences and innovative sides – resulting in a specific knowledge gathering according library terminology and typology. This will then function as a range of inspiration to be drawn out, in order thereby to select positive elements to candidate the following

sketching and design phase. In the Appendix, the full compound text concerning each library including a presentation of functions and a review on the architecture can be found - along with references used. This following text is based on these individual studies from the Appendix and is going to hold the selected functions up against each other to terminate the overall study. The libraries selected are depicted on the following page.

comparison

As mentioned above, the different elements comprising the selected libraries have been pointed out. Starting the description from the outside areas, the text will then stepwise move inwards and define each separated function of the relevant reference projects. The aspects are presented below:

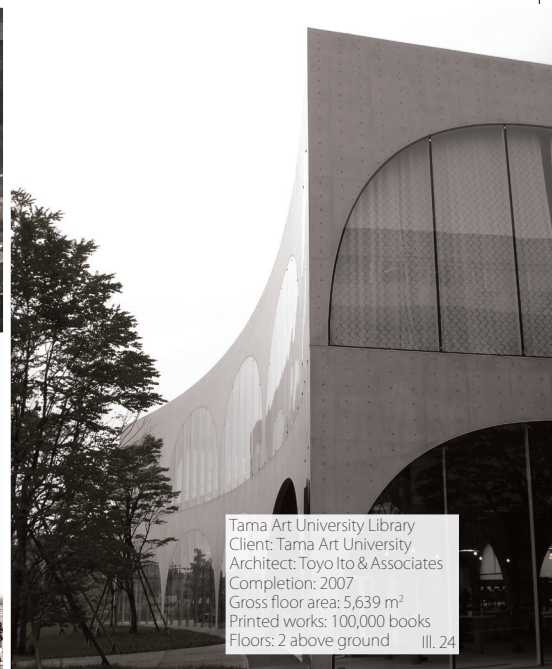
- typology
- facade
- entrance
- foryer area
- book collection
- workspaces
- café
- administration
- construction



Rolex Learning Center
Client: EPFL (Polytechnic University of Lausanne)
Architect: SANAA
Completion: 2009
Gross floor area: 20,000 m²
Office space for: 100+ staff members
Study areas for: 860 students
Printed works: 500,000
Floors: 2 (one is basement) III. 22



Multimediehuset, Aarhus, Denmark
Client: Municipality of Aarhus and Realdania
Architect: Schmidt-Hammer-Lassen Architects
Completion: Planned 2011 - 2014
Gross floor area: 30,000 m²
Floors: 4 III. 23



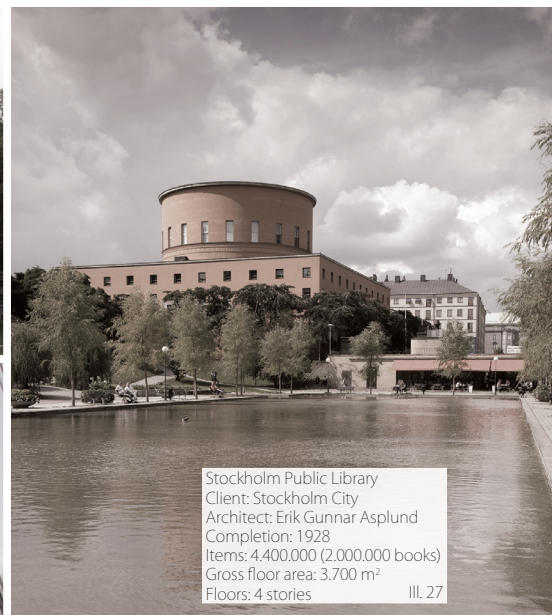
Tama Art University Library
Client: Tama Art University
Architect: Toyo Ito & Associates
Completion: 2007
Gross floor area: 5,639 m²
Printed works: 100,000 books
Floors: 2 above ground III. 24



Sendai Mediatheque
Client: Sendai City
Architect: Toyo Ito & Associates
Completion: 2001
Gross floor area: 21,682.15 m²
Floors: 6 III. 25



TU Delft Library
Client: ING Real Estate
Architect: Mecanoo Architects
Completion: 1998
Gross floor area: 15,000 m²
Workstations: 1000 +
Floors: 4 III. 26



Stockholm Public Library
Client: Stockholm City
Architect: Erik Gunnar Asplund
Completion: 1928
Items: 4,400,000 (2,000,000 books)
Gross floor area: 3,700 m²
Floors: 4 stories III. 27



Seattle Public Library
Client: The Seattle Public Library
Architect: OMA/LMN
Completion: 2004
Gross floor area: Total 38,300m² (incl. 4,600 m² of parking)
Printed works: 780,000 (on opening 2004)
Work space with computers: 400+
Floors: 11 III. 28



Phillips Exeter Academy Library
Client: Phillips Exeter Academy
Architect: Louis Kahn
Completion: 1971
Total floor area: 6,861 m²
Items: 160,000 books
Floors: 9 III. 29

typology

Beginning with the outside the oldest library among the selected, the neo-classic Stockholm Public Library stands out together with the Aarhus Media Space through the use of pedestals, raising the buildings high above the city. Where the plateau and staircases here provides space for public functions and recreational areas through the use of a separate structure, the TU Delft incorporates a recreational outdoor area above its own volume – pulling the surrounding landscape up on the roof scape. On the contrary the Rolex center works with the surrounding landscape by pulling it underneath its volume, creating connecting recreational pathways below the building. Similar outdoor areas are not represented in the other selected libraries; instead the Seattle Library together with the Sendai Mediatheque and the Phillips Exeter Library offers open roof gardens on top of the volumes – emphasizing the positive element of recreational access to outdoor areas for the users of the buildings.

As the first aspect into characterizing the libraries, the overall functions can be classified by either public libraries or university libraries. For this text the TU Delft, together with the Tama Art Library and the Exeter make up the selected university libraries. By also looking into public-serving libraries, the aim is also to study the social aspect of such library-types in general.

In order to determine the different typologies of the selected libraries, the cases can roughly be divided into three main types; a) a traditional vertical stacking of floors – seen with the Seattle Library, the Mediatheque, and the Exeter and b) a low horizontal orientation with the Rolex Learning Center, the Tama Art Library, the TU Delft Library, and Aarhus Media Space – placing the Stockholm Library c) soaring between a mix of the previous two, containing both a horizontal lower element and the vertical cylinder.

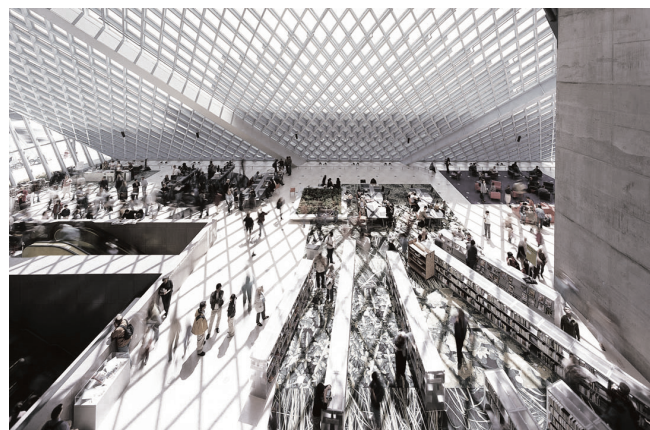
The differences between the libraries are of course caused by different architectural approaches but can also for example for the Mediatheque and the Seattle Library depend on a narrow urban contextual condition – resulting in high-rise buildings – where the Rolex Learning Center for example is located in a mere suburban quarters of the Lausanne campus, creating room for a low landscaped building.

When looking on the varying heights and footprints of the libraries together with different urban or suburban contexts, it is noteworthy to look back on the AUB Library. The AUB shares the similar typology with the Rolex Learning Centre (low large one-story-building), but where the Rolex Centers bulging learning landscape is located within

the campus, the main issue for the AUB is the remotely placement away from the connecting campus.

As with the AAU area and this project in mind, an aspect of height, visibility and recognition-factor of a library from long distances may concern the visual impact and architecture according to developing a building, which can be used as a landmark to navigate from.

Inside the libraries very different spatial principals are incorporated. The Aarhus Media Space almost tents to simulate a large covered public square, using only one large, and high-ceiling room for the main library functions. The use of urban elements can also be seen in the Seattle Library, where the uneven stacking and incorporation of many functions upon each other, creates large covered squares and many varying heights, terraces and niches. In terms of the selected libraries, it can be stated to resemble a modern shopping mall typology, with its use of large covered areas providing both shopping (in this case library functions), recreational areas and also parking underneath. The Rolex Learning Center also uses many of these spatial elements. Here, the movement through the building is though not upwards but around a landscape of different services and functions. With the Mediatheque as a range of compact open plans shattered with functions, the TU Delft stands out as a 'one' room volume – though providing much more open space and horizontal orientated functions than for example the Aarhus Media Space. As with the Exeter and the Stockholm Library as the oldest libraries, these resemble a more traditional focus on library-related aspects together with the Tama Art Library.



III. 30 - Seattle Public Library and its large open browsing area



III. 31 - Seattle Public Library with it's transparent skin

facade

According to an architectural aspect, the facades of the libraries has been assessed in order to determine the function and means by the appearance of the selected buildings. From the closed facade of Stockholm Library to the completely open glazed facades of the Sendai Mediatheque, the aspects of transparency maintain. Apart from Stocholm library and the semi-open appearance of the Exeter Library, all the other libraries possess large transparent facades. As mentioned in the history about libraries, the perception of libraries (and other public institutions) through the last century has moved in terms of a protective 'shell' towards a more democratic revelation, meaning that the terms of transparency – both in systems and more literary speaking – has demanded a relieve within the appearance of the public buildings as 'shielding' enclosures. At the same, time the opening up of the facade has been made possible by innovation in materials and construction, but may also have been of use for the libraries, in order to translate the function of the library out through the facade to the public and its users as a service manor.

entrance

When looking at the entrances of the selected libraries, these can be divided into two types; a traditional main entrance and a diffuse open access from many sides – allowing visitors to seep inside from all sides. With the first type, along with the neo-classical entrance of the Stockholm Library, the TU Delft works with an impressive 'staged' entrance, carved out of the grass landscape. The Exeter also works with one main entrance only. On the contrary, the Rolex Center together with the rest of the libraries stands out keeping the first floors open from many sides, with no demarcated entrance – resulting in a very informal approach and easy access to the building. As with the enclosed appearance the incorporation of de-centralized entrances is also a step away from the typical neo-classic trend, which characterizes many old libraries of the 19th century today.



III. 32 - Sendai Mediatheque and it's 'open' ground floor

lobby/foyer area

With the foyer area of the Tama Art Library only sheltered from the outside by a floor-to-ceiling glazed façade, the sloping ground of the lobby acts more as a public transition area between outside and inside. From the entrance areas direct access is provided to the reception by only one door, acting as a sluice entrance to the library areas. As with the rest of the libraries, it is generalized that the public reception areas are placed at the bottom of the buildings, acting as the welcoming area together with service and information guidance. The lobbies are also characterized by the use of lounge areas and furniture for waiting visitors along with toilet and service facilities.

The TU Delft is comprised by one large four-story lobby room binding together the entire building, only divided by the large cone housing the reception. In the Seattle Library the level of the context is two floors higher on the backside of the building resulting in different levels of entrance. This has resulted in the use of a three-story high room with large escalator bringing the visitors up to the main level. The sluice aspect is also used in the Exeter library, where the lobby is made

up by the impressive atrium at the first floor. Here visitors encounter the reception desk as the first thing when entering the room from the cornered spiral staircase. The use of a large central staircase is also incorporated in the Aarhus Media Space, connecting all visitors through a large main reception area from below the pedestal.

At the Rolex Center the reception area is located slightly up the hill when entering through the main court yard. Here the 'floating' landscape reveals itself taking the visitor past the information counter and into the white scenery. Only the Stockholm Library is represented with a slightly smaller reception area located at the right hand of the entrance. As with the general function of a foyer, the many different lobbies shown in this case study, is created in order to provide an informal open atmosphere capable of dealing with large amounts of visitors at the same time, though providing a certain degree of security towards the collection by either incorporating the use of sluices or detectors placed at the exits.



III. 33 - Rolex Learning Center with curved interior spaces



III. 34 - Stockholm Public Library's main book collection

book collection

Within the library terminology there are two general types of collections. One collection which is on display, and one, stored away, often made up by rarely loaned volumes, broken or outdated materials, and lastly significant volumes of great importance, not suitable for public loans. [AUB]

As the main collection of volumes stands as the key aspects in the general understanding of libraries, the actual way the books and medias are kept tends to vary from library to library.

The Phillips Exeter Library represents a traditional way of libraries, with the collection on display located on long straight rows of shelves and a more compact collection stored in the cellar (the same appears with the AUB). The separate book shelves create a monotonous, repetitive order on each of the four floors they cover. The same type of shelves is used in the Mediatheque and in the Tama Art Library – but in the Tama library, the shelves contribute with a more dynamic order due to the alignment of the construction, creating interesting curved fans

of shelves. In the next described libraries the book collection are used in a more three-dimensional way, working with upwards movement between the books: In the TU Delft, the lending collection has been stacked on a four-floor tall wall, run through by narrow pathways and staircases. Here the different books create an enormous visual 'wall painting' of colors in the tall and open foyer hall.

This aspect was also used in the Stockholm Public Library, where the books are placed in a circular pattern, stepping upwards and away from the main book hall – creating almost an ancient arena of books. In the Aarhus Media Space the upwards moving motion is resembled in a 'media ramp' comprised by a large plateau stepping upwards, containing both books and other media. The movement upwards is emphasized in the Seattle Library, where the main collection is located on a four-floor ramp spiraling up around an atrium. The idea with the spiral is to create a continuous connection between the different literatures providing an on-going supply of new shelves for new requisitions.

workspace

The workspaces characterized by the Stockholm Library, consist of a traditional reading hall with rows of tables and chairs. The workstations are surrounded by books, and light is provided from highly placed windows. The Exeter library provides the traditional shielded carrels, which are not seen in the other selected libraries. These carrels are located next to the walls with high windows and isolated quietly away from the atrium by the book shelves. This provides good light qualities for studying. In the Rolex Center, the Aarhus Media Space and the Mediatheque, the workstations are located in clusters around the entire building. These clusters differ between enclosed glazed boxes for quiet studying to regular group tables into more informal furniture formations for relaxed work. Both the Seattle and the TU Delft libraries also provide different large clusters of work areas. The TU Delft mixes between a very large area for students, with rows of tables and computers to the more intimate and quiet work stations provided by the cone in several separate floors. The packing of the Seattle func-

tions upon each other provides a large covered internal urban square, which also provides hundreds of workstations with internet access for the visitors. These standard workstations are supplemented by a range of different lounge areas with high café-chairs and -tables, and comfortable couch areas between different functions. With a large focus on medias other than books, the Tama Art Library and the Mediatheque especially offers interesting areas for viewing digital audio and visual media. These areas are characterized by more intimate surroundings with low ceiling height and comfortable chairs, together with a placement away from window glare and sun reflections. These two libraries also offer large areas of lounge furniture for the only purpose of relaxation and stay within the building.

On top of the book spiral in the Seattle Library the entire floor is reserved as a reading hall. Other traditional enclosed reading halls are also found in the Mediatheque, on a raised level between the two book collections on third and fourth floor and in the wing of the Stockholm Library.

As for visitors' browsing and service areas, the Stockholm Library uses its main book hall, which is provided with different counters giving assistance and information. In the TU Delft this is provided by the reception area under the cone, as well as in the Exeter, but in the Seattle Library a large area on the fifth and sixth floor is reserved to interaction between librarians and patrons. This creates an immediate feeling of easy access for help and guidance. The same 'close' services are seen in the Rolex Center, the Tama Art Library, Aarhus Media Space and the Mediatheque.



III. 35 - Sendai Mediatheque with public work stations

café

Within the Rolex center, the different cafés located around in the curved landscape of the building, are situated on small plateaus with different step heights in order to follow the sloping floors as much as possible. This creates small islands which are circled by a glass railing, creating different spatial divisions within the otherwise open hilly environment. In the Mediatheque the main café is located on the ground floor, in a corner next to the entrance. Together with the large glazed facade this creates a well-lit environment and a lot of visual overview, both to the inside and outside. In the Aarhus Media Space, the main cafés are located in the pedestal pointing towards the harbor. This creates both great views to the harbor front and allows for outdoor service in summertime. The cafés in the Seattle uses the large differences in heights to create interesting overviews across some of the downstairs activities, at the same time providing visitors with the possibility to bring the books to the café area.



III. 36 - Seattle Public Library's lounge area



III. 37 - Administrative floor of Sendai Mediatheque

administration

For staff working in the administration area of the Mediatheque, the office workspaces are located on some of the same floors, which are accessible by visitors. In order not to close off these offices entirely, organic-shaped semi-transparent walls have been incorporated. These walls create dynamic pathways and corridors and brakes the rigid lines of the building. Such organic shaped curved walls are also used in the Rolex Center to shield or demarcate office workspaces for staff members. In the TU Delft the staff offices are located in a cluster in one end of the building, which is also the case with the Tama Art library, where the staff office areas are closed for the public. In the Seattle Library the administration is provided with a placement at the very top of the building allowing offices and meeting rooms with a view to the nearby harbour. This location is also incorporated in the Aarhus Media Space, where the entire office section and administration is placed in the polygonal upper volume of the building. In the Exeter and the Stockholm library the administration is provided within the lower parts of the building, in separated areas.

construction

In continuation of the spatial matters of the libraries the structural aspects can be derived to look at how the structures underline the spaces within the buildings. Both the Stockholm Library and the Exeter Library use masonry in their facades, resulting in heavy enclosed facade envelopes. Inside the dome of the Stockholm Library, the large plastered walls reveal use of large rocks instead of bricks. The large span of the dome is hidden away under the rendered roof but is carried by an arched structure supported by beams and trusses in steel. On the contrary, the inside of the Exeter is constructed with large reinforced in situ concrete structures, creating the large spanned atrium. Also in the Tama Art Library, the use of reinforced in situ concrete has resulted in a range of varying arches following curves around the library, resulting in both stability for the curved walls, and a division of the library space into smaller areas. The Rolex Learning Center also makes use of concrete, but here the large spans of the sloping landscape is held up by the use of pre-stressed cables, which then have been encased in concrete and then polished. These large spanned arched concrete slabs then carries the similar shaped roof on thin steel columns. The very roof is made out of a lightweight steel-ribbed structure in order to keep down the weight.

The same type of steel-ribbed structure is also integrated within the concrete slabs of the Sendai Mediatheque. Here, they span the entire floor areas connecting them on the many horizontal tubular steel structures providing large open areas while holding up the entire building. The steel columns are preassembled and welded together by large steel pipes and then later on put together in sections during the erection of the building. The TU Delft Library also uses a construction of large steel pipes to carry the large spanned open central room of the building. Here, the large characteristic concrete cone underneath - acting as a large column - is carried by a range of triangulated steel tubes allowing for an open ground floor within the reception area.

The Multimedia House in Aarhus stands out as the construction is a more traditional column and beam construction made out of concrete. To support the straight rows of large squared columns these are supported by nine large concrete cores containing elevators and staircases - protecting these from fire. Here the large number of straight columns acts as dividing objects within the large otherwise open room.

As the last library, the Seattle also stands out with its load-carrying structural facade grid. The grid is constructed by large squared hollow steel columns. Together these create a strong and dynamic facade

carrying the entire building. This gives the possibility to obtain very large spaces and squares inside the building. To divide these large spaces every second floor is constructed as an enclosed box providing smaller spaces and niches for work, books etc. The rest of the floors are then located on top of these enclosed volumes making these floors completely open. Binding together the whole building is a range of concrete cores with staircases supporting the large escalators otherwise running through the library.



III. 38 - Concrete structure of the Phillips Exeter atrium

conclusion

As this analysis acts as a brief specification on the libraries, it is not concerning the contextual placement of the libraries, and the interaction to the context, thus focus will be held on the organization of functions and spatial features. The text will try summarizing on the aspects enlisted in the study, in order to specify and provide a potential design brief for a future library.

Beginning from the outside, the argument of the use of transparency entails the aspect of opening up to the activities inside. This will reveal the functions of the library to the outside thus emphasizing open knowledge-sharing. In order to communicate the way into the 'knowledge' of the library, the entrance area/areas therefore have to be visual and easy to access from the surroundings. In this report, this feature also circles around the visibility of the library at distance; due to the request of the new AUB library acting as a 'light tower' of orientation.

The different recreational areas enlisted also points in the direction that as well as indoor areas, outdoor spaces will function as an extra offer to the visitors in summertime – also advertising the life and functions of the library to the general public.

Inside the building, the study seems to show the necessity of good overviews from the reception area providing information about functions within. In many cases, the entrance floor also acts as the public square of the building, housing all the public functions, services and informal stays.

As with a public square the rest of the library clings around this central spatial element for example working with different heights, other spatial constellations or city scape making interesting combinations that urges investigation. Beside the traditional library functions the usage and placement of other functions forces the blend of both knowledge and social relations. This would also include areas of recreational aspects providing time for resting. On the other side smaller and more intimate areas are required as a counter-strategy to large open areas.

As both people and activities differ from each other, the aspect of learning craves many different environments for knowledge gathering. Going from completely silent study areas, calm semi-private carrels, to reading rooms, comfortable lounge areas to maybe café inspired areas will provide everybody the chance to find and personalize a request of reading. Regarding this, the library has to accommodate both individuals and smaller groups, especially in terms of the Aalborg University's working model.

Whether the light is a combination of natural daylight or electric

lights the amount should be selected for the different purposes of activity inside the library.

Books can be used as graphical 'pictures' in the library as well as in different spatial organizations as a contrary to the 20th century straight rows of books. The library also has to make room for the incorporation of the two types of collections, which aims on either hidden or shielded display of the collection not in use.

As for the staff office areas, these should be provided with a restricted access, but also contribute with life and activity, which should be incorporated within the design of the library.

Regarding a café and other café-like quarters, these can with advantage be used to create informal areas for studying along with the rest of the work stations.

Finally, the ever growing collections of digital medias urge for an incorporation of modern facilities providing the viewing of many digital medias to be placed within the library. This in combination with upgrading and finding new ways to adapt existing medias to the modern usage of knowledge searching – for example the incorporation of RFID chips in physical volumes such as books, magazines etc.



Before initiating the design process, an understanding of the area has to be conducted. The context analysis will consist of a look into the use of the existing library, accommodated by a vision of how the use of the library should develop in the future. As an addition to this, a mapping of the area will be provided, which will include a climatic as well as a contextual analysis.

III. 39 - University students at work within the AUB

the users

Today modern libraries are in many ways defined by the users. The function of protective knowledge storing has passed, and today the libraries are open to everyone, developing itself into the direction of being a place for social knowledge production, which in the end, places the users as a central piece in the design of a modern library. The following chapter describes how the students use the existing university library, and provides a vision of how the user should embrace the new library.

The use of the existing AUB has already developed away from the traditional library, and is today also used as educational space for the one-year master degree program and Ph.D. students. This has proven to be a very successful mix, and has contributed to bring life into the library, thereby creating a more dynamic space. The library is also being used by the undergraduate students and staff, but the amount of students change a lot during the different semester periods, and has not been as high as the library expected.

The university has a collection of 867.702 physical volumes, a third of which is going to be thrown away when moving to the new building. All the books are ordered by the Universal Decimal Classification (UDC), which is a further development of the Dewey Decimal Classification (DDC), and the system used by most university libraries. At Aalborg University, using the UDC, the system divides all books into ten main categories, which then are divided in ten sub categories, which then again have ten sub categories. UDC uses numerals based on the decimal system to classify their material, an advantage of this system is that it is infinitely extensible, and when a new subdivision are introduced, it do not disturb the existing order. [W. 3] and [FF]

The diagrams to the right shows the level of activity during the week and during a semester, the diagrams are based on conversations with Niels-Henrik Gylstorff, the director of AUB, and should therefore be seen as an approximation.

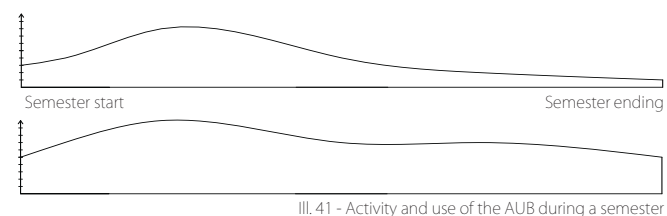
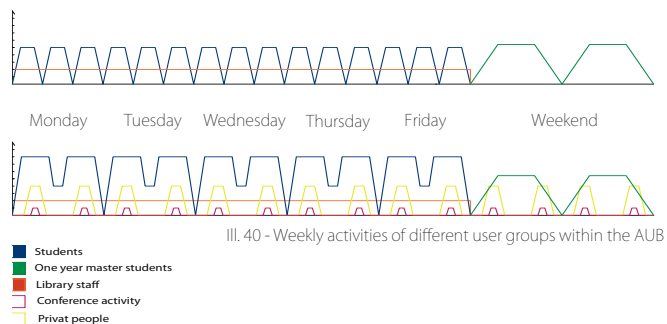
The first diagram shows the activity level during the week. During the week days the users are the staff and students. While the number of staff is consistent, the numbers of students vary a lot during the day. Today students just enter the library to pick up their books, and then leave again, only a few students are inspired to use the library as a place to study. In the weekends the library is used as education space

for the one-year master students.

The second diagram shows a vision of the activity level for the new library. The important thing to notice here; is that the number of students is higher, and they are inspired to stay in the library for a longer period of time. As an addition to that the library should provide conference facilities to private companies, which could also contribute to a communication between these and the students visiting the library. The last initiatives is to get private people to use the library.

This diagram shows the activity level during a semester. Here the important thing to notice is that the activity level change a lot during the semester. This is due to the library mainly being used in the initial face of the students project, when the students need to gather information.

The last diagram shows the vision of the activity level during a semester. The vision is to create a higher and more consistent level of activity during a semester. This should be done by creating inviting and interesting spaces and by introducing other than just library-related functions.





mapping

The mapping is an investigation into the important aspects of the surrounding area, and should in the end provide an understanding of the university area.

The chapter will contain six investigations: an overall distribution diagram, a close-up distribution diagram, four sections through the surrounding area, a flow diagram and finally a sun and wind diagram.

These investigations accommodated by site visits and photographs, should provide the contextual knowledge needed to start the design process.

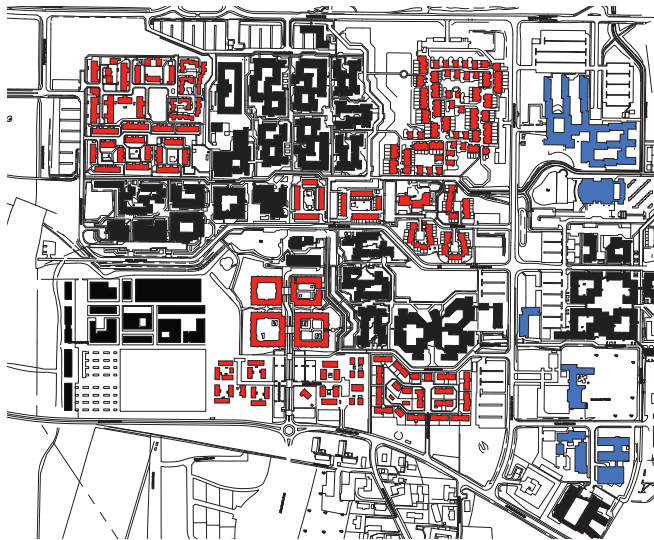




III. 42 - Panoramic view of the site



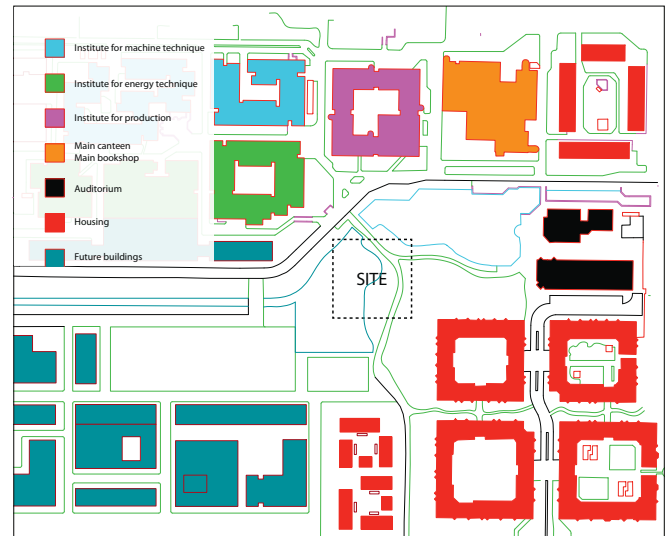
III. 43 - Panoramic view from the site towards north



III. 44 - Aalborg University campus: Black represents AAU buildings, red represents residential housings and blue represents commercial business.

distribution diagram

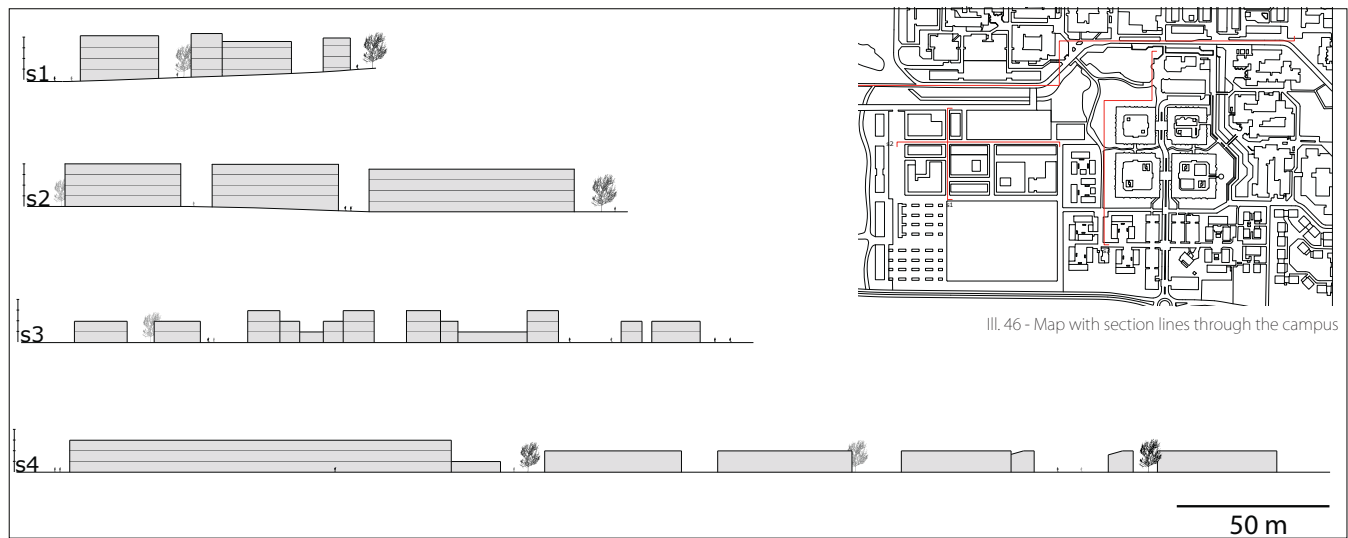
The diagram shows how the different functions (university, residential and commercial) are distributed in the campus area. The main functions in the area are university and residential buildings mixed with a few commercial buildings.



III. 45 - Aalborg University campus: function distribution

close up distribution diagram

To get an understanding of what the buildings surrounding the library-site contain, a close up distribution diagram of the area is made. The diagram shows that the students' area, is located to the north and east, with the main canteen as the only common building, where students from different faculties meet. Functions situated to the south and west is planned to contain administration.

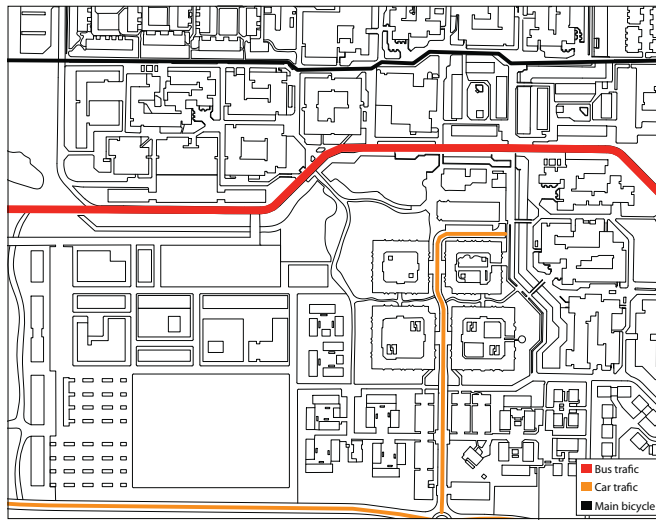


III. 46 - Map with section lines through the campus

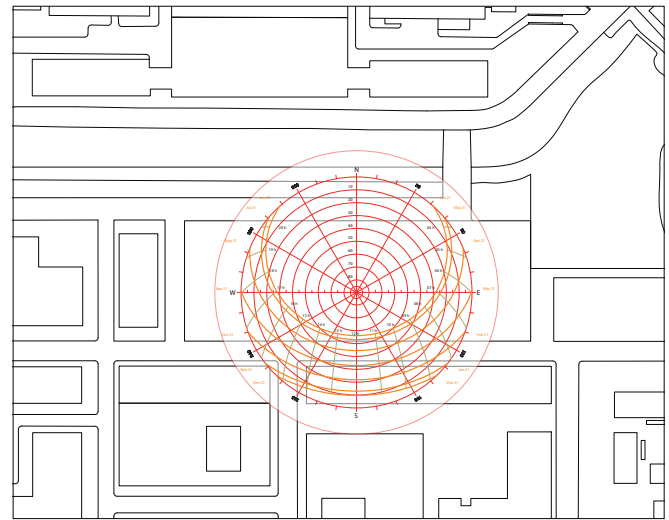
III. 47- Sections through the campus area

heights

The buildings in the campus area are constructed mainly in one or two stories, and only a few of the newer building breaks this pattern. To investigate how the buildings close to the library site vary in height, four sections have been illustrated. Two that investigate the existing buildings in the area, and two that investigate the new area.



III. 48 - Map showing the main flows within the campus area



III. 49 - Sun diagram

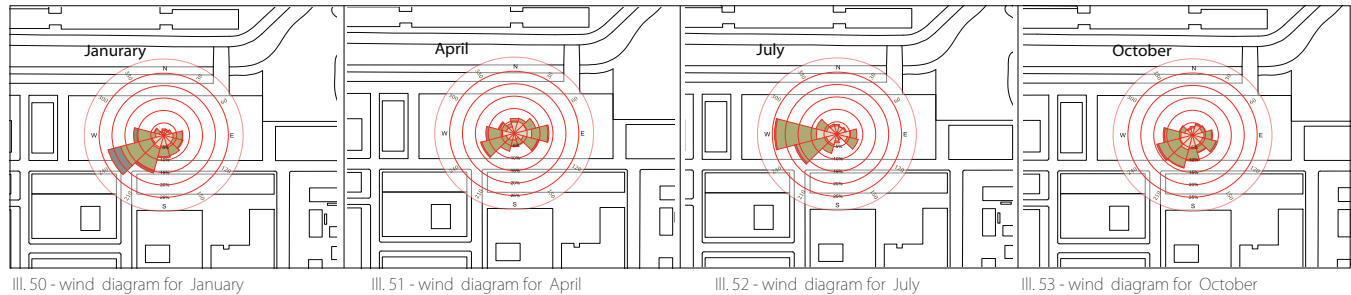
flow

Aalborg university campus is designed as a pedestrian area, cut through by a few main traffic roads. Future plans include a light rail connection directly to the center of Aalborg.

The functions at the campus are distributed over a large area, with pedestrian walkways between almost every building. This makes it difficult to define a main pedestrian flow clearly, although the main canteen acts as a focus point in the western part of the university.

sun and wind

To get an understanding of the environmental factors, a sun and wind diagram is developed. The sun diagram is made to study the movement of the sun during the year. This knowledge base will be used as foundation for studies of shadow effects, which a new significant higher building could cause. The wind diagram is made to get an understanding of the main wind directions, and how they change during the year.



conclusion on mapping

The library site is situated just next to the main bus line, which provides a good connection between the city and the library.

As the campus area consists of buildings in one to two stories, all within the same architectural language, it is difficult to navigate in the area and to specify some points of interest would be obvious. As it is today the only point of interest in the area is the main canteen, therefore it is decided to orientate the building site towards the main AAU canteen. This will provide a better connection between the two buildings, and at the same time create an even more dense area.

The entire campus area is planned to fit within a straight grid, which gives all buildings the same overall direction, an element that will have to be considered when placing the building on the site.

04

Here the results of the investigations manifest itself into an architectural vision for the project. The vision is divided into main themes, which are found important when designing a modern and innovative university library within the AAU campus context.

VISION.

context

The first step of the function of the library should be to enforce the future plans of a compressed urban strip through the AAU campus. With the location it should embrace the visitors of the university as an entrance gate to the campus from west. Within the campus area, the building should function as an easy recognizable landmark enabling the inhabitants in navigating the low streets of the university. With a visual contact to the main AAU canteen, a central placement of the library will contribute to the life around the city strip.

expression

First of all, the library should express and emphasize its function as a place to work and study. Through an appearance of transparency, the function of the library should define a cultural place attributing to diversity with the ever present opportunities of random encounters for knowledge sharing, being it physical or digital.

atmosphere

The overall inside atmosphere of the library should be well-lit and welcoming with a large spatial feeling.

It should at the same time offer a variety of different possibilities of experiences and places to explore.

This should also be incorporated in the general movement around the building, which should allow a three-dimensional access in the infrastructure. To do this, the building should provide interesting views from many sides and angles by the use of different floor and room heights.

collection

The collection of books should be thought in as a spatial and visually interesting element, and by this prepare the book for a retrieval as the main information source to an equality with the new medias, but withholding its symbolic nature for the community, knowledge, culture and history. At the same time a focus on other media is important and new medias should be well-integrated providing access for new types of usage. This should also concern flexibility within the collection, in order to withdraw for example predeceased books in favor to modern media.

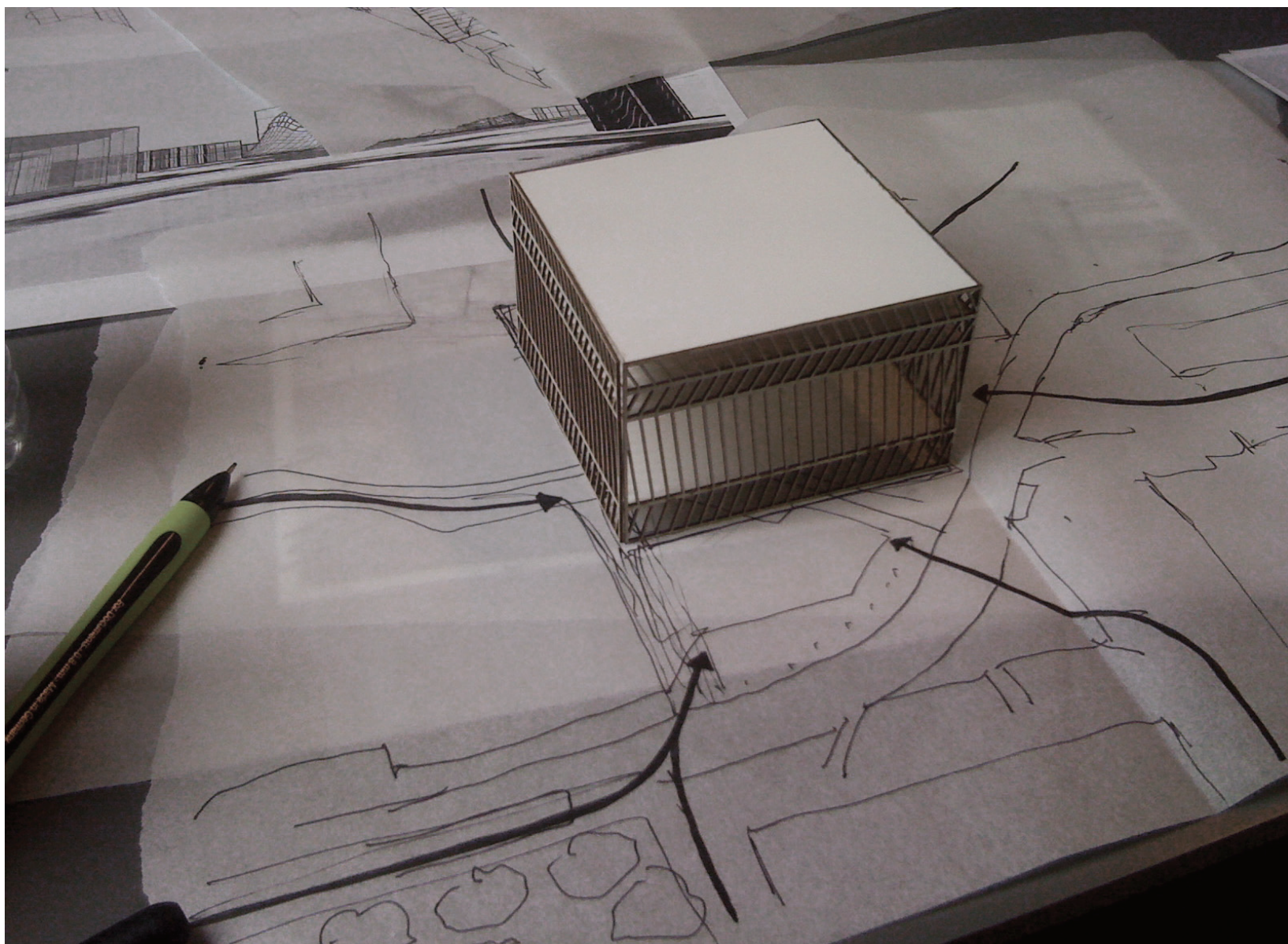
As a gesture to the large collection not on display, this group should somehow be opened up and revealed instead of hidden away in consistency-less cellar rooms.

public aspects

The library should provide a variety of possibilities for informal social encounters in terms of spaces and points for persons to meet. It should be a place for social interaction with a focus on both the function as a place for knowledge gathering but also a site for knowledge production. This should be read and result in different degrees of public space around the building, giving the possibility for incorporation of other user-groups and functions from the local area to create an environment of diversity and liveliness

05

DESIGN
PHASE.



III, 54 - Picture from the design phase

design phase 1

After gathering information regarding the contextual aspects within the university campus and the AUB library the actual upstart of the design proposal is initiated. Along with the writing of the project program, a range of meetings with the executive administration of the library were held. Here specific aims and requests together with wishes and initial ideas were discussed as well as the present Kjær & Richter proposal was deliberated. This proposal has meant that the AUB already possess a detailed and elaborated set of schedules regarding desired room programs, square meters and other related material concerning a future library. This material has been used a outset for this project.

Design brief

The overall design criterion is a new university library with the size of approximately 10.000 m².

The functions are going to relate to the present AUB with a main division between an open shelve collection of different medias and a compact collection system.

Within the project, the number of shelf meters are taken from the Kjær and Richter proposal. These numbers were later supplied by a new measurement conducted by the staff of AUB in part behalf of this project.

The amount of books within the AUB collection holds more than 12 km of volumes. In order to keep track of these vast amount of papers existing within the modern research libraries (the Harvard University libraries for example holds more than 16.000.000 volumes [harvard.edu]) the entire lengths of shelving are processed by dividing with 2,5. This is the result of a general simplification where 40 volumes are set to form one shelf-meter, equal to 2,5 cm pr. physical unit. [harvard.edu]

Within the appendix the entire sum up of the room program and the required room sizes can be found.

Apart from the collection of volumes, the library is going to contain a reception area along with a foyer area suitable for exhibitions. The new library should also hold a larger canteen area and a café for the visitors along with a wide range of auditoriums, seminar rooms and meeting spaces for students, master-students and staff. Then there should be a range of reading areas along with group facilities and other student facilities. As a new element the library should hold a video cinema, able to conduct video projections in larger scale.

The administrative quarters should hold a working staff of around 70 people.

Finally a range of more technical elements should be incorporated ranging from storage facilities to service maintenance.

Compared to the room program developed by Kjær & Richter, a few functions are added to create a modern library, that can fulfill a wide range of different purposes. The two functions added, are the university fitness, which currently is situated in a basement close to the site, and AAU media that also could benefit from a more inspiring environment. The university fitness as well as AAU media is both functions that are relevant to all students, and could thereby be beneficial when aiming to create a gathering point for the campus area.

Location of the library

In the new plans for the library and appertaining administrative buildings, the location of the library area is placed in the north-eastern corner within the group of new buildings. This leaves the library with a long distance of emptiness towards the AAU canteen and the lake. This is regarded as a problem and is assessed to be too far away from the center of activity in order to make the library a central gathering point within the new densification of the area. Therefore, one of the initial acts in the design of the building is to move the site towards the lake in order to create visual connection and shorten the needed distance of transport with more than 75 meters.

Looking at the AAU campus, one of the most distinctive elements of the area is the north-south going grid, which has been applied to the entire university. Around the lake the building volumes are furthermore characterized by approaching of 50 x 50 m blocks including both university buildings and residential housings. Within the new location the surroundings are embraced by having faculty buildings like laboratories, auditoriums, and the AAU canteen on the opposing side of the bus-road, lake, and the residential areas of Klingenberg to the east.

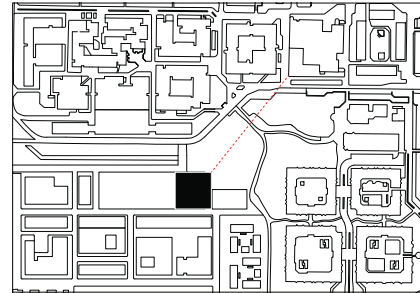
An initial approach to create a simple volume was made taking origin in the 50 x 50 m base. As the building height was set to 31 meters by the authorities (and the wish of a landmark), this as a start was used; resulting in a tall cubed like volume. To investigate the spatial effects of such a volume within the site, an unrefined model in 1:500 was created.

The first initial idea was to turn the library volume towards the angled corner made up by the lake and the road. Here, the library building would come really close to the canteen building, resulting in a 45 degree angle volume compared to the north-south going grid. The idea of this was to make the building stand out; to literally break with the grid, creating its own starting point within the area. As the building elegantly followed the lines of the road and the lake, this position though by time was questioned. This issue became clearer when elaborating for the design, because what was actually the case, was that the building in all its eager to break with the 90 degree design of the grid had returned to the same strict and rigid lines with the incorporation of the 45 degree turn – achieving perpendicular diagonals going north-south.

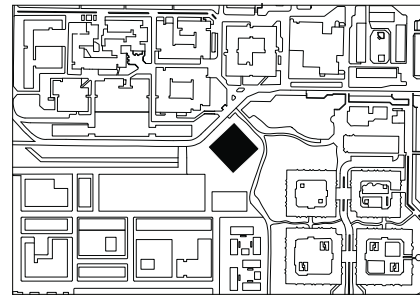
Instead the building was turned back to the regular grid in order to create a more natural composition within the site, accompanying the rest of the context instead of working against it.

Two lines, a north-south going and an east-west going were drawn

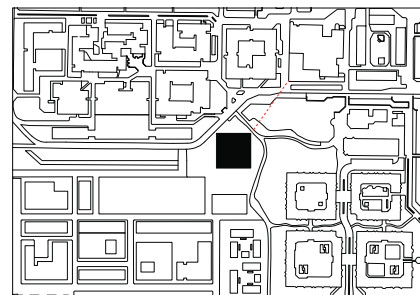
from the present neighboring buildings which initially settled the volume north-east of the residential housing, maintaining the evening sun, while still allowing a six meter wide passage around the building to the north.



III. 55 - Original site for the library



III. 56- Initial location of site



III. 57 - Final location of library

Initial volume experimentation

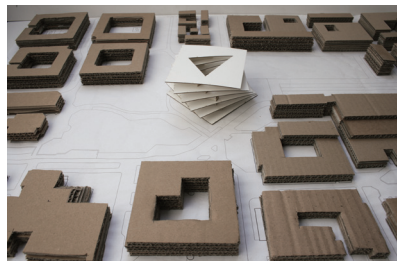
Besides the initial cubic draft volume, tests were made experimenting with various geometrical shapes in order to investigate the spatial effects created by other compact shaped volumes within the site and the context. These tests amongst other featured a cylindrical shaped volume, which compared to the square created no direct element of orientation due to the circular plan. This was the same case with a more organically shaped amorphous volume. As experienced these tests revealed well-established spatial qualities around the buildings, but also showcased a lack of hierarchy and defined spatial character in terms of a potential square around the building. The following experiments were conducted by volumes taking their origin within the initial boxed volume, testing different simple configurations of form-language.

As the initial conceptual ideas for the interior of the library at this time was yet only on the drawing board, a feeling that if the inside of the library should be as impressive and complex as described within the architectural vision, the exterior should not necessarily comprise a vast expressive outside appearance.

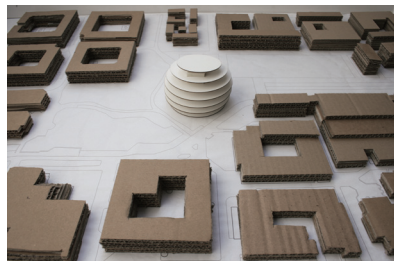
A faceted suggestion proved to be a too forceful element together with a twisting of the box. Another attempt working with a dynamic rounding of the volume proved interesting along with a volume com-

prised of displaced boxes initially inspired by the inside of the Seattle Library showcased in the case study.

Simultaneously, with the initial volume experiences the work with the inside of the library was started, and it became clearer and clearer that the outside appearance should reflect a simple and meek exterior thus revealing the inside through its facade – emphasizing the key library functions kept inside.



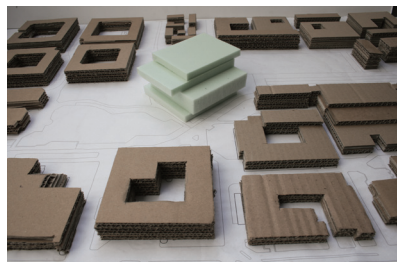
III. 58 - Twisted volume



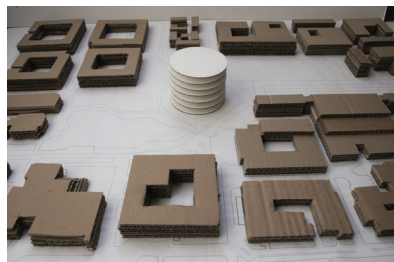
III. 59 - Amoeba-shaped volume



III. 60 - Rounded edges



III. 61 - Displaced volumes



III. 62 - Cylindric volume



III. 63 - Faceted volume

Initial inspiration and ideas

Historic aspects within display of books

When designing a new library one of the first things to be carried out is to investigate the history of libraries, in order to create and build-up knowledge and literacy within the fields of libraries.

In terms of designing a modern library the aspects of research mainly encircled contemporary libraries from within the 20th and 21st century, but, in order to draw on inspiration and references towards the past, a minor search for old and long-established libraries was also conducted. This should contribute to establish a thread within the new library and the evolution and historic aspects of previous libraries.

The architectural research looked for historic and architectural reading rooms and book-displays in order to be incorporated within the design and development of this project. As a summary the three libraries that were found most interesting is depicted here. What they

all have in common is the impressive display of volumes (often in several stories) which is found to be both interesting and useful within this project. Especially, the Trinity College Library attracts attention, by the way books are revealed as integrated within the overall structure. This makes it appear to be the books carrying the building merging the tectonic aspects together with the function of the columns supporting the bookshelves.



Ill. 64 - Austrian National Library in Vienna (1722)



Ill. 65 Old Reading Room (1857)
(former British Library), British Museum, London, UK



Ill. 66 - Trinity College Library (1732), Dublin, Ireland

The user experience I

Work and social aspects

In the chapter of the prospective future of the libraries, one of the main opinions within the research establishment was elaborated being the important aspects and focus on the incorporation of public functions. Both the possibility of knowledge production together with the more social aspects of mingling, browsing and personal encounters are enhanced. In order to attract as many patrons as possible and to offer a vast range of possibilities a list of different ways of 'seeking knowledge' is generated. This is thought to incorporate many types of stay, rest and study situations together with many types of work conditions. The illustrations depict situations that are intended to take place within the new library. The different stages of contem-

plation are in this simplified into the acts of different postures and ways of interacting. The types of work situations are an anticipated mix of functions ranging between concentrated studies of scientific literature and relaxed fiction reading/listening to music. The same regards should be shown to the type of work conducted by students, staff and the public; providing a library offering different sized work-stations, both suitable for individuals and for larger groups.

As regards spaces for social interaction and informal meetings, this should also include the same variation of different types of areas able to offer different moods and atmospheres. Both to people discussing over a cup of coffee or the crowd of students awaiting class should be thought of providing spaces for both silence and lively chatter.

III. 67 - Sketches showing different work situations



Standing browsing and conversations



Standing service and guidance



Focused vs. relaxed



Stools and low sitting possibilities



Regular work stations



Carrel-like stations



Liftable tables (i.e. for staff)



Café-tables and chairs



Different sized work stations



Teaching possibilities



Steps and edges for sitting



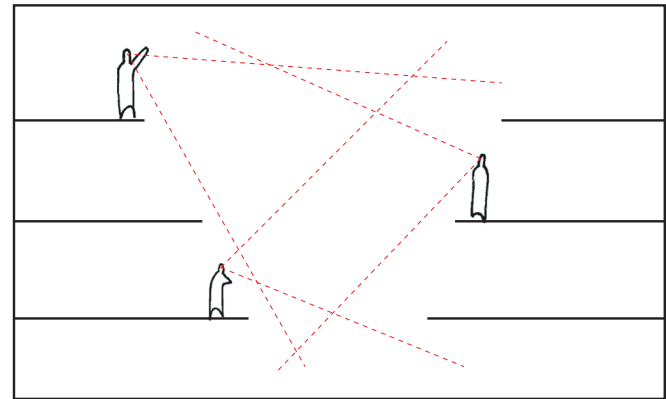
Edges and areas for 'hanging'

The user experience II

The adventure

As the previous text showcased ideas of how the more static activities of the library should take place, a more dynamic approach is thought of the movement around the library. As described in the vision the inside atmosphere and physical frame work inside the library should provide a large spatial feeling enabling the visitors and patrons to explore and investigate. As much as easy navigation and overview should be embodied as much should the patron also be allowed to withdraw to a remote corner with possibility to be absorbed within reading.

As the building should stand out as a landmark in the area, reaching tall over the campus, the integration of general movement around the library would be an unavoidable issue and due to this, doing so could just as well be made interesting. This is also seen in contrary to the rest of the campus area which only encompasses low-rise buildings, and where the movement is much more comprised by horizontal movement. As the best example to this, the present AUB itself stands as comprised by only one floor above ground. Another aspect of the incorporation of height within the new library is the possibility of differences in levels and room heights, which could provide interesting views and visual connections within a pulsating work space – tying functions more together than what is today comprised by the atrium within the AUB building. Finally, the use of visual connections should be used in terms of piloting around on adventures; always being able to steer around by incorporating elements of different hierarchies and points of orientation.



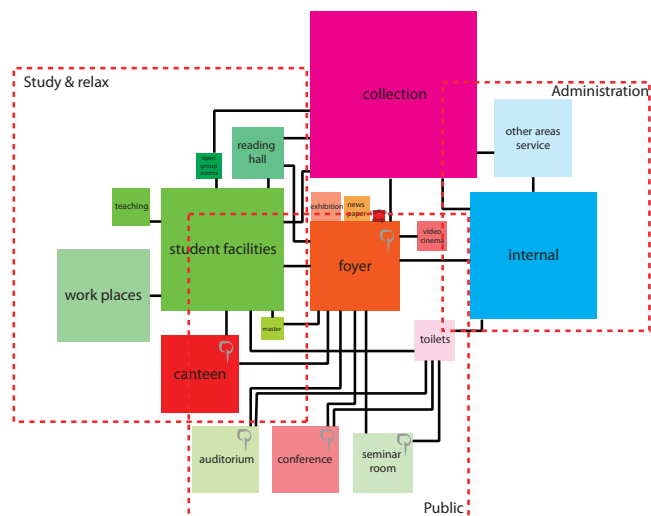
III. 68 - Visual connections created by variations in heights

Programming the functions

Clustering of functions

When mapping the different functions together with sizes and initial connections an intricate diagram emerges. In order to get a comprehension of the large amount of rooms and square meters, the functions are divided into clusters of similar meanings and purposes. The main library functions of keeping the volumes are assembled under the term 'collection'. Areas for study and social encounters are set as 'Study and relax', while the entire functions of running the library are gathered within 'administration'. The rest is collected under the term 'Public', which holds the vast range of the utility rooms, canteen functions together with the large number of seminar rooms, auditoriums etc.

This act creates a small group of building blocks, that programmatic can be seen independent and therefore reorganized according to requirements, activity and outer rations.



III, 69 - Initial room programming

City typology and stacking of functions

After clustering the functions, a number of layout proposals investigating different configurations between each other emerged. Due to rational approaches the public functions in most of the cases were placed in the ground floor, offering small variation between the proposals. Though the incorporation of a public platform in the height offered interesting aspects together with the collection held in the very top of the building, these were decisive rejected as well as placing the administration in the middle, which were thought as quite a barrier towards the study room.

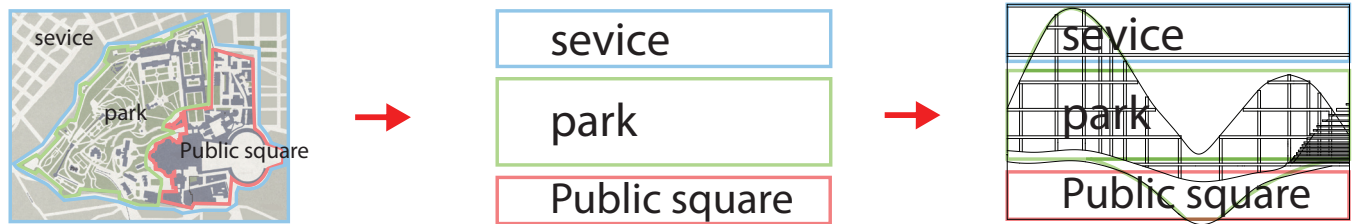
In terms of what and how different wings of the library should be put together, there have in an early stage appeared a comparison of the library functions with the 'city' as a term. This comparison was conducted due to the similarities found in the organization of functions within the interpretation of a stylistic city; seen as containing a town square where major public functions are gathered followed by a more intimate and personal district/park consecutive followed by surrounding functions servicing the city.

This vast abstract interpretation of functional organization found its way into the project as a way of rationally explaining the hierarchy and composition within the building.

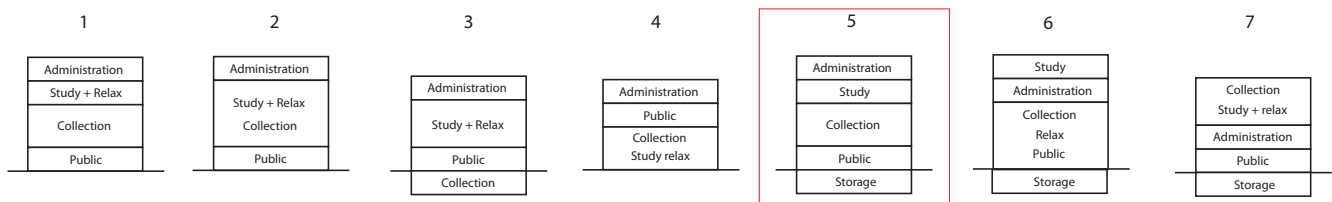
As the organization of the city center was the source of inspiration, the decisive layout of the library was conducted by locating the public functions (resembling the town square) within the ground floor of the library in order to provide access from all directions. The incorporation of the public area in the ground floor will also enable a recreational area within the library suitable for a foyer area and areas for rest between seminars and conferences. It will also provide short access to the canteen areas from the rest of the campus area.

In the new proposal the entire library function is assembled together under one roof incorporating both the collection and the studies conducted within. This is described in the illustration as a park – an aspect and term also used in the chapter describing the future of the library – by the meaning, that this place should provide a casual atmosphere compared to the public ground floor, which should meet a more pulsating and active atmosphere. The main library function should be located in the very heart of the building – thus creating a band through the building, accentuating the stacking of the three functions.

Finally the administrative wing – as the service element – is located in the very top of the building. The administrative staff is the user group to occupy the building most of the time, thus providing these with an interesting view and good lighting qualities. Finally, after a meeting with the AUB it was clarified that the vast amount of employees are going to be engaged with organizational task and are not going to be present as service personnel within the browsing.



III. 70 - Organization of functions within a city is used as reference to the organization within the library



III. 71 - Different initial configurations for the stacking of functions - no. 5 pictures the selected design with the public ground, study and collection in the middle and an administrative wing in the top.

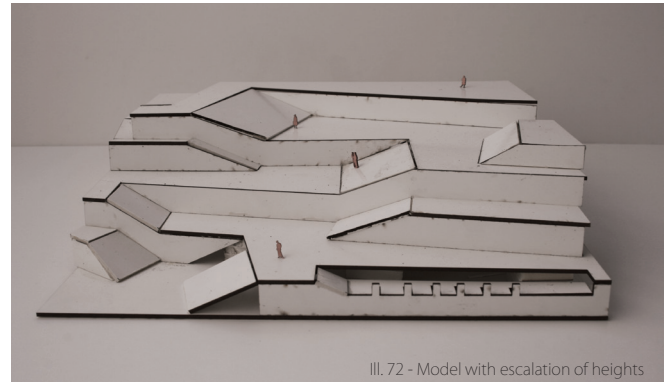
Introduction of the 'landscape' term

In order to investigate the possibilities of three-dimensional movement in correlation with the display of books several conceptual ideas were presented; all engaging the aspect of exploration and movement within heights. Each concept incorporates the possibility of vertical climbing together with different views and interconnections visually and between spaces and platforms. Although these models represent conceptual proposals, they at the same time work with the creation of squares in conjunction with open rooms and more enclosed private areas and niches. To categorize the ideas each model is labeled within three concepts; 'landscape', 'valley' and 'mountain'. Within the 'landscape' term the models are concerning the aspect of possible vertical coherent movement.

The first model works with the escalation of heights within one large room creating interesting and differentiated spaces all the way up to the top platform. It offers different ways of navigation together with the hierarchical incorporation of a square in the low parts and areas for intimate studies and immersion within the higher levels. As a vast amount of space is occupied to the levels and ramps this though is in lack of space for books. The next three models exhibit the possibility of movement within and between stacked floors. The first two investigates the connection possibilities of stacking. These concept models create interesting spatial 'landscapes' within each floor taking visitors up and down, while at the same time providing large spaces for bookshelves. Nevertheless, they do not fulfill the long views and the lack of central unifying element. An atrium in the last two models does include this aspect, but the spiraling of overlapping floors does not provide suitable space for books.

The concepts working with the term 'valley' makes use of terraced canyons, where streets and paths carves their way out of solids. With the straight valley a strict room is achieved providing total overview. This is changed with the bending in the other model dividing the room and the street into separate sections. When adding more canyons a potential unifying square is achieved as showcased in the last 'valley' model, which creates corridors and openings of different orientation and size allowing an easy navigation within. As an extra element the bridges creates new connections and pathways urging for exploration.

The final group contains a concept of a more organic approach where hills are 'drawn' up creating peaks and heights along with valleys and corridors. The model creates a complex network of combined streets allowing both a centered square along with the different quarters separated by the 'mountain peaks'. As hills are merging together they create pathways also in the height, which provides dynamic and interesting qualities.



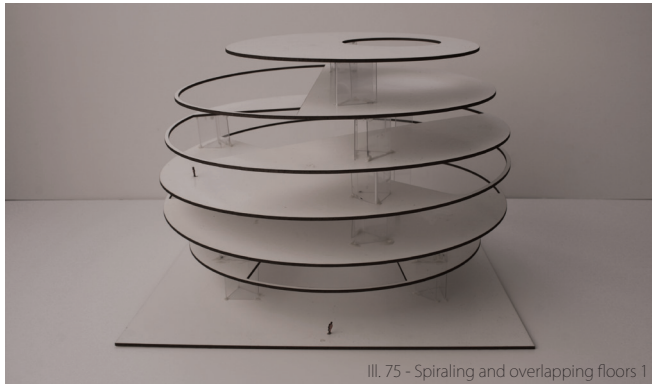
III. 72 - Model with escalation of heights



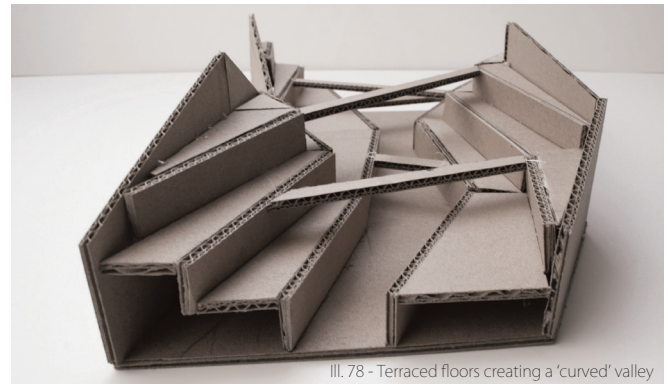
III. 73 - Model with stacked and tilted floor slabs



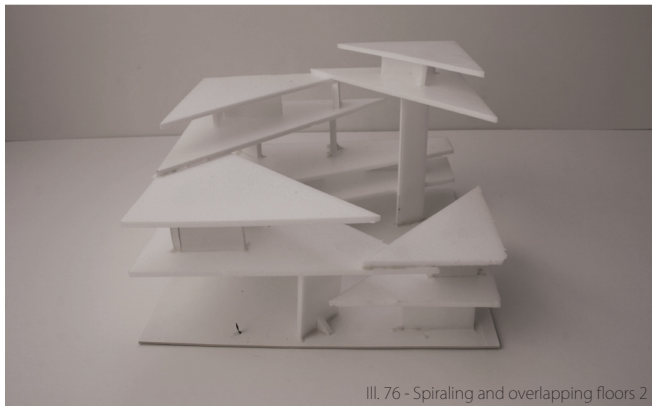
III. 74 - Model with stacked and tilted floor slabs 2



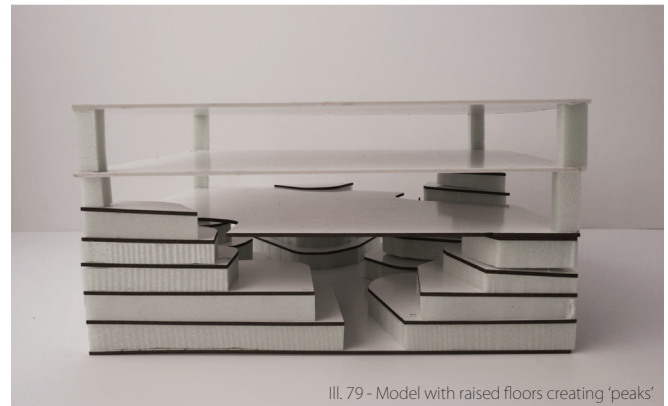
III. 75 - Spiraling and overlapping floors 1



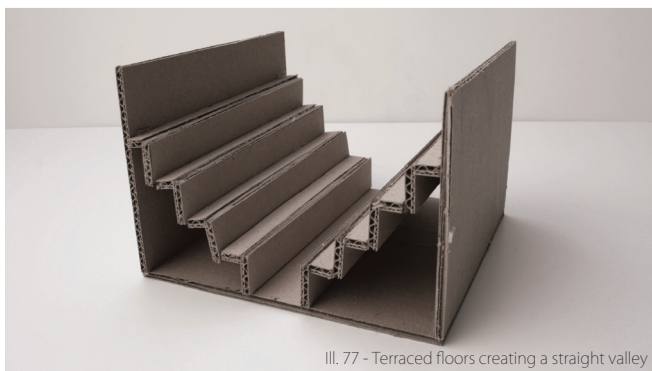
III. 78 - Terraced floors creating a 'curved' valley



III. 76 - Spiraling and overlapping floors 2



III. 79 - Model with raised floors creating 'peaks'



III. 77 - Terraced floors creating a straight valley



III. 80 - Model with morphed 'peaks'

phase 2

Evaluating the concepts

Upon the early draft models circling the qualities of an artificial landscape, a set-up was conducted with the purpose of assessing the qualities and disadvantages of each of the models. Within this, the aspects described in the previous phase were evaluated and considered, and it was found that no individual concept possessed the envisioned and wanted comprehensiveness to be taken on as a main concept. It was then established that a concept would either consist of a hybrid of previously showcased models or, the 'landscape' as a vision would have to be further investigated.

This resulted in the experimentation related to the concept of the 'mountain', but instead of working with 'handmade' elevations, the concept was derived to a two-dimensional surface, which was then inside the Rhinoceros (tm) software exposed and manipulated to extruded peaks. This would create double-curved surfaces that by the use of a 'simple' computer program, developed specific for this project with the parametric software Grasshopper (tm), was transformed into contour line upon each other creating the plans in the building. In the same way, the program was used to generate the slabs and walls, by 'slicing' the double-curved surface in the horizontal direction. The developed program generated a great degree of freedom to create interesting forms and shapes while maintaining control of the placement of levels and walls, resulting in a very fast work flow where quite complex models were created within a short period of time.

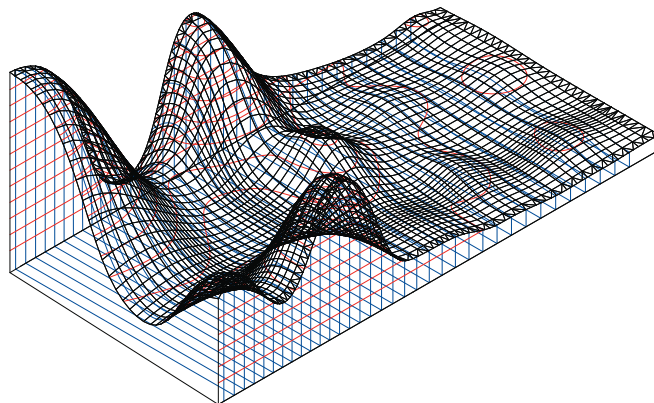
The 'Book Mountains'

The result of this process was a new conceptual model incorporating a vast range of the qualities of the previous generation of models; the possibility of three-dimensional movement, differences in heights, possibilities of overlooking views, private and intimate areas inside the hills together with options for squares and paths.

The combination of the vertical and horizontal 'slicing', resulted in a rational and straight divisions of the surfaces into usable slabs and walls. By doing so, a new concept became evident at the same time; namely the incorporation of books and volumes within a standardized system allowing for a large amount of shelves. The incorporation of vertical walls reaching all the way down to the ground also made it apparent to use this system tectonically, by incorporating columns and loadbearing walls these places. This aspect would result in a conjunction between books and structure, which were initially requested in the vision.

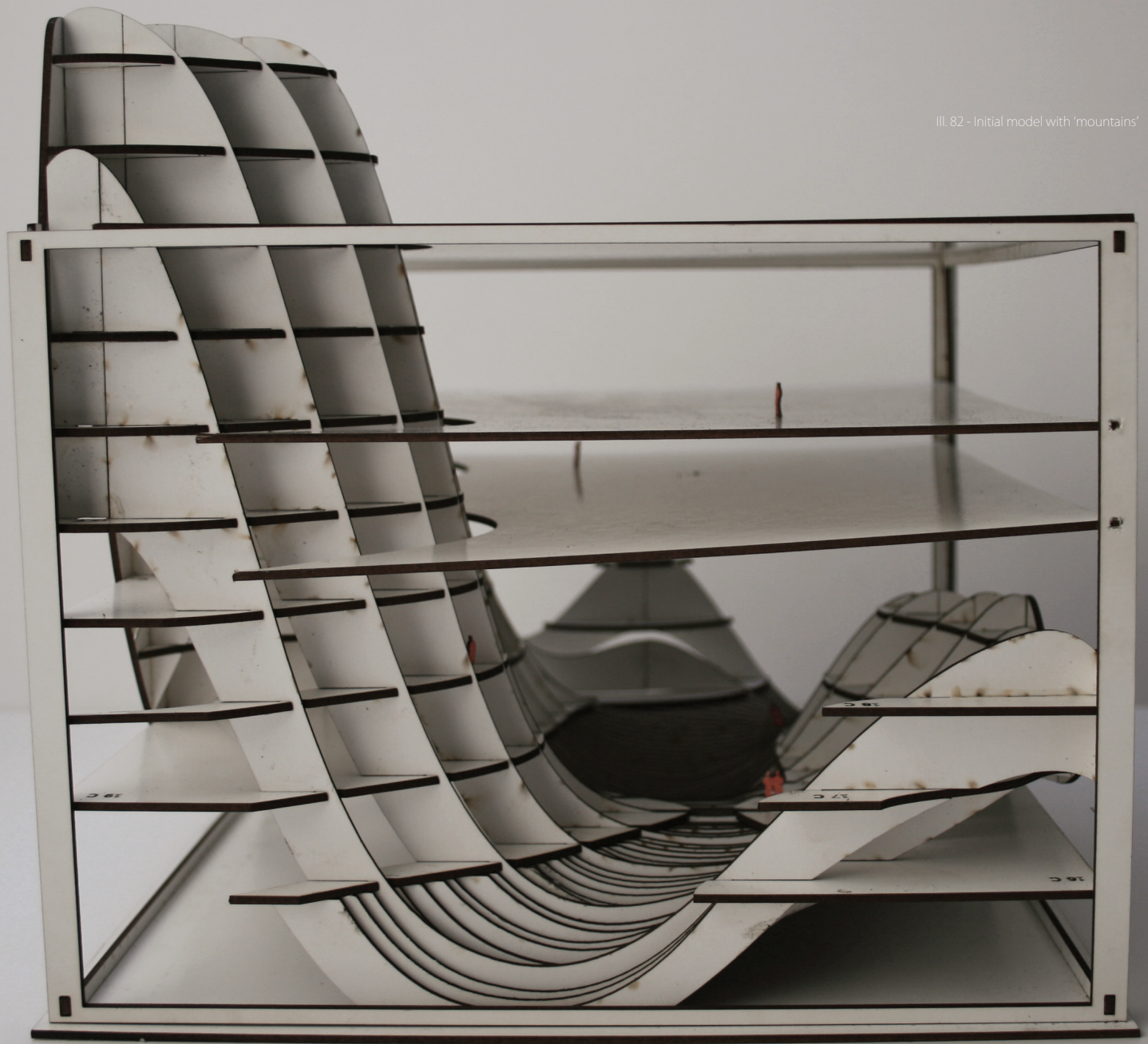
Initial design of the administration

As the work with the library room evolved the administrative wing above also began to take shape. Within the cardboard model a test with two superjacent floor slabs were made. This though proved to work against simplicity of the three stacked floors above each other, and it was decided that the administration should only hold one single level. What was also initially elaborated in the model, was the penetration of 'Book Mountains' through the floor slabs of the administration, which created interesting and unusual spatial configurations.



III. 81 - The contour-lines created by use of the parametric software Grasshopper

III. 82 - Initial model with 'mountains'



phase 3

Further investigation

As it was made clear that the new concept possessed the desired qualities, the field was broadened out in order to perform different tests with spatial configurations and shapes. Different approaches of form were conducted ranging from rigid and tight idioms into very organically curved surfaces.

At the same time, the required elements from the previous conceptual models had to be incorporated.

As investigations quickly showed, the presence of a mountain in the middle of the room would occupy too much space inside the room, thus resulting in the orientation of hills to the periphery of the library room.

This automatically created a central low area suitable for e.g. a square with browsing, but it also revealed a too enclosed spatial feeling where the library room would appear too withdrawn to itself while turning its back to the context, somewhat like a bounded volcano crater. The solution to avoid this was taken from the previous conceptual model of the valley. By arranging the mountains oblique in front of each other, an s-curved path was achieved stretching the square across the north-south axis of the building. This opened the building up in both these sides creating an inviting peek into the building, thus revealing the books and library functions inside.

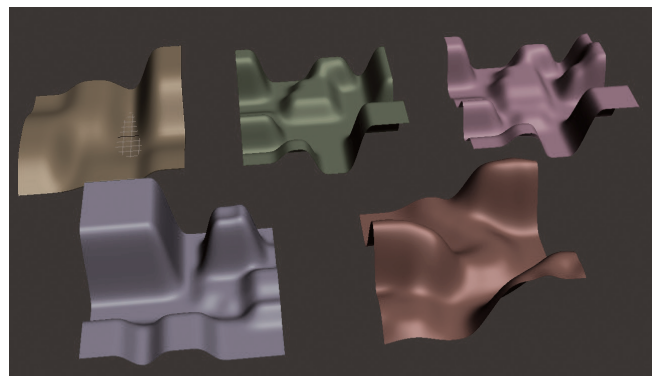
As the 'peaks' became more and more characteristic, questions of vertical movement and transport began to rise. As a natural step staircases and elevators were placed centered in the 'mountains' facing out towards the facades, determining the upright transport within the entire building. These staircases would also create a shift in the rhythm of the small cubed enclosures created by the 'waffle-structure'.

Access between the underneath public area of the ground floor and the browsing area were also created within the same typology of extruding surfaces, resulting in a smooth stalactite hanging from the ceiling in the ground floor.

A low area of the canyon towards the southern corner of the room was made into a café area due to the cornered orientation and the possibility of access towards a southern sunny recreational area.

Around the conducted cardboard model, a range of emerged niches were also investigated and found interesting in terms of creating different study and relaxation areas.

The previous works with incorporating different hierarchies already was exhibited in the cardboard model moving away from equally sized 'mountains' and into a differentiated number of magnitudes.

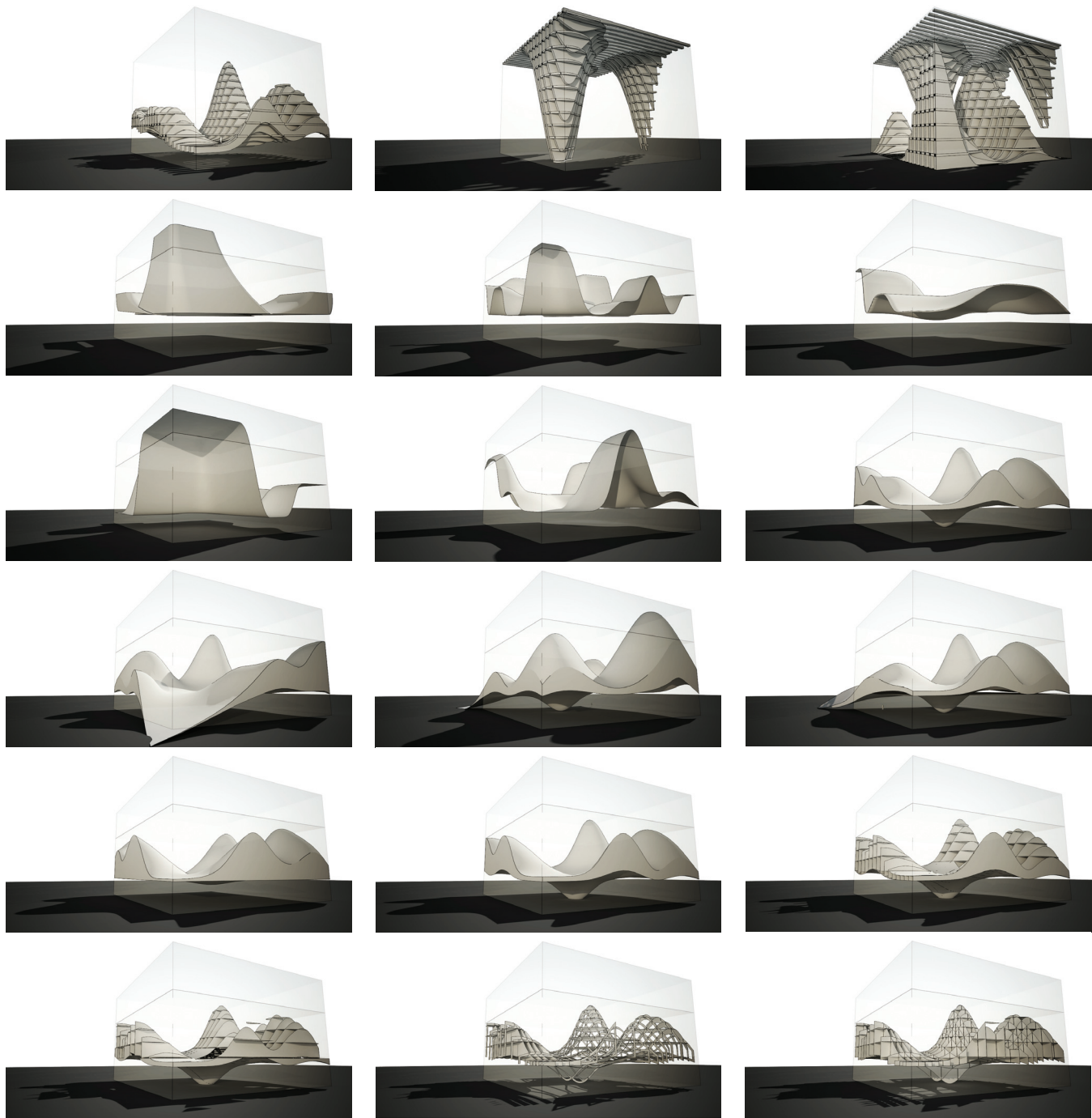


Ill. 83 - Models testing different levels of stringent curvatures

Initially, the work with reconsidering the first waffled model ended out in a new proposal. As the first model was seen as a test of the concept, the new model was made reflecting a simpler layout where the expressive peaks of the initial model were resized and relaxed in order to advance a more rational and esthetically tighter curvature. Along with the scaled down architectural grasps, the way the peaks reaches its climax's was changed towards being restrained by the edges of the boundary squared shape. This meant that the 'mountains' only slope inwards avoiding useless small peak-tops and waste-spaces behind them.

The administration also received a range of tests configurations conducted with focus mainly on its affection within the library room. As the underneath of the wing would appear as the roof within the library an effort was made to make this more interesting than just a white surface. This resulted in a proposal where the use of the developed program ('slicing-tool') again was used.

As the constructive function of the administration was not yet settled at this moment, different structural systems were at play. One of these incorporated that the actual floor slab of the administration acted as a large ribbed beam construction, spanning all the way between the 'Book Mountains' while carrying the roof on columns. This of course would incorporate a large ribbed beam construction and here the use of the waffle-tool could create the desired effect. The idea was to create a curved surface reaching its peak at the middle where the forces would be vast, thereby creating a 'sky' of either one-way running or gridded cassettes in the roof. Alternatively, the construction could be reversed creating a carrying roof in the administration from where the administration floor would hang, leaving a potential more



III. 84-101 - Investigations of the 'mountain' concept

Lastly, the administration was thought to incorporate some kind of skylight for several reasons; first it would provide more light inside the administration itself while at the same time easing the consumption of material creating a lighter construction. Lastly, a skylight down into the library room would provide the room with a large amount of daylight from above removing focus from the vast sized roof area, plus giving visual connection between the administration and the main library room.

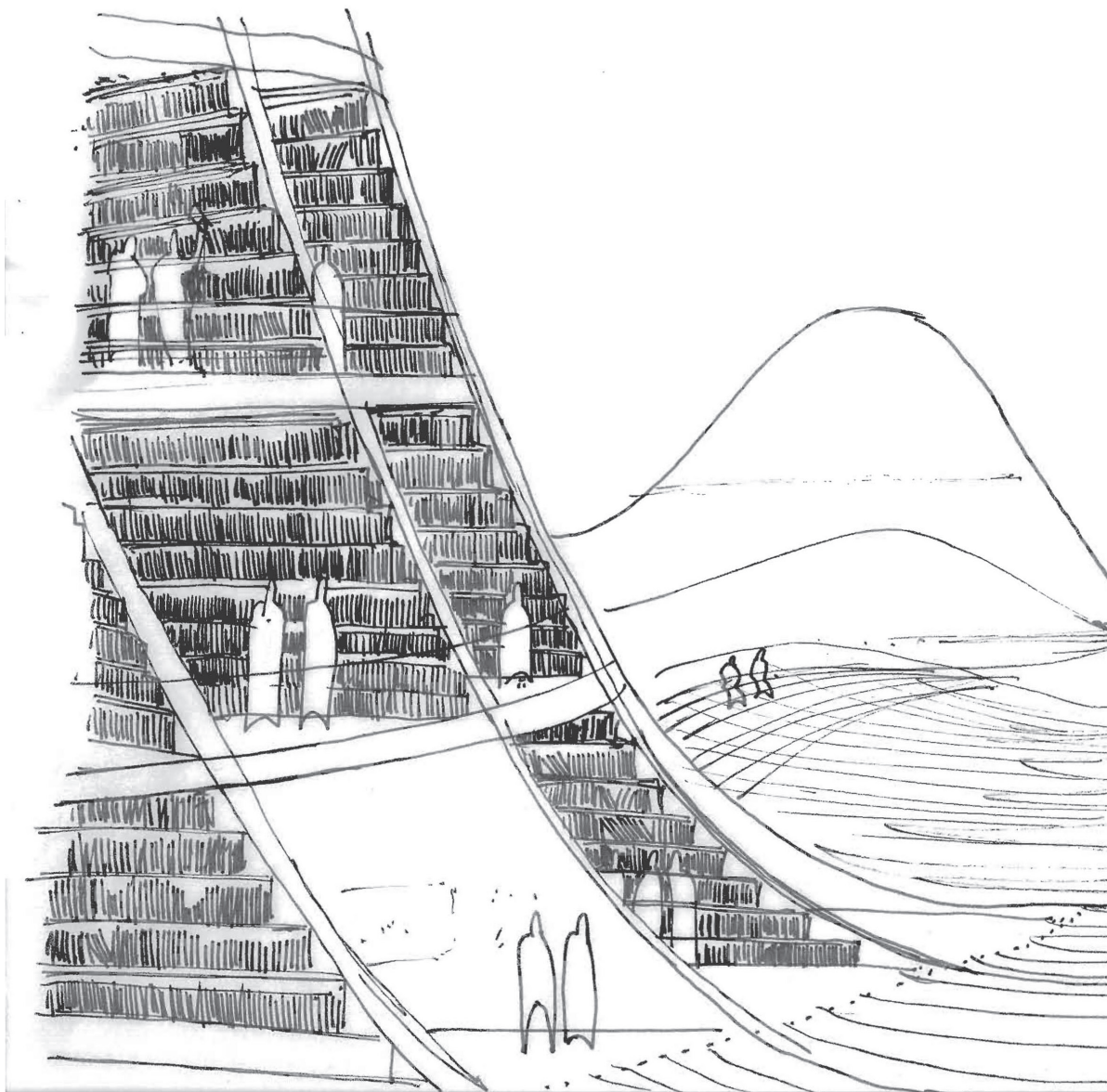


The midterm seminar was held the 7th of April 2011, where the at-the-time-being concept of the library was presented. Together with the new cardboard model a range of sketches and visualizations were produced. A draft plan and section was also drawn explaining the different elements within the three bands of functions. After presentation, a critique were held where responses and constructive comments were discussed.

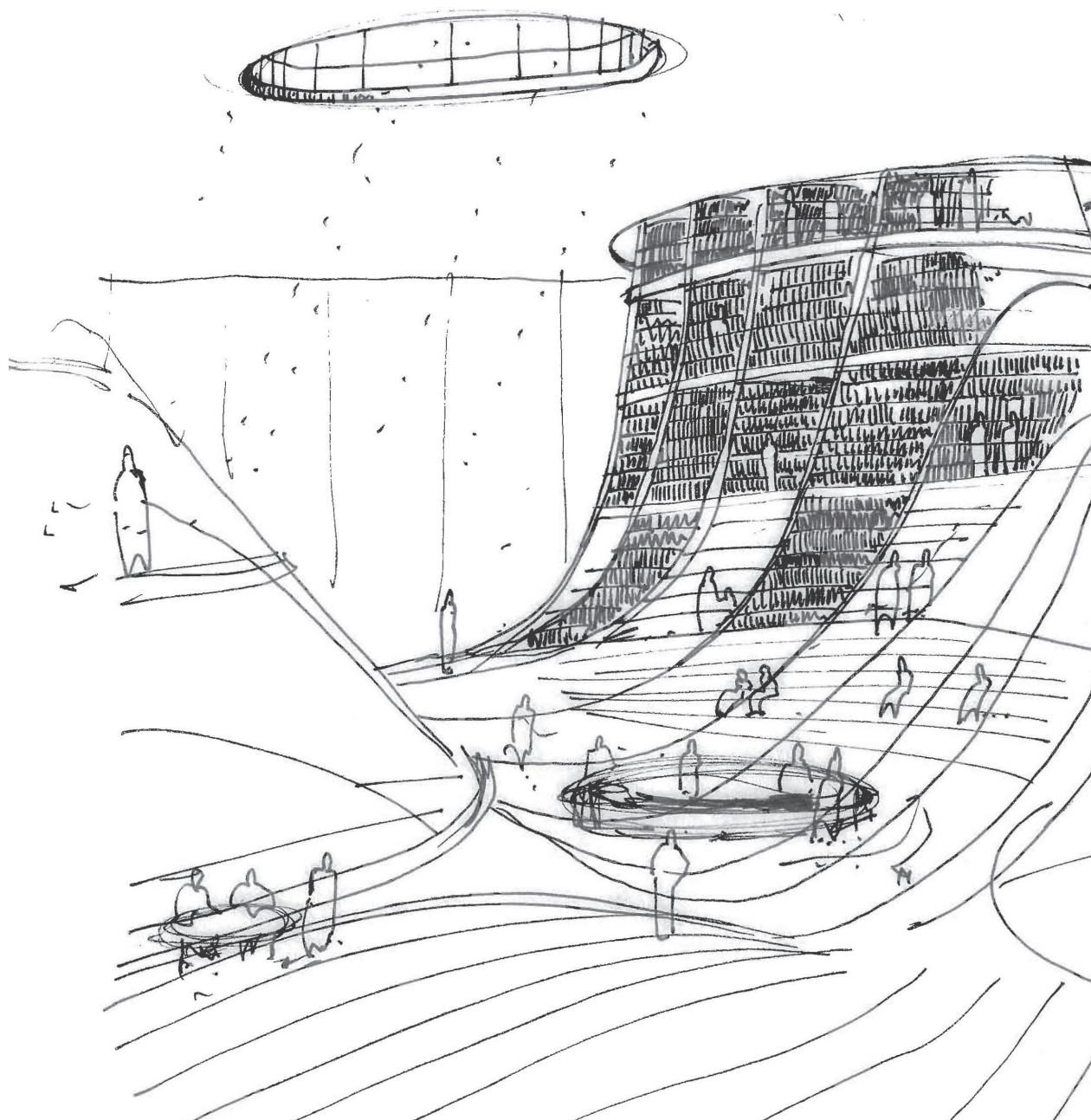




III. 107 - Model from midterm seminar



Ill. 108 - Sketch of 'Book Mountain' from midterm seminar



Ill. 109 - Sketch of cafe and browsing area

phase 4

Learning from midterm seminar

The reflection of critiques and responses put forward on the meeting circled around the main aspect of the 'Book Mountains'. As it was concurrently stated, the 'peaks' had lost some of its energetic as it was rationalized in the model from midterm. As a consequence of this, the focus was put on the initial vision of the project, which inspired to rethink the layout once again. The focus on rationality and attenuation of the building had removed its virility.

As a result the 'peaks' once again were drawn up high with an even more differentiated hierarchy as result.

To create the possibility of flexibility the floor slabs within the 'Book Mountains' were made open with columns – allowing detachable systems of shelves.

The largest 'Book Mountain' was likewise drawn out through the roof construction in order to create a connection and link between this corner and the AAU canteen on the opposing side – resulting in a dramatic top point.

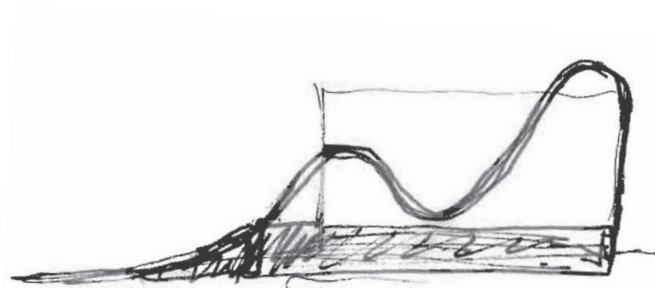
As another step towards a more utilizing use of the 'Book Mountains' was to determine these to carry the overhead placed administration. This was signified by the placement of the three largest 'peaks' within a triangle across each other creating a solid tectonic tripod support.

In order to incorporate an element of adventure the elevators were moved from the vertical cores and into the library room, following the slanted curves of the mountains creating an interesting tour upwards. The footprint of the building was also changed from 50 x 50 m to 47 x 47 m, which entailed a little less intrusive appearance – the height proportion though was held keeping the overall proportional aspect within 1,6 resembling the golden ratio, making the mani building height 28 m.

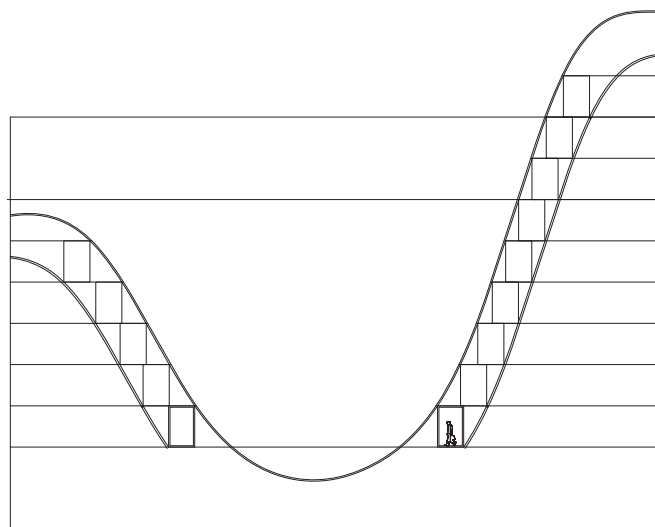
Finally, an idea, which had for long just smoldered, was taken forth, namely a concept of drawing the organic landscape inside the building out and make use of it in a recreational way.

This was going to underline the curves of the 'Book Room', beginning in the southern part of the site and then building up as a wave, running through the building and peaking at the very top point of the building.

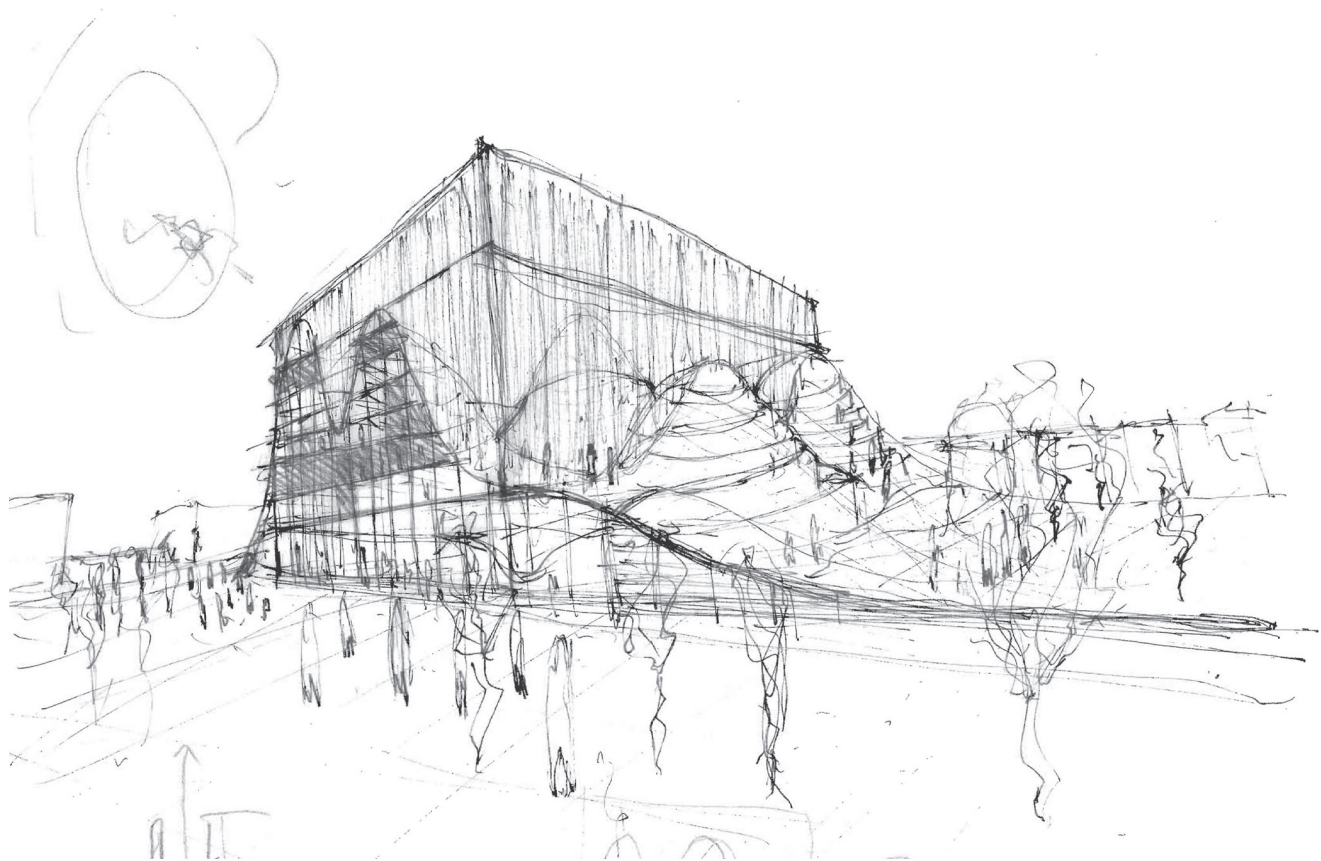
This created a dramatic motion tying the south side together with the building.



III. 110 - Sketch showing the escalation of the landscape and the 'peaking' top



III. 111 - Sloped lifts provide vertical transport within building



III. 112 - Sketch of the landscape f'floating' out of the library's southern side

16

DETAIL
PHASE

the master plan

The overall development plan for the entire building site traces back to the initial analyses and mappings from the program. As the area and space close to the library defines the link to the surrounding context, it is of great importance, that a right layout is defined in order to accommodate the many different functions within the area. As the mapping and the investigative site visit revealed, the main element of importance would be to manage the traffic to and forth the library in order to ease the access for the visitors and patrons. Secondly, the placement of the project would denote the library as the linkage between the campus and the new wing of administrative buildings bound for the south-western area of the university.

This entailed that the different sides of the building, created by the north-south going location would have to be analyzed in terms of functions.

Beginning with the northern area, this would represent the direct contact with the rest of the campus.

Due to the northerly orientation, the square will be in shadow during the day, which indicates that the space would not invite to a longer stay, but merely function as an area of transit. Together with the shade, the urban character and the use of the space for passaging resulted in a hard surface pavement suitable for many visitors during the entire year.

Along the lake side across the AAU cantina, a new wide strip of pavement is going to ensure safe traffic for pedestrians and cyclist from the immense traffic of busses passing the site every 5 minutes. The lake itself has been cut by the same lines as the building, to emphasize the action of the "cutting" of sides in the library volume. This has resulted in a medium sized square directing all visitors from the north, east and western part of the university towards the library. On the new emerged western bank of the lake, a submerged recreational area with a wooden deck has been located which will receive sun both in the morning and the afternoon. The original bus stop has been moved a few meters towards the AAU canteen in order to keep the area around the north-western corner more open for passage, resulting in a six meter corridor past the building.

The access strip runs along the western side of the library where the landscape slopes up towards the south-west. In order to follow these tilted surroundings, the lines and rhythms of the sectional 'Book Mountains' have been traced down into the square. In the western square these lines are then extruded creating a low ramping stair towards the south. The line-work is also traced out in the northern square linking these two areas together and at the same time links the

outdoor area together with the building – giving the illusion that the building is reaching or melting out into the area.

In order to create a guiding effect towards the library and the administrative buildings behind it, another line work has come in use, namely the angled 45 degree bus road defining the northern square. By adding these tilted lines as dividing objects across the straight ones, a series of guidelines are created.

To create a spatial more interesting public area, a number of these blanks are raised in order to create seatings, beds and foliage. Some other blanks have been submerged a small amount in order to capture rain water – causing a mirroring reflective effect.

Last but not least, the northern square close to the library volume holds a large amount of parking spaces for bicycles.

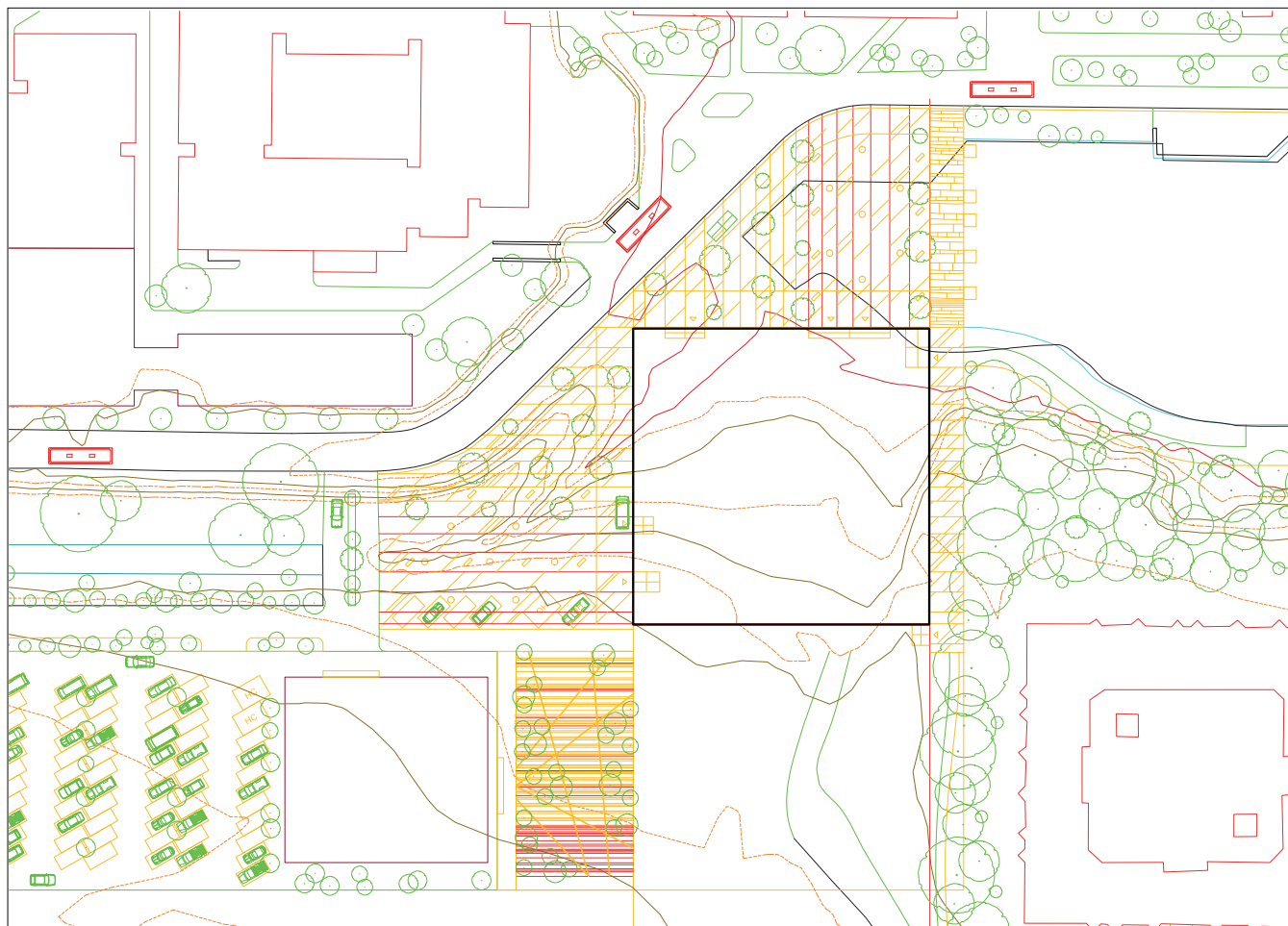
On the western sloped square the same urban elements are present, but this side is far more seen as a square for recreational stays because of the non-shaded location. On the west side the entrance to the storage room of the library is found, it is provided with the possibility of reversing a truck directly to the entrance doors easing delivery of freight and books. The western square also holds a couple of short-term parking reserved to the library staff together with a number of handicap parking lots.

The rest of the parking spaces are located to the south-west of the library, behind a new low administration building.

On the contrary side of the library, the eastern side is characterized by a compilation of high vegetation down to the lake. This foliage shields the underlying residential housings and is going to be preserved. A small path is drawn along with the north-south going cut in the library, connecting this side to the south parts of the building site. Travelling down this path takes the visitor on to the southern side of the library complex, where the landscape of the book room is drawn out of the building in order to create a recreational green southern slope, that are characterized by green organically curved surfaces with small enclosures and systems of paths. The landscape is in direct connection with the café located in the south west corner of the bookroom, where the landscape is pulled up, creating an area for outdoor service and stays in the summer period. The curved landscape covered by concrete lamellar sloping up towards the building contains the two auditoriums, a video cinema and storage facilities underneath.

At the very south of the site a larger green barrier is created of foliage and trees in order to create a green fence towards the dormitory rooms further south.

To the west of the green landscape a small transit square is located, providing light traffic a passage towards the library.



III. 114 - Draft sketch of the area and the masterplan

the public ground floor

To indicate the ground floor being the entrance gate to the building, the use of a clear glazed band is incorporated and slightly drawn inwards. The transparency of the ground floor facade creates openness, draws in light, and gives a sense of lightness to the building while at the same presenting the functions inside. Different entrance areas are placed all the way around the ground floor, while the presence of the main entrance is kept similar to the other entrances. This should reflect the idea of 'oozing' arrivals from all sides and not only a single entrance gate.

Entering the library from the north the first thing seen would be the book store café area facing out to the northern transit square. The organization inside the public ground floor is centered around a large square, which on the middle is divided by a mezzanine.

The use of a mezzanine floor both creates interesting floor heights inside the same room, but it also allows for direct views and connections between the functions of the first floor and the compact storage located behind a glazed screen underneath the mezzanine floor slab. This both provides visitors with a glimpse of the large compact shelves systems, and enlightens and cheers up an otherwise not that interesting enclosed basement. The eastern part of the room is dedicated to a cornered café (which includes the possibility of outdoor serving in summer periods) together with new facilities for the university fitness center 'Uni-fitness', which is in two stories. On top of the café the AAU media platform is located overlooking the lake.

In the south-eastern corner the area is arranged with storage facilities,

creating a quite zone towards the neighboring residential building. In the other side of the square, the teaching facilities are located on a line along the western facade. Here university and corporate master students will attend lectures and afterwards split up in smaller groups for project work and assignments.

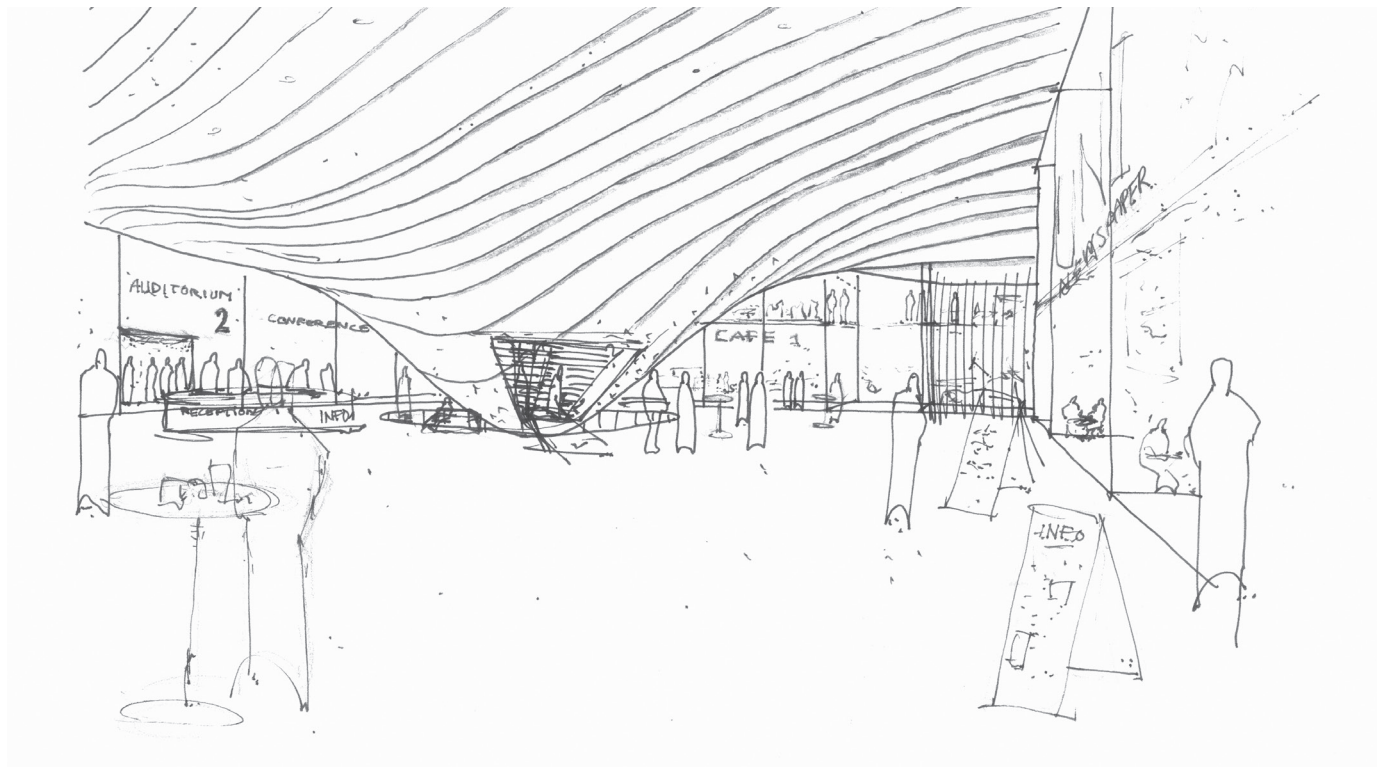
Binding everything together is the large stalactite-shaped staircase. It contains a spiraling stair that attaches to every floor from the compact collection and all the way up into the 'Book Room'. The staircase also holds a lift for transportation of new books and library material between the shipping/delivery room and the library collection. Inside the staircase, an information counter also allows for personal service and guidance.

From the mezzanine, two raised balcony floor, provides access both to the before mentioned AAU medias and in the other side to the seminar rooms above the conference rooms.

Instead of one large canteen the cafeteria function has been divided into three smaller units offering different configurations of meals as seen within shopping malls and airports. This should also invite the visitors and patrons with new experiences.

Finally, the ground floor houses the large auditoriums, which both provide seating for more than 100 persons each. Indoor recreational spaces for stay and rest are generally provided for both the main indoor square and for breaks within seminar, conference and auditorium lectures.

As described within the vision, the auditoriums are also seen as small theaters capable of offering public evenings and events outside normal opening hours, which should attract the population of the campus area inside the library – creating a vibrating house of culture.



III. 115 - Conceptual sketch of the ground floor showing the main square and the entrance to the 'Book Room'

organization of the 'Book Room'

The overall concept behind the bookroom is to create the feeling of being in a book world, a landscape of books that makes the users eager to go on adventure and explore the library. The bookroom is thought of, as being the very heart of the building, and the transparent facade reveal the books visually from the outside.

As referred to earlier, the modern library contains many different functions of activity. The 'Book Room' is going to contain a mix of workspaces (single and groups), media area, video cinema, cafes, areas for relaxing and meeting rooms. The different functions are organized so that navigating around the library becomes an experience; between open and closed areas, active and not active, working and relaxing. In this way, the users are always confronted with new impressions, which make piloting around in the library an interesting and eventful experience.

All the reading areas are placed towards the north, to create good and calm lighting conditions for reading, and in the case of late-night studying, all the desks are provided with sharp halogen desk-lights.

In that sense, the northern facade is turned into a vertical reading hall, creating a living facade, communicating with the rest of the university. Distributing the reading areas up through the library, makes the distance from the book to the reading "carrels" small, providing visitors to easily float out into the reading areas. Along with the different work stations, copy-machines and scanners are provided in order to let the patrons conduct prints and references.

The open square in the middle of the atrium – the browsing area – is created by the valley, which the mountain forms. The edges of this area run out to become a set of stairs, creating an informal hangout

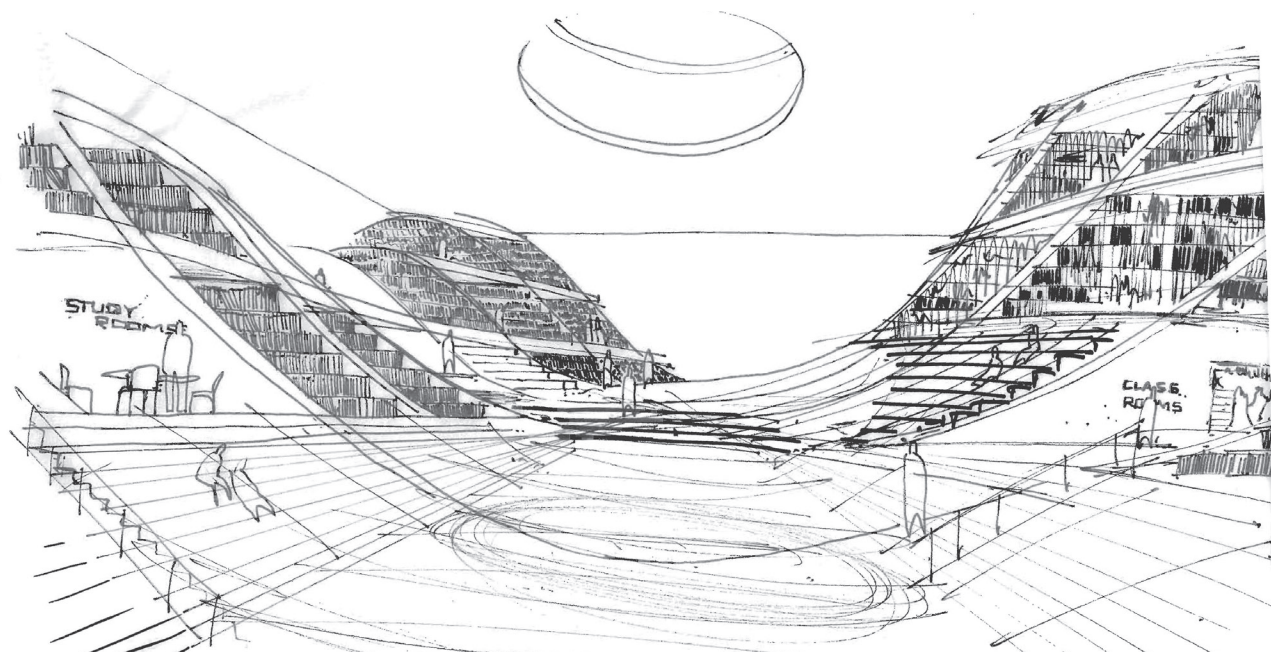
area around the open space at the mountain base. The browsing area also holds an info area with a counter, where librarians will stand by providing guidance. Here quick-loans/returns are also conducted by automated book stations. The browsing area also displays new books within a range of low book shelves creating a homely atmosphere. This mood is brought on in the café area, which will provide visitors and patrons with coffee and small snacks during the visit.

To make it easy for the user to move around and for the staff to distribute books, the four main mountains are equipped with elevators. The elevators are placed, so that they are able to carry people all the way to the administration, and at the same time being visual when entering the room, making it easy for new users to navigate within the building. Each elevator takes up to six persons at a time, allowing both visitors to move swiftly around while assisting the staff with heavy book carts. Within the vertical cores toilets and staircases is located together with a ventilation duct, cleaning rooms and control rooms for service and maintenance.

At the northern part of the browsing area, the lower reading area is located. This place is seen as a more traditional open reading room, with rows of reading tables overlooking the lake side and the AAU canteen.

Finally, a range of electronic touchscreens are located around the entire library providing service information. Together with these, a number of larger screens on selected spots provide signposting for subject browsing and activities.

The way of constructing the library with the bookshelves placed in between the loadbearing concert frames, provide a flexible building, with the possibility of removing the bookshelves creating the possibility of alternating the rooms according to the desired function.



III. 116 - Conceptual sketch of the 'Book Room'

administration

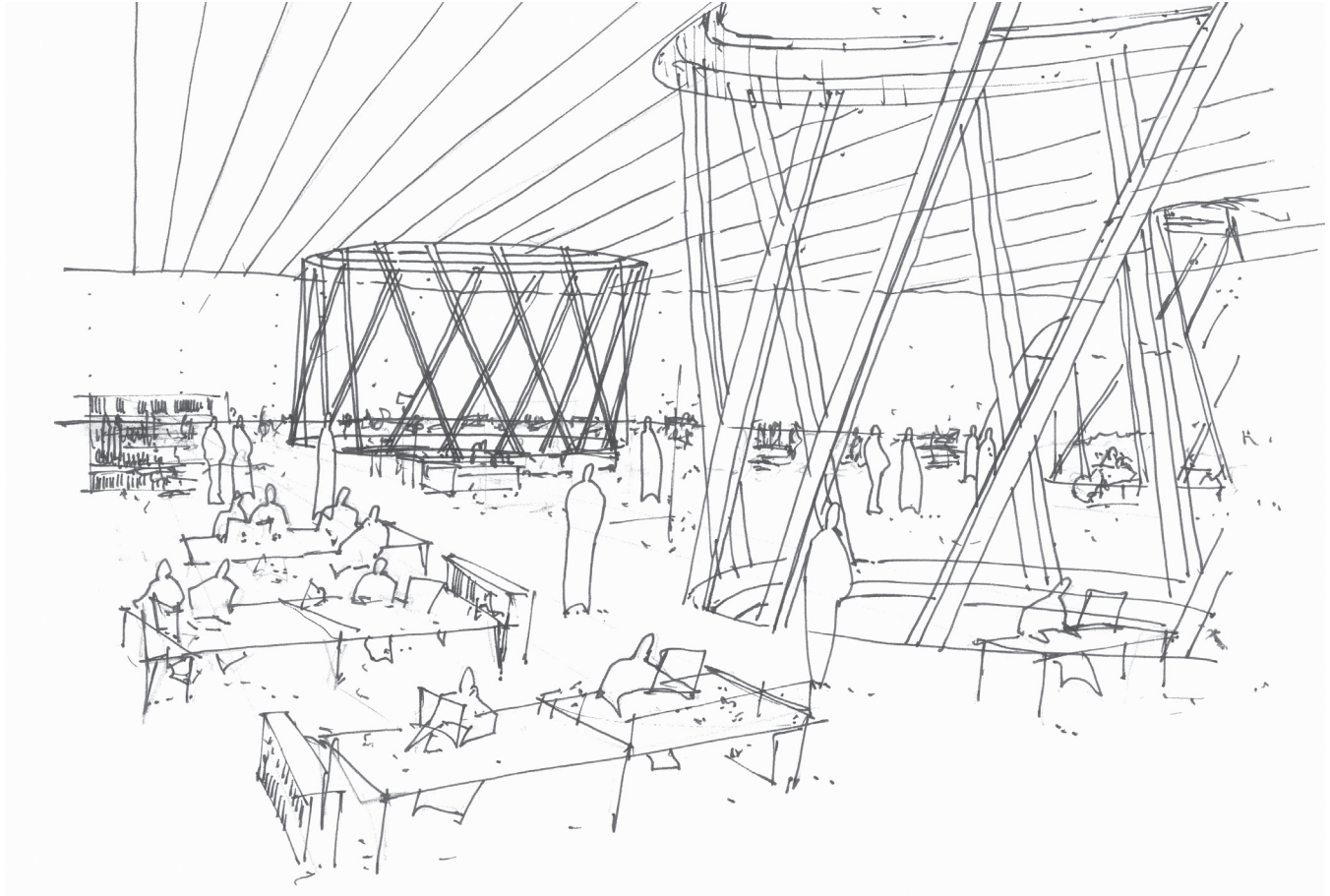
The administration can be seen as a vital element within the running of the library. Here, the large number of staff is settled in a 360 degrees panoramic view overlooking the entire university campus. The floor is thought visually as one large open area only divided by the skylights providing both the 'Book Room' below but also the administration with light. The space is conducted as two intersecting rooms only separated by a glazed fire-screen running north south through the skylights, preventing fire from spreading. Due to the open plan office space configuration, the full amount of staff can be united under the same roof. The entire administration holds 60+ workstations within the room and due to the conditions of the open room, a range of other future configurations are possible. The desks are placed in traditional clusters of four all the way around the edge of the floor, providing the desks with natural daylight and vista. Together with the private work stations, a range of informal areas are distributed around providing space for different meetings and social encounters. Furniture for resting and breaks are also placed around the main path to create a welcoming atmosphere. At the two west-facing corners larger meeting tables are located for group meetings and appointments.

Within the east-facing side four larger enclosed offices are located providing either small quite meeting rooms or staff executive offices. With the three large skylights located in the middle of the room, they create a Y-shaped pathway around, separating the large open office spaces into more intimate areas, though keeping the room visually open. These skylights are organized by the vierendeel trusses positioned around the round cut-outs in the floor and are supplied with a tubular glazed fire-screen in order to lead smoke past the administration and not inside in case of fire.

Three places, the peaks of the Book Mountain penetrate the floor slab creating interesting spatial rooms within the corners. As described in the text about the 'Book Room', these mountain peaks holds the transport corridors for access to the administration. The lifts and staircases all connects to the main transport corridor between the skylights. Toilet facilities are also incorporated within the peaks providing the staff members with lavatories. In the largest of the mountain peaks the reception area is located. Here, a service counter is located together with a cloakroom for visitors.

As the main mountain of the reception continues up through the roof, it makes room for a large and imposing meeting room at the very top of the entire campus.

Finally, the main peak provides access to a minor roof terrace, suitable for outdoor reading for example receptions during the summer periods.



III. 117 - Sketch of the open office space within the administration wing

facade

With large areas of open atrium and rooms towards the outside, the building needs a facade skin to protect its interior. The design of this facade was based upon an analysis of, how it should perform.

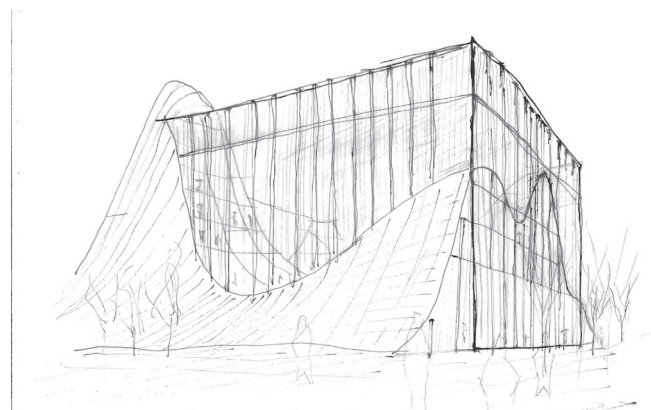
As stated in the vision it should provide a certain transparency towards the exhibited books and functions inside the 'Book Room'. On the other side a large amount of glazed surface would require the need to be shielded of during the summer period in order not to create a greenhouse environment inside. As a third issue, a large glazed facade during winter time and cold conditions is not going to provide good insulation. This could result in the use of closed-of areas within the skin or the use of vast expensive types of glass able to provide an insulating effect. But as the desired effect of the facade skin was to appear as an overall glazed surface, a third approach were incorporated. This was the incorporation of a multi-story ventilated double facade, able to pre-heat air in winter time and to ventilate heated air off in the summer period.

As the cavity between the two glazed walls creates an enclosed space, the air inside is heated by the sun creating the air to rise up through the void. In winter period the pre-heated air can be used for heating inside the building. In summer times the heading of the air generates a chimney effect allowing hot air from inside to be ventilated out.

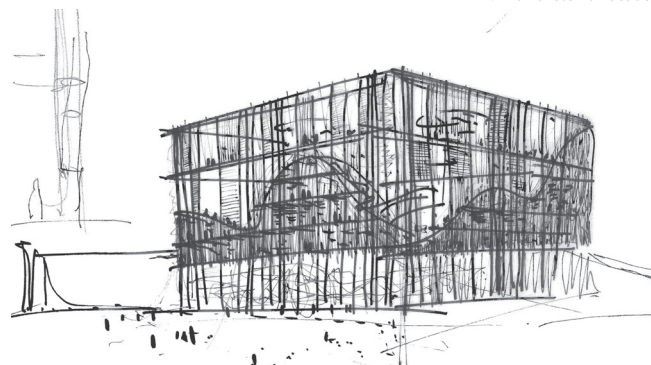
The facade also offers good acoustic damping, though the northern road of Bertil Ohlins vej only is trafficked by the pendulum driving busses, the atmosphere inside the library would benefit from a quite study environment. [bbri.br]

To underline the floor slabs and at the same time introduce a sun screening function, a shading-device was incorporated in the facade. By the use of 'MicroShade' (tm) perforated metal foil inside the glass, a blockage between 50 and up to 90 % of sunrays is achieved depending of the angel of the sun. This foil is perforated in an angled direction allowing low winter sun through, but preventing overheating during summer period when the sun stands high on the Danish sky. The sun shading is going to be located within the outer facade skin, providing most shade before the heat rays enters. As the MicroShade is semi-transparent, the glass will appear slightly darker than regular glass. [microshade]

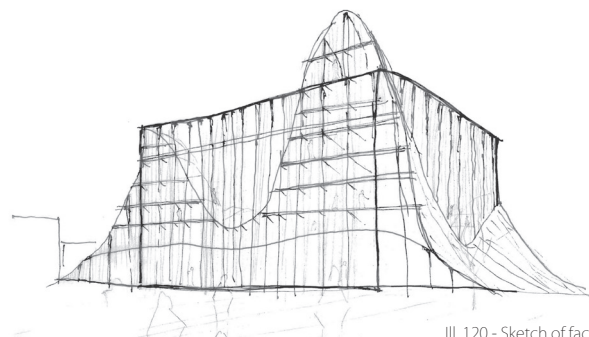
The facade should allow the three stacked functions to appear visible divided within the skin in order to 'read' the building and its purposes. At the same time, each floor should also be visible in order to keep a human scale within the 28 meter high building. In order to underline the levels of the building, the solar screening was suggested to be



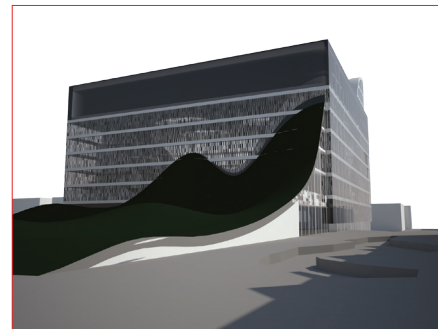
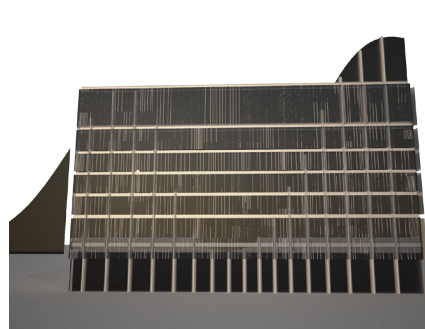
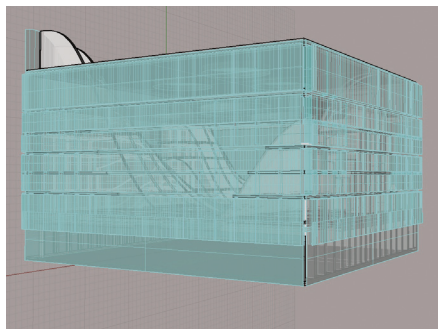
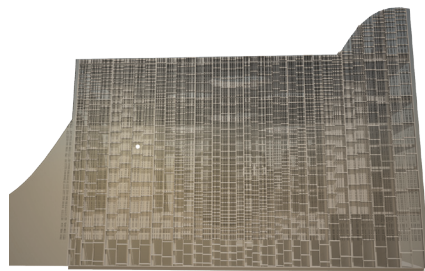
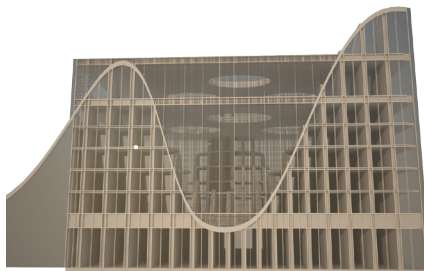
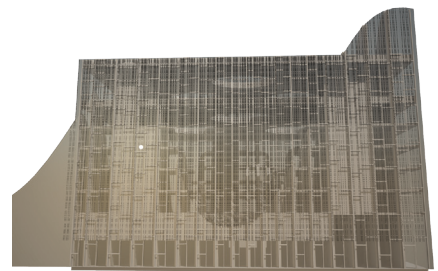
III. 118 - Sketch of facade 1



III. 119 - Sketch of facade 2

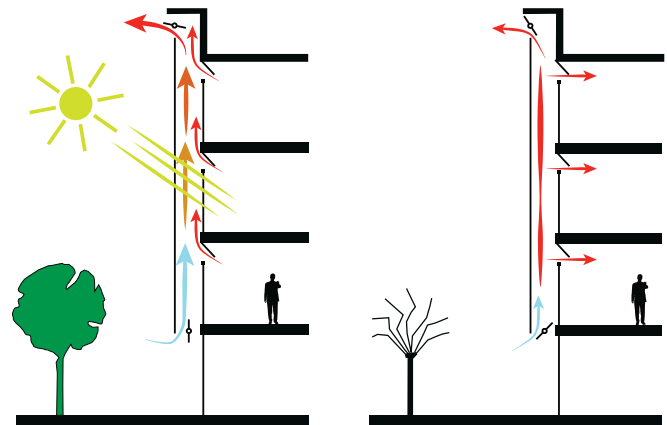


III. 120 - Sketch of facade 3



III. 121 -129 - Renders of different facade try-outs, resulting in the selected facade in the lower right corner

used, by conforming it into horizontal bands that would both emphasise the floors and create a visual 'slimming' effect of the building. As work with different forms of graphical usage of the sun screening was tested, an idea of a reference to the stacking of books inside were generated and incorporated within the facade, using rectangles of different levels of sun screening created a mosaic pattern, which created a lively aspect to the otherwise vast surfaces of glass. Towards the north, the glazed facade stands completely clear with no solar screening due to its orientation; this is also done to communicate the function of the library with all the work spaces overlooking the lake and AAU cantina.



III. 130 - Concept of the double-facade during summer and winter time



III. 131 - Concept of the double-facade during summer and winter time

technical considerations

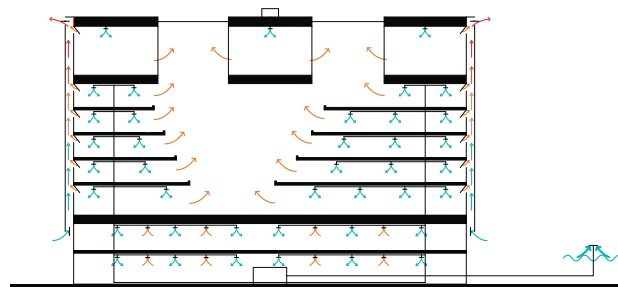
Technical routes

Within the building a vast amount of technical installations has to be planned and integrated in order to make the library function. Here the large concrete double-frames are vital. Within the hollow concrete cores of these, electric cables are drawn in order to provide a large amount of sockets to all the working stations around the house. These will also provide electricity to the lightings, necessary to run the library after dark. Internet is going to be wireless thus routers will be installed to provide patrons and staff with fast on-line connection. Within the vertical concrete cores of the stairs and toilets, pipes for ventilation will be drawn. Toilets are placed on top of each other all the way from the ground floor to the administration, in order to create a simple route for the water and waste pipes. On level number five in the bookroom where toilets are not present in two of the mountains, water and waste pipes will be drawn in the bookshelves taking a way a few shelfe meters.

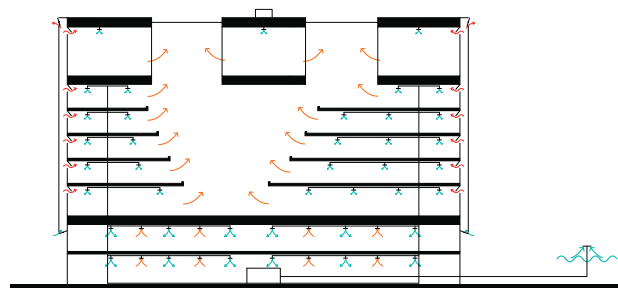
Ventilation

The library is going to make use of a combination of ventilation systems. A hybrid of natural ventilation and mechanical ventilation is going to keep a well-defined air change in order to provide a good indoor climate within the library. The natural ventilation is going to function within the main book room, where the heights of the "atrium" create a chimney effect. As hot polluted air raises to the upper levels of the Book Mountains, the three skylights conducts the air out through a range of automated window panels at the roof. At the same time the double façade contributes by ventilating out hot air in summer time, and sucking in preheated air in winter time, also the double-façade all-year-around provides the possibility of manual opening and closing the inner façade, providing more self-control for the users. In order to make a more energy efficient building the air intake is placed in the neighboring lake, which will provide cooler air in the summer half.

In terms of space for mechanical ventilation ducts, the vast space above the bookshelves is thought to incorporate this. This will provide mechanical ventilation within the workspaces in the 'Book Mountains'. Inside the fitness center located within the first floor, the ventilation will be separated from the rest of the library due to the vast air-changes here. Finally the large ventilation aggregates needed for the ventilation are divided into two aggregates located respectively in the basement and on the top of the roof – slightly retracted to visually hide it from the street view.



III. 132 - Ventilating out hot air in summer time



III. 133 - Illustration of preheated intake of air in winter time

structural system

initial considerations

As a way of procedure the structural design it was made clear from the beginning, that the system should reflect a clear tectonic approach. In order to incorporate a clear structure within the project, different considerations are highlighted. These regards:

- The way loads are distributed down from the very top of the building to the ground.
- The structures are not hidden or concealed
- The implementation of functions within the structure
- The minimal use of redundant material

A tectonic approach would also essentially create the overall guide lines when engaging the quite significant amount of square meters as of this project.

This should result in a rational and well-thought-through approach where structures are elegantly exhibited as part of the building itself – urging a refined overall finish.

This is also important in the question regarding the use of materials. Here a 'so-called' honest approach calls for the usage of material properties in terms of what requirements suits the structural elements.

Regarding integrated design the rest of the building should be thought-in together with the structure aiming towards a holistic and rational approach emphasizing the overall design.

structural principals

Open shelves and structure

Beginning with the concept, the inspiration has been found when investigating libraries from previous times, including the eras of the Renaissance, the Baroque and the Enlightenment. Here the distinct visual exhibition of volumes provided in the case study by for example the Trinity College Library (1732) in Dublin, Ireland was found fascinating. The ideas of visual presentation of the volumes also triggered an idea of a direct incorporation of the books within the structural systems of this project. This should be seen as opposed to the now days often standard way of thinking a library as a series of interconnected rooms with rows of bookshelves inside.



Ill. 134 - Trinity College Library

'Mountain' concept

As described in the design phase these conceptual ideas led to an organic landscaped library-section comprised by 'Book Mountains'. This library landscape-element is then placed in the middle of a vertical stacking with an open ground floor underneath and an administration wing above.

To achieve a clear structural idea the 'mountains' were then erected in four places creating a stable platform supported in four places, carrying the administration. This system was selected in favor of another one, in which a strong facade would carry the administration and the mountains only the books and floors itself.

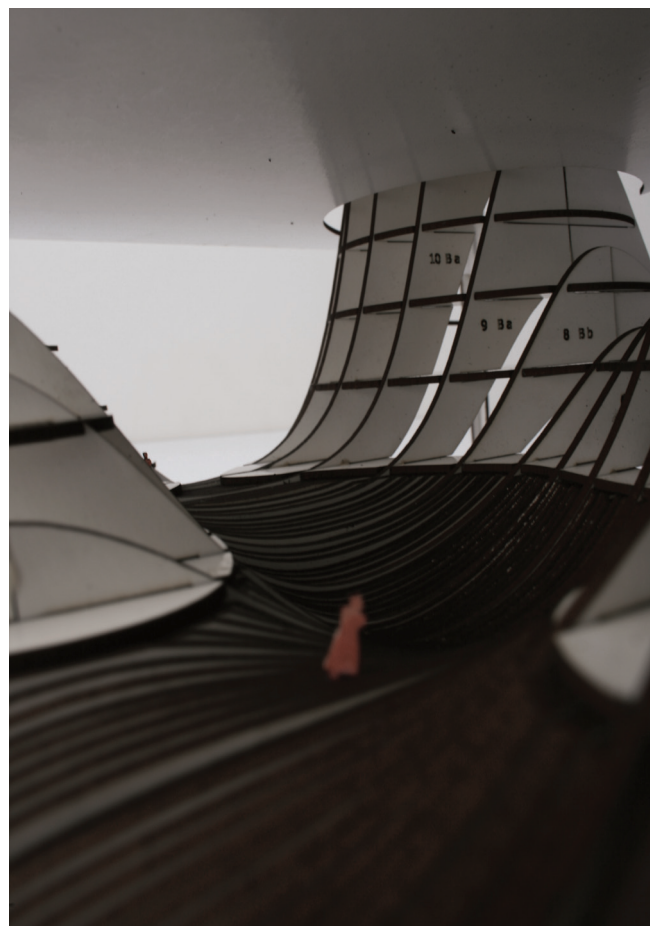
In order to create spaces, floors and room for books, the three-dimensional landscape was then processed by the use of the software Rhinoceros (tm) and the parametric plug-in Grasshopper (tm). This created a 'waffle'-structure, instating vertical and horizontal planes within the surface which were suitable for floor slabs and walls for bookshelves. In tectonic terms, the vertical planes immediately would be read as walls and frames directing loads vertically downwards while the many planar slabs would act stabilizing by taking other directional forces. As pictured in the initial models of the building the horizontal walls acts as disks, filling up the entire book mountains. Together with the staff of the AUB this design though proved to be a too static solution, urging in the removal of mass within the walls creating open flexible floor plans within the mountains. This resulted in the emergence of a double frame-system, keeping the outer lines of the mountain shape while maintaining an open floor. The action then called for an answer on how to obtain the massive forces of the exhibited books and volumes – resulting in the creation of a modular column-grid within the library.

The grid was constructed to follow the parallel frames of the Book Mountains which, in order to create different sized rooms, had a varying distance between each. The columns would then create a rhythm within each floor, arranging the disposition of the detachable bookshelves.

The material chosen for the double-frame is a smooth light-grey concrete, which is well-suited for large compression forces. The concrete was chosen in favor of large steel trusses both because of the tactile feeling of 'heaviness' inside the library room, but also due to the possibility of easy on-site shuttering formwork incorporating reinforcement and a hollow core for cable routes. The width of the frame has emerged from the length of two bookshelves next to each other – reaching 600 mm. The length is set to one meter in order to underline the direction of the frame. This creates a rather large structure, but in terms of the large size of the entire library this ensures a certain

appearance within the room. At the same time it will eventually be hollow corresponding to two smaller 200 x 1000 mm columns placed together.

The columns distributed around the floors in the mountains are going to be slender concrete columns of 200 x 200 mm in order to obtain the stresses caused in the vierendeel system.



III. 135 - Initial model showing the frames of the 'Book Mountain'

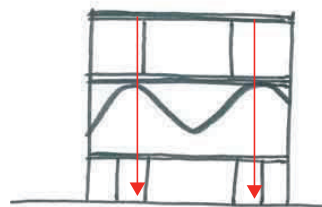
Large-spanning vierendeel-trussed administration

In terms of the structural system of the administration, several concepts have been a possibility. After the mountains were selected to carry the administration floor two options stood out. One principal is that the book mountain carried the administration floor which then carried the roof on columns. The other is that the book mountain carried the roof of the administration and that the very floor of the administration was then suspended down from this. Both solutions applied use of a large perpendicular-ribbed floor slab which created a visually impressive effect due to its size and form. Eventually these two designs resigned to a simpler layout in which the entire administration would act as one unit, performing as one large space frame truss suitable for the vast span.

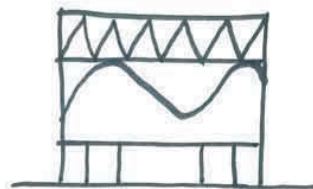
Due to the vast distance that the administration has to span, this solution also made sense due to the increased height of the structure – which would enhance the resistance torque of the structure. In order to achieve a strong and rigid administration body, the floor slab and the roof construction is going to be connected by a number of trusses in order to create a stiff overall structure. This is done by the use of triangulated trusses or a space frame construction, but in order to avoid tilted and slanted lines the vierendeel truss is selected. This type of truss is characterized by vertical beams with fixed joints capable of transferring and resisting bending moment. The trusses create quadratic openings allowing flexibility of fenestration and work space. The placement of the columns makes use of the same modular grid as applied in the library 'Book Mountains'. The floor of the administration is thought to be a concrete ribbed floor slab with the height of one meter in order to achieve enough stiffness to obtain the large tensile forces and compression forces.

Public ground floor:

As the first floor contains all range of public functions the aim has been to create an entirely open floor providing access from many sides. The module lines from the library room are used to place columns around the area. At the boundary edges of the building the concrete columns of the double-frames are drawn all the way down to the ground. The roof of the ground floor – separating the public areas from the above-placed library – is created in in-situ-casted concrete, creating an organically curved roof scape with a reference to the roof in the administration.



III. 136 - Mountains carries the administration



III. 137 - Administration acting as one large beam



III. 138 - Traditionel beam with pin-jointed trusses



III. 139 - Vierendeel truss with rigid joints

structural analysis

This text will shortly look into the results of the FEM analysis conducted by Staad-Pro (tm) software. The structural analysis has been conducted upon a two-dimensional simplified section of the 'Book Mountains'. In order to differ from the vast amount of information provided by the program the main focus will be held on the forces, stresses and nodal displacements of the section. In the appendix the preliminary load combinations are showcased, revealing that the dead load itself is the most unfavorable load, which is why the following graphic is depicting this load combination.

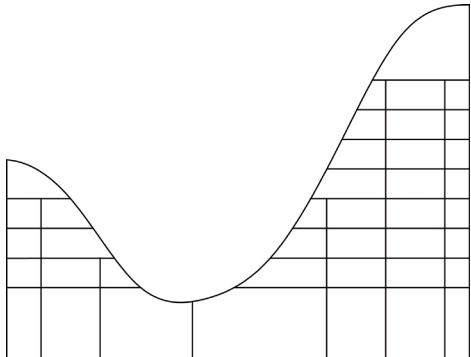
The loads applied were following:

- Dead load = 42,4 kN/m
- Live load = 2,5 kN/m
- Wind load = -1,08 kN/m (negative due to suction)
- Snow load = 0,72 kN/m

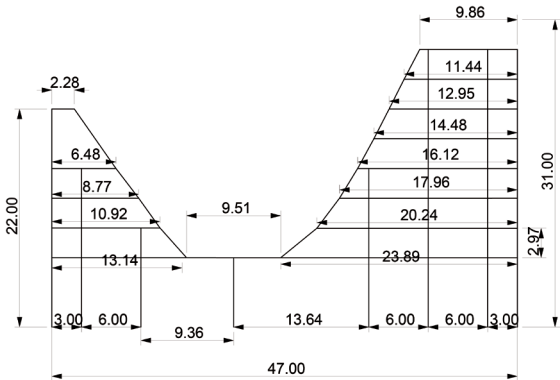
Most unfavorable load combination: Dead load · 1,2

The constraints within the two-dimensional section are all fixed supports to the ground and the jointing between slabs and frames are also stiff in terms of moment.

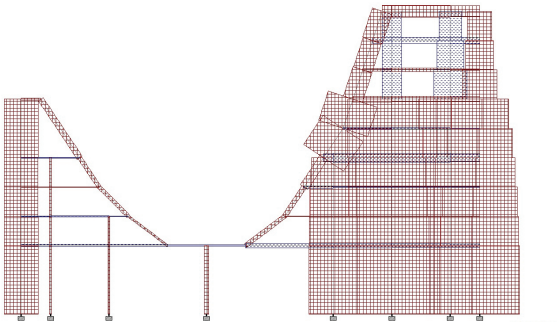
In the appendix and on the enclosed CD-ROM the entire file along with print screens, spreadsheets and reports can be found and viewed.



III. 140 - Illustration of the two-dimensional section



III. 141 - Illustration of the simplified section with dimensions i meters



III. 142 - Illustration of axial forces (Load combination: Dead load x 1,2)

Remark

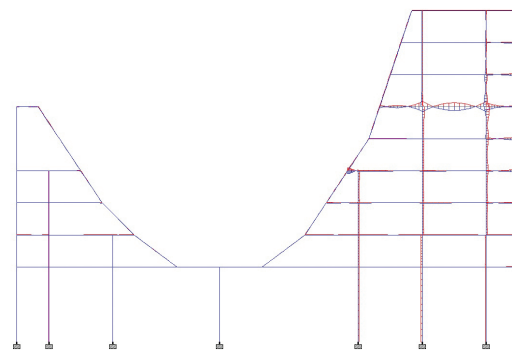
As the main structural system of the 'Book Mountains' was established early within the design phase, the subsequent physical models revealed some extraordinary strength. This consequently established a sense that the library would possess a very rigid body, which is substantiated by the later conducted FEM analysis. First of all the focus should be on that small nodal deformation which the FEM program revealed.

Due to the massiveness of the concrete double-frames, the initial proportions of 1000 x 600 mm were also considered too extensive resulting in a hollow core. This reduces the material use and cost by a third, keep the overall proportion but bring down the column proportions into two slender 1000 x 200 mm connected columns.

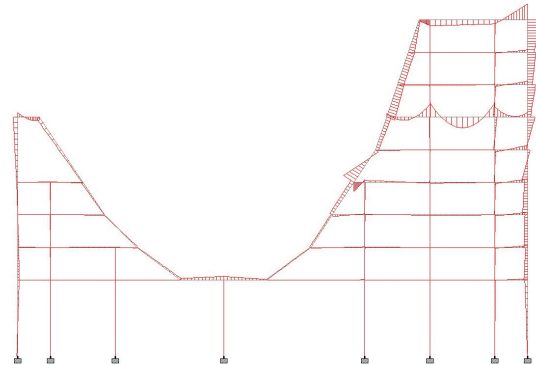
After the FEM analysis was conducted the number of columns has also been possible to increase, creating more supporting members everywhere inside the three sections of the library.

The thicknesses of these columns were also changed to the present 200 x 200 mm concrete columns – the initial ideas were columns of tubular 150 mm steel, the squared concrete beams proved to create a better reference to the large concrete double-frames, as were they carved in the same concrete.

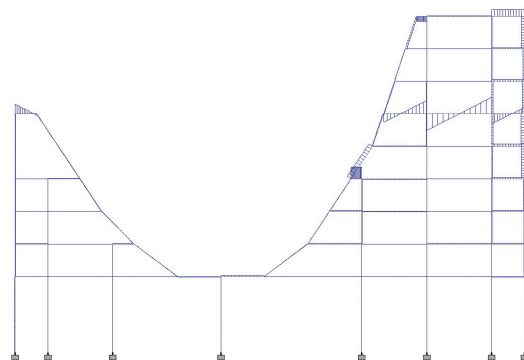
Finally the use of a thicker floor slab within the 7th floor in the book mountain, where the administration attaches, is going to aid this floor as the one where the immense forces are present. This is naturally affected due to the height (1000 mm) of the administration floor slab which, from the book mountain otherwise would have required a small stair to reach the 600 mm difference in height.



III. 143 - Illustration of the beam stresses



III. 144 - Illustration bending Z moment



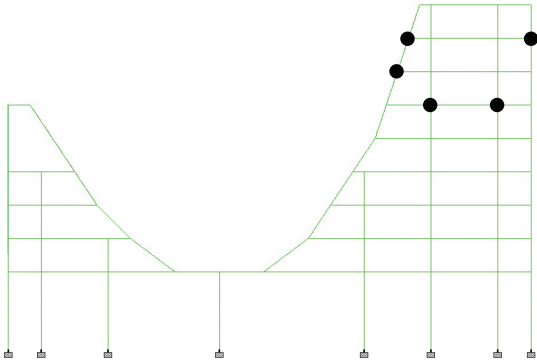
III. 145 - Illustration of shear Y force

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the largest tension value for an beam.

	Beam	Node	L/C	Axial			Shear			Torsion		Bending	
				Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)				
Max Fx	104	9	2:LOAD CASE	330.239	-0.106	0.000	0.000	0.000	0.000	0.000	-0.219		
Min Fx	59	45	4:COMBINATIC	-84.540	9.176	0.000	0.000	0.000	0.000	0.000	11.139		
Max Fy	58	46	4:COMBINATIC	13.474	151.750	0.000	0.000	0.000	0.000	0.000	127.780		
Min Fy	58	53	4:COMBINATIC	13.474	-153.530	-0.000	-0.000	-0.000	-0.000	0.000	133.123		
Max Fz	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Min Fz	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Max Mx	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Min Mx	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Max My	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Min My	1	2	1:LOAD CASE	170.333	-2.852	0.000	0.000	0.000	0.000	0.000	-0.001		
Max Mz	49	38	2:LOAD CASE	-2.091	50.338	0.000	0.000	0.000	0.000	0.000	167.453		
Min Mz	24	3	4:COMBINATIC	61.765	28.201	-0.000	-0.000	-0.000	-0.000	-0.000	-143.009		

III. 146 - Illustratins a summary of beam end forces

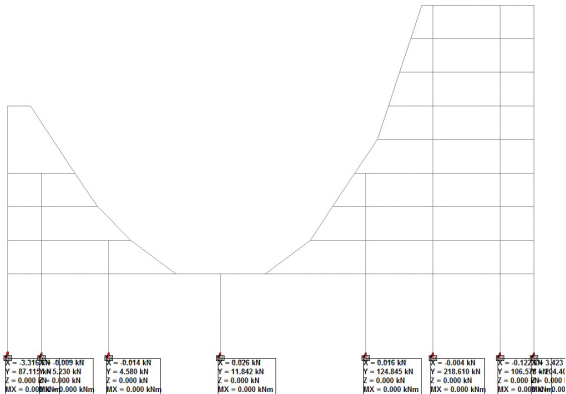


III. 149 - Illustration of the five worst node displacements

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	25	4:COMBINATIC	7.732	-0.526	0.000	7.750	0.000	0.000	0.000
Min X	26	3:LOAD CASE	-4.723	0.472	0.000	4.746	0.000	0.000	0.000
Max Y	37	3:LOAD CASE	-2.279	0.498	0.000	2.333	0.000	0.000	-0.000
Min Y	24	2:LOAD CASE	3.665	-6.105	0.000	7.121	0.000	0.000	-0.000
Max Z	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Z	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rZ	46	4:COMBINATIC	6.271	-3.132	0.000	7.010	0.000	0.000	0.003
Min rZ	53	4:COMBINATIC	6.318	-5.621	0.000	8.456	0.000	0.000	-0.002
Max Rst	26	4:COMBINATIC	7.635	-5.423	0.000	9.365	0.000	0.000	0.000

III. 147 - Illustrates a summary of node displacements

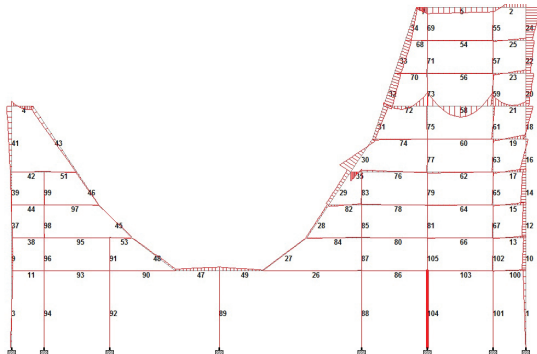


III. 150 - Illustration of the support reactions

Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	1	3:LOAD CASE	29.431	11.190	0.000	0.000	0.000	-122.054
Min FX	1	4:COMBINATIC	-3.316	87.115	0.000	0.000	0.000	9.361
Max FY	9	2:LOAD CASE	0.106	330.239	0.000	0.000	0.000	-0.219
Min FY	9	3:LOAD CASE	0.199	-12.140	0.000	0.000	0.000	-0.707
Max FZ	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Min FZ	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Max MX	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Min MX	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Max MY	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Min MY	1	1:LOAD CASE	-2.763	72.596	0.000	0.000	0.000	7.801
Max MZ	1	4:COMBINATIC	-3.316	87.115	0.000	0.000	0.000	9.361
Min MZ	1	3:LOAD CASE	29.431	11.190	0.000	0.000	0.000	-122.054

III. 148 - Illustrates a summary of reactions



III. 151 - Illustrating beam end forces

fire verification

The fire regulation has six overall criteria that need to be fulfilled in order to approve a building for use.

This can be done by either following the example collection of buildings or by calculations and computer simulations in cases where a building exceeds the example collection. Those calculations and simulations need to be performed by a fire technician and thereafter approved by the fire authorities. The six criteria's are as follow:

- **General escape routes and rescue conditions**
- **Constructive conditions**
- **Fire technical installations**
- **Fire and smoke spreading**
- **Fire and rescue services response possibilities**

In this project the main focus will be on "escape routes and rescue conditions", while "fire technical installations" and "fire and smoke spreading" only briefly will be considered.

Building sections

The first thing that needs to be considered is how the building can be divided in building sections and thereafter how each building section are going to be used; this will then decide into which application category each section will be placed.

The building is going to be separated into three sections, the ground floor, the Book Room and the administration.

Application categories

The application category used for the ground floor and the Book Room, are application category 3 which stages:

"Application category 3 concerns buildings sections with many people for daytime use, where the people that stay in the building section, not necessarily have knowledge about escape routes, but are capable by own force to bring theme self to safety.

Application category 3 concerns buildings such as: Shops, common-rooms, canteens, cinemas, restaurants, banqueting room, certain parts of schools, sports halls, churches, theaters, garage compounds,

meeting rooms, concerts halls, exhibitions rooms and other similar rooms created for more than 50 persons."

"The application category used for the administration is application category 1, which stages:

Application category 1 concerns buildings sections for daytime use, where the people that stay in the building section, have knowledge about escape routes, and are capable by own force to bring theme self to safety." [BR10]

Fire cells

The first step when placing the escape routes is to divide each building section into fire cells. The first floor could due to its many escape routes, be considered as one fire cell, but here it is quite simple just to use the existing divisions as fire cells, this would contain a fire better and thereby minimize the damage in case of fire. The bookroom is in terms of fire regulations a quite complex room; therefore the group conducted an excursion to the Fire department of Aalborg, where a meeting was held with Fire Inspector Bent Pedersen. Bent Pedersen is, amongst others, responsible for approving buildings in Aalborg. This is done either by the example collection or in cases where a building does not apply within the example collection; his task is to approve the work made by the fire technician. Due to the complex atrium of the library, Bent Pedersen were not able to conduct a solution, but he made clear, that it was possible to get the bookroom approved by the fire authorizes, if a range of steps were effected. In terms of dividing the room into fire cells, the solution proposed by him was to regard the floors in each mountain as a fire cell, and then mount a fire protecting element in each bookshelf. The openings towards the open atrium should be equipped with heavy sprinkling, which then would create a 'wall' of water, and the openings in the bookshelves should be equipped with fire doors. These could be open and automatically closed in the event of fire. The last building section being the administration is going to be divided into two fire cells, by fire protecting glass which will still create the visual effect of an open floor.

Number of escape routes

Depending on the size and number of people, each fire cell can be placed to fit within three different cases, which are decided for the number of escape routes and rescue openings needed. The three cases are showcased in the diagram next page.

Access to Escape routes and rescue openings			
Room area	Number of persons	Number of accesses to escape routes	Rescue opening
<150 m ²	<50	1	Yes
>150 m ²	<50	2	Yes
-	>50	Min. two independent escape routes	No

Ill. 152 - Illustration of required escape routes of different sized rooms

First floor

The first floor is going to use the example of all three cases, depending on the function of the fire cell.

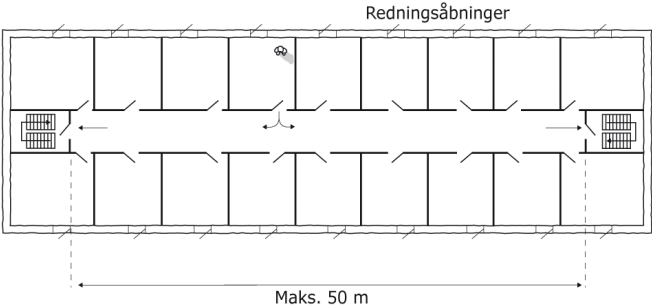
Exhibition (open area)	case three
Confrence	case one
Fitness	case three
Café	case two
Bookshop	case two

The Book Room

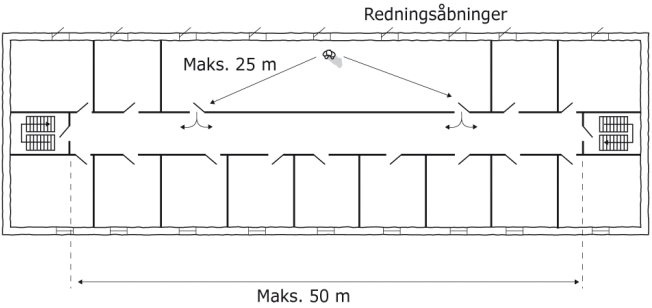
Within the main atrium is as mentioned going to consider the floors in each mountain as fire cells. The entire bottom floor are considered as one fire cell, and will be placed within case three, floor number two will also fall with in case three, on floor number three the two biggest floors will be placed in case two while the two small floors will be placed in case one, on floor number four the biggest floor will be placed in case two while the rest will be placed under case one, the rest of the floors will be placed within case one.

Administration

The administration will be divided into two fire cells where both fire cells are placed within case three.



Ill. 153 - Access to escape routes and rescue opening for fire cells up to 150 m² and max. 50 pers.



Ill. 154 - Access to escape routes and rescue openings for fire cells larger than 150 m² and max. 50 pers.

Dimensions of escape routes

The minimum width of an escape route should be 1,3 m. This is though not always enough to ensure easy passage, therefore escape routes from buildings sections within application category two and three dimensioned for many people (more than 150), should have a width of minimum 10 mm per person that uses the escape route. The Book Room are as explained considered as being one building section, and should therefore in theory have its escape routes dimensioned by the number of people in the entire bookroom. In this case it would though be more realistic to dimension the escape routes in relation to each fire cell, because each fire cell has its own entrance to an escape route.

Placement of escape routes

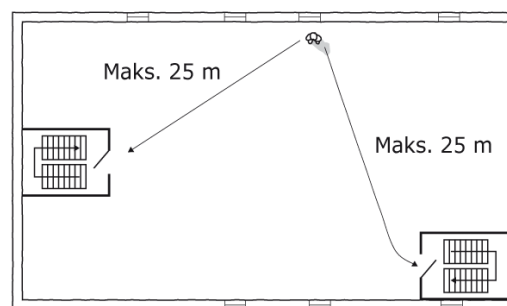
There are four escape staircases in the building, these staircases are placed in the four biggest mountains, and three of them go all the way up to the administration, while the last one only reaches the second floor in the bookroom. The bookroom also have the exit in the café area as an escape route, while the first floor uses all the existing exits as escape routes.

Fire and smoke spreading

When fire-dimensioning a room, fire and smoke speeding are an important factor. The better the fire can be contained and the better the smoke can be led away, the smaller the change is for a disaster fire. There are several different measures that can be taken to help slow down the fire. Useful fire-technical installation for this project could be: an automatically sprinkler system, that puts out a fire in the beginning phase or helps to control the fire until other forms of fire-fighting can be set in motion. A automatically fire alarm system (ABA) that registers a fire in the begging phase and hereafter automatically alarms the fire department. This installation can also activate other fire-technical installations; a fire alarm with a spoken message could help to create a more efficient evacuation of the two public areas in the building. Firefighting equipment (fire hoses, extinguishers etc.) for persons without particular firefighting skills can be placed on selected spots in the building; this can help to put out fires in their early stages. High-pressure water outtakes (riser pipes) can be placed in the building so firefighters have easier access to water and a better mobility in the building. These installations would in combination create a building with a high degree of fire-safety, and could thereby be applied to help get the building approved by the authorities. Smoke ventilation is also imported both because of smokes toxic effects and its impact on the visibility in the building, which could cause

confusion in the evacuation and create difficult conditions for the fire fighters. There are two forms of smoke ventilation, one is thermal ventilation which uses the heat of the smoke and the other is mechanical ventilation. In this building a mix would properly be necessary due to the height of the building, which would cause a cool down of the smoke and thereby stop the thermal ventilation. The smoke ventilation will be conducted through the three holes in the ceiling and windows in the façade.

[BR10]



III. 155 - Access to escape routes for fire cells with more than 50 pers.

daylight verification

To test and document the light conditions in the building, the software application Autodesk Ecotect (tm) is used to simulate the natural light in the building. The analyses' are performed on the ground floor, in the bookroom and on the administration floor. These three places are found to provide indications of the daylight quality within the library. The area of investigation has been conducted in one meters height above the floor.

Bookroom

In the bookroom the daylight calculations are only preformed on the browsing area and the two lowest floors; due to this being the most challenging in terms of getting good daylight conditions. The problem area are behind the two building cores (fire escape stairs and toilets), but even here the daylight factor is 14 %. Another problem area could be in the center of the browsing area, as this is located remote from the facades; but here the tree big skylights in the roof helps to bring light deep into the room, together with the height of the glazed façade, allowing light to reach deep within the room. As an addition the skylights also helps to get a further even light distribution, and the daylight factor in the center of the browsing area are above 25 %. All in all the analyses shows that the Book Room have quite good lighting conditions, with an average of 8 % and a lowest around 6 %.

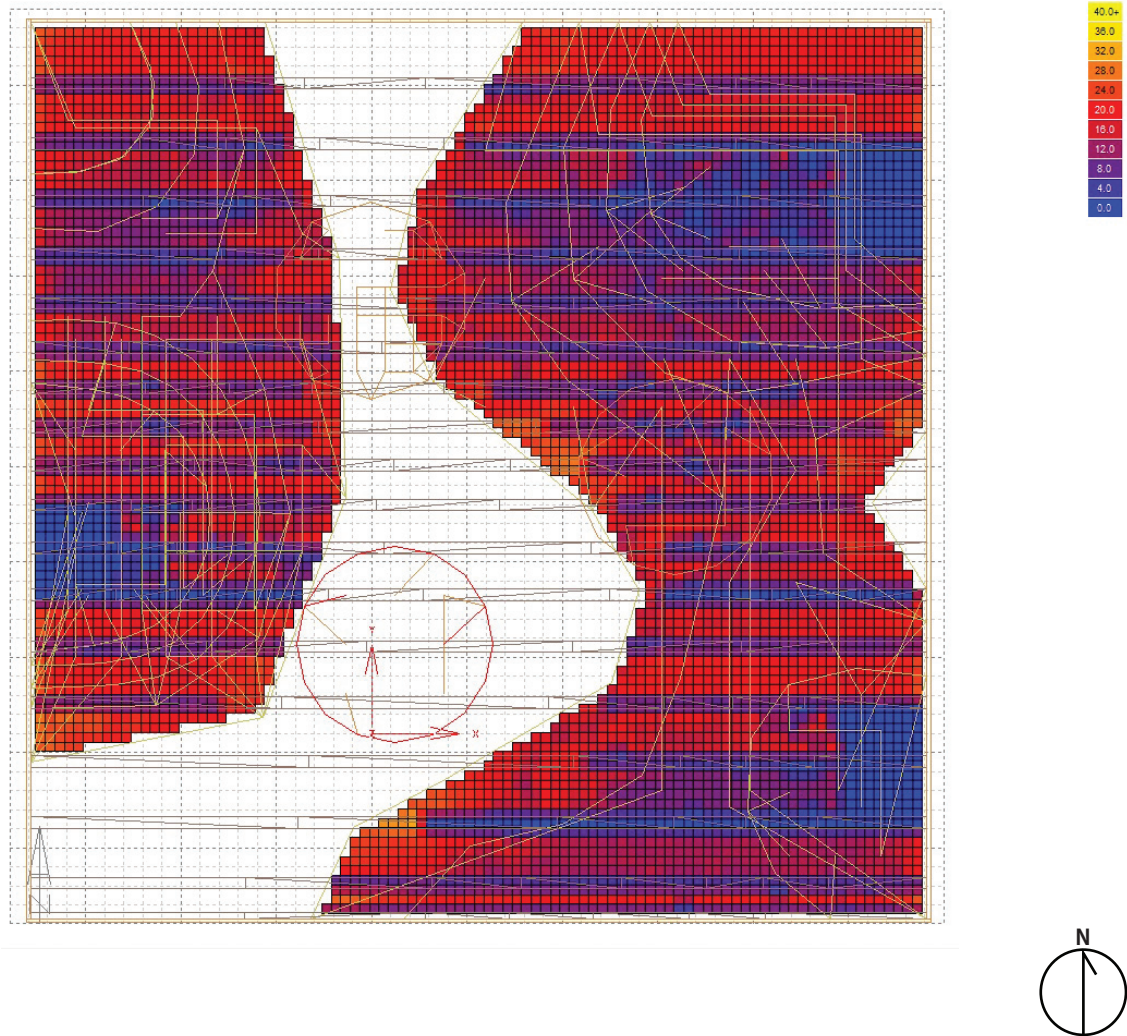
Administration

The administration has as expected very good light conditions, and with an average of 26,4 % and a lowest of 15 %. Light here should not a problem due to the high placement and the large glazed panorama view. This is also why the façade is provided with shading lamellas towards the sun in order to provide shade. The holes in the roof have the same effect as in the bookroom, and even though light is not a problem in the administration, the holes creates a more even light level. Finally the height of the roof construction creates shading from direct sun rays.

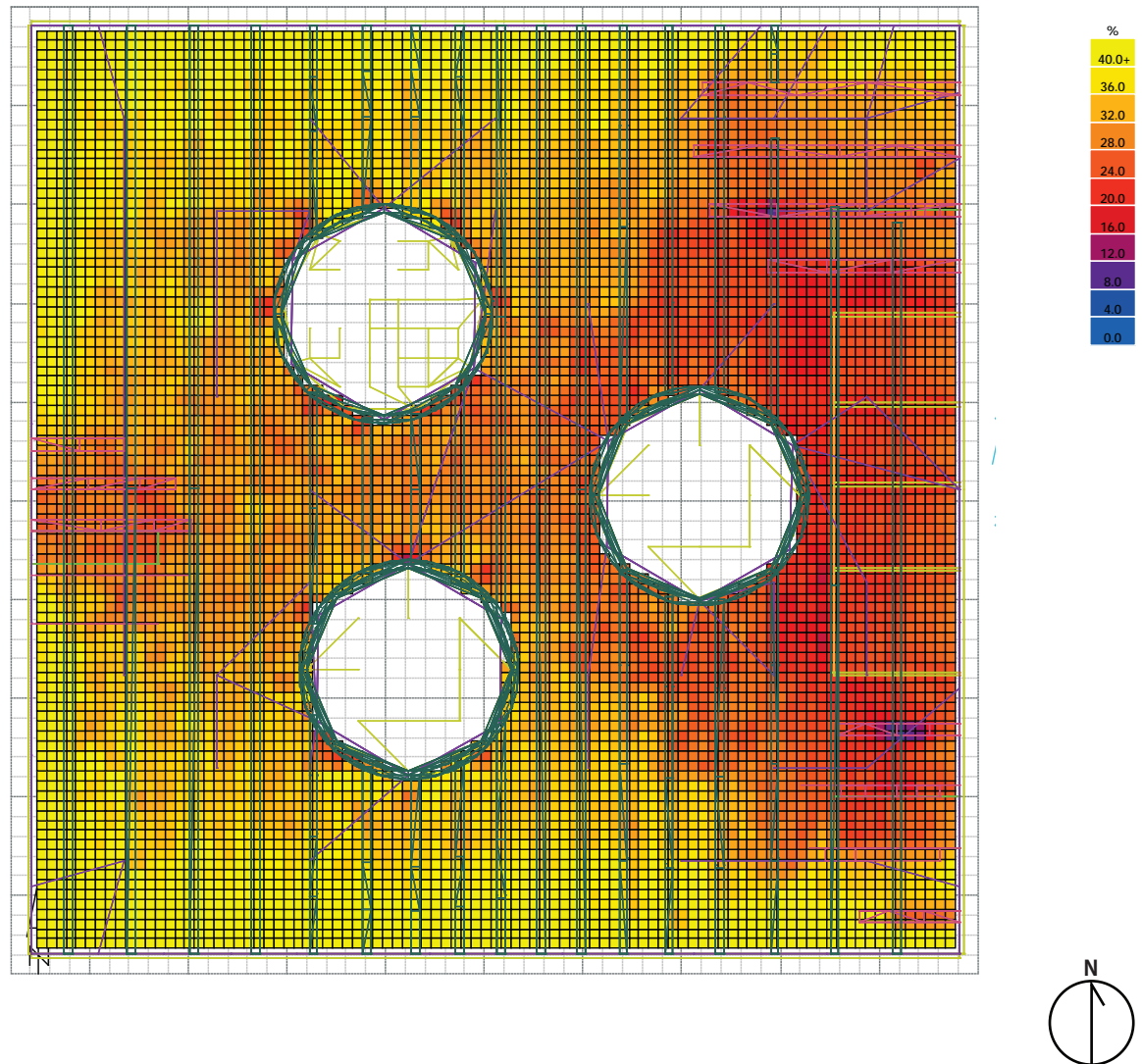
Ground floor

The ground floor poses the greatest challenges in terms of getting enough daylight into the room, because this room does not have the tree holes in the ceiling, and thereby have some problems with getting daylight into the center of the room. But with an average daylight factor of 18,5 % and a lowest of 8 %, the room still have enough daylight, but a problem with uneven light levels could acquire. The results of the ground floor should though be seen with the fact that the potential shading from the foliage to the east and the sloped pavement towards the west would create extra shading towards the ground floor causing a lower daylight factor. The daylight here is thus thought to be supplied by electrical lightings in the public areas of the first floor.

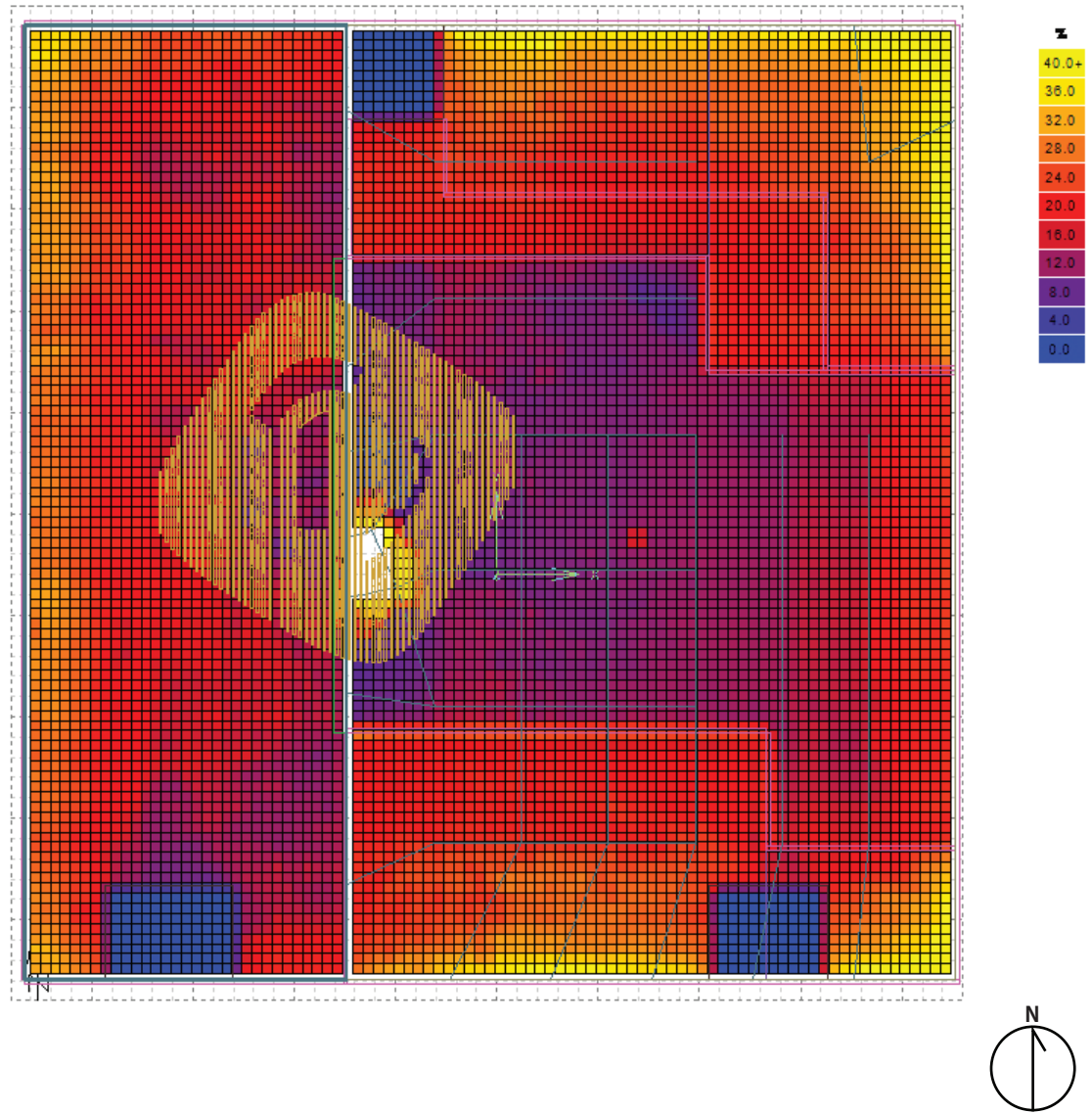
To conclude the light analyses, the building has a quite good overall light performance, it provide no overall dark spots and light is always present from at least two sides - in fact the Book Room is provided with light from all five directions opening up for the question of overall solar shading of the entire building.



III. 156 - Shows the analysis grid of the 'Book Room' used for the daylight simulation within Ecotect



III. 157 - Shows the analysis grid of the administration used for the daylight simulation within Ecotect



III. 158 - Shows the analysis grid of the ground floor used for the daylight simulation within Ecotect

acoustic verification

The 'Book Room' is chosen for the acoustical analyses, because this room presents the greatest acoustical challenge. It has a vast atrium and a range of open floor slabs discharges into this. At the same time a range of different functions are going to take place within the Book Room ranging from relaxed browsing and conversations to meetings and studying. To accommodate these different aspects of use the acoustical investigation will be showcased.

Room acoustic

Good room acoustic is not only about controlling the reverberation time; to create good acoustic comfort, four parameters needs to be for filled, the parameters is as followed:

- **Appropriate reverberation time**
- **Uniform sound distribution**
- **Appropriate low background noise**
- **No echo or flutter-echo**

The reason why the word "appropriate" is used is that every factor needs to be adjusted according to the conditions. [troidtekt.dk]

Appropriate reverberation time

To find the appropriate reverberation time for a library, the national building regulation BR08 (part 6.4) have been used. This however do not specify the acoustic demands for a library, so instead an outset has been taken in the acoustic demands for a classroom and a common-area used for group work together with a conducted graph of large-room reverberation time recommendations produced by W. Furrer. This has led to an wish of a reverberation time approximately between 0,6 and 1,0 seconds. As an edition to this the reverberation time should be as constant as possible, in the entire frequency spectra.

Uniform sound distribution

Uniform sound distribution is quite simple, it means the sound level only are allowed to have small variations, this is important issues in theaters and auditoriums, so all the spectators are able to hear. This

aspect is not an important issue in this building, and will therefore not be elaborated within the project.

Background noise

Ensuring a low background noise is often one of the most important aspects in creating good room acoustical conditions. When working with background noise, the focus is often only on external distortion such as traffic noise, but background noise can also be emitted from technical installations such as projectors, computers and ventilation.

No echo and flutter-echo

Before a room can be considered as having good acoustic conditions, echoes or flutter echoes are not allowed to appear. An echo appears when the reverberation time in a larger room creates strong isolated reflections. This can occur when a room has a large rigid wall in the opposing end of a sound source. The echo appears when the time delay is more than 50 ms – equivalent to the sound having traveled around 17 meters.

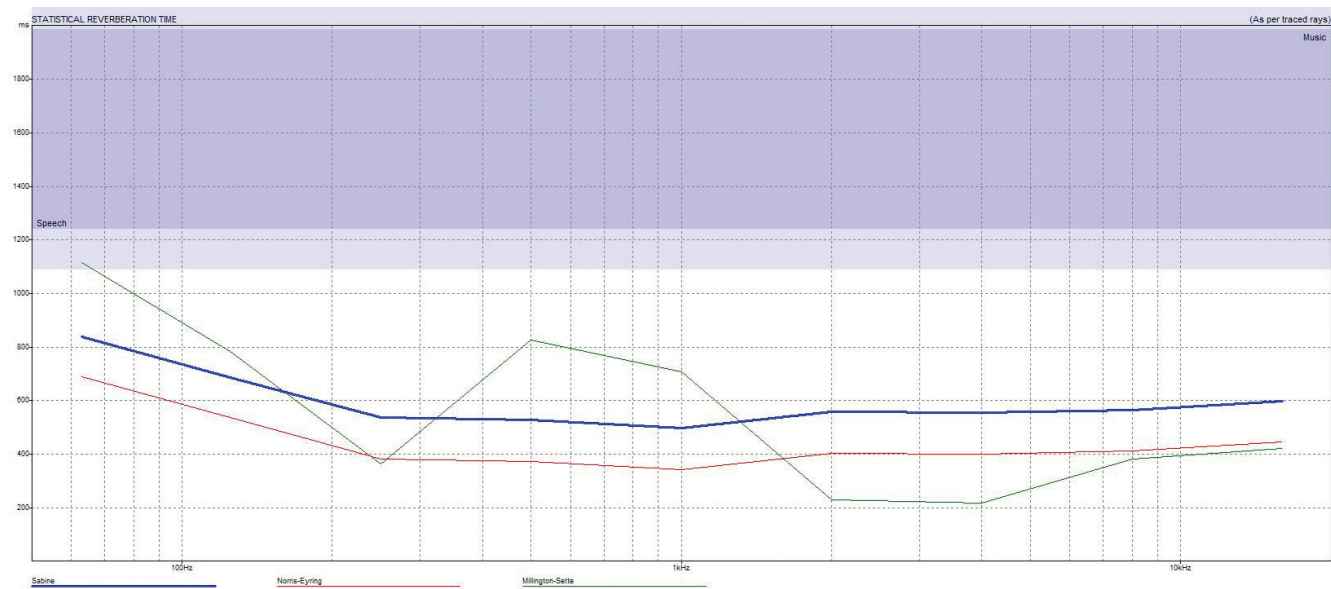
Flutter echoes are different; they appears when a room have two large, smooth and hard wall surfaces, which are parallel to each other. In this case a sound source will create an echo that wander back and forth between the two walls. A little sound absorbing material on one of the walls will efficient remove the flutter-echo.

Calculating the ‘Book Room’

The relevant parameters in this project, is reverberation time, echoes and flutter echoes. To substantiate that the library preforms well acoustically, a mix between computer simulation, reference projects and knowledge about acoustics have been used. As a first step to analyze the acoustics the computer simulation software Ecotect has been used to calculate the reverberation time. The program uses tree different formulas to calculate the reverberation time; Sabine formula, Norris-Eyning formula and Millington-Settes formula. These calculation methods all have their advantages and disadvantages, but together they provide a good picture of the acoustic conditions – and the reverberation time. An important parameter when calculating the reverberation time is the acoustical properties of the materials. A library have the advantages of having large areas covered by books, which on top of having a good sound absorbing, also provides an irregular surface that distributes and defuses the sound. Besides book which covers the main part of the surfaces within room, the Book

Room consists of an acoustic tiled ceiling, wooden floors, and concrete on the edges of the double-frames, acoustical panels that cover the edges of the floor levels and finally glazed internal facades. (The absorption coefficient of the materials can be seen in the appendix) When calculating the reverberation time with these materials, it proved to be a little too high – therefor the upper parts of the bookshelves are covered with acoustical panels. This increases the amount of acoustical panels in the room by approximate 25 percent. The new calculation then showed a quite good reverberation time. I terms of defusing the sound, the library naturally performs quite good, due to the many books creating an uneven surface with a random pattern – this is close to the optimal surface when wanting to defuse the sound.

The absorption coefficients of the selected materials can be found in the appendix section in the back of the report. On the following page the calculated times can be viewed.



III. 159 - Graph illustrating the three calculated reveberation times of the ‘Book Room’

Estimated reverberation:

Number of Points: 91024 (64 Reflections)
Effective Surface Area: 16520.695 m2
Effective Volume: 27776.143 m3

Most Suitable: Norris-Eyring (Highly absorbant)

FREQ.	TOTAL ABSPT.	SABINE RT(60)	NOR-ER RT(60)	MIL-SE RT(60)
125Hz:	6609.565	0.68	0.53	0.77
250Hz:	8442.207	0.53	0.38	0.36
500Hz:	8591.153	0.52	0.37	0.82
1kHz:	9170.443	0.49	0.33	0.70
2kHz:	8210.927	0.54	0.39	0.23
4kHz:	8259.601	0.54	0.39	0.22

The mean times are presented underneath – each column has been summed and the average time found:

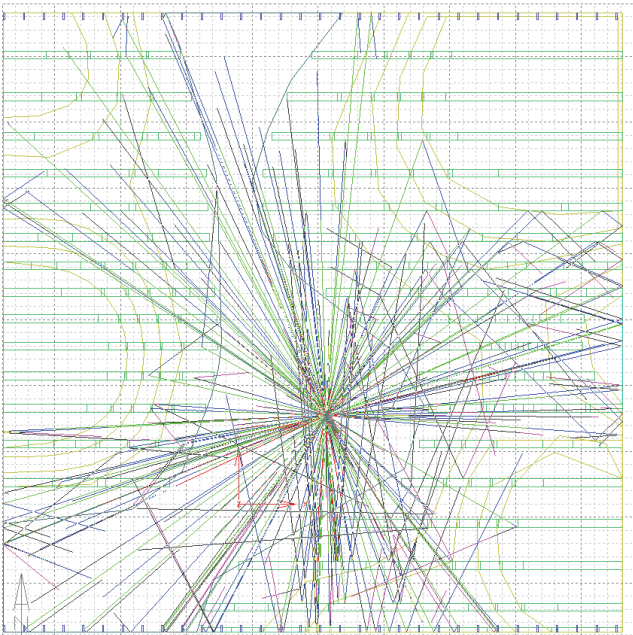
Sabin: 3,30 / 6 = 0,55 seconds
Nor-Er.: 2,39 / 6 = 0,39 seconds
Mil-Se.: 3,10 / 6 = 0,51 seconds

Summary

As the requested reverberation times are reached within the Book Room, this text will summarize the acoustics of the house. The times tend to be a little low in order to hover around 0,6 – 0,8 seconds, but are seen very satisfying. The times should be seen as approximations, mainly due to the simplified model geometry used in the software. The calculation is also conducted without persons and furniture inside. As this aspect would increase the absorbing areas within the room, the presence and noise level of many people inside the room is presumably seen as out-leveling this. As with the function of the library mainly orbiting around the act of serious working and studies, this aspect is not seen as inferior to the project.

As the Ecotect uses ray-tracing software when computing the reverberation time, this also, can be seen as a simplification of the results, due to the confined amount of computer power available. The results show cased here are conducted by 500 rays, ejected spherically from human height in the browsing area.

Finally it could be argued that the sabine formula together with the two other methods, thus conducted for architectural analysis, mainly is addressed for minor and less complex room types than with the case of the Book Room.



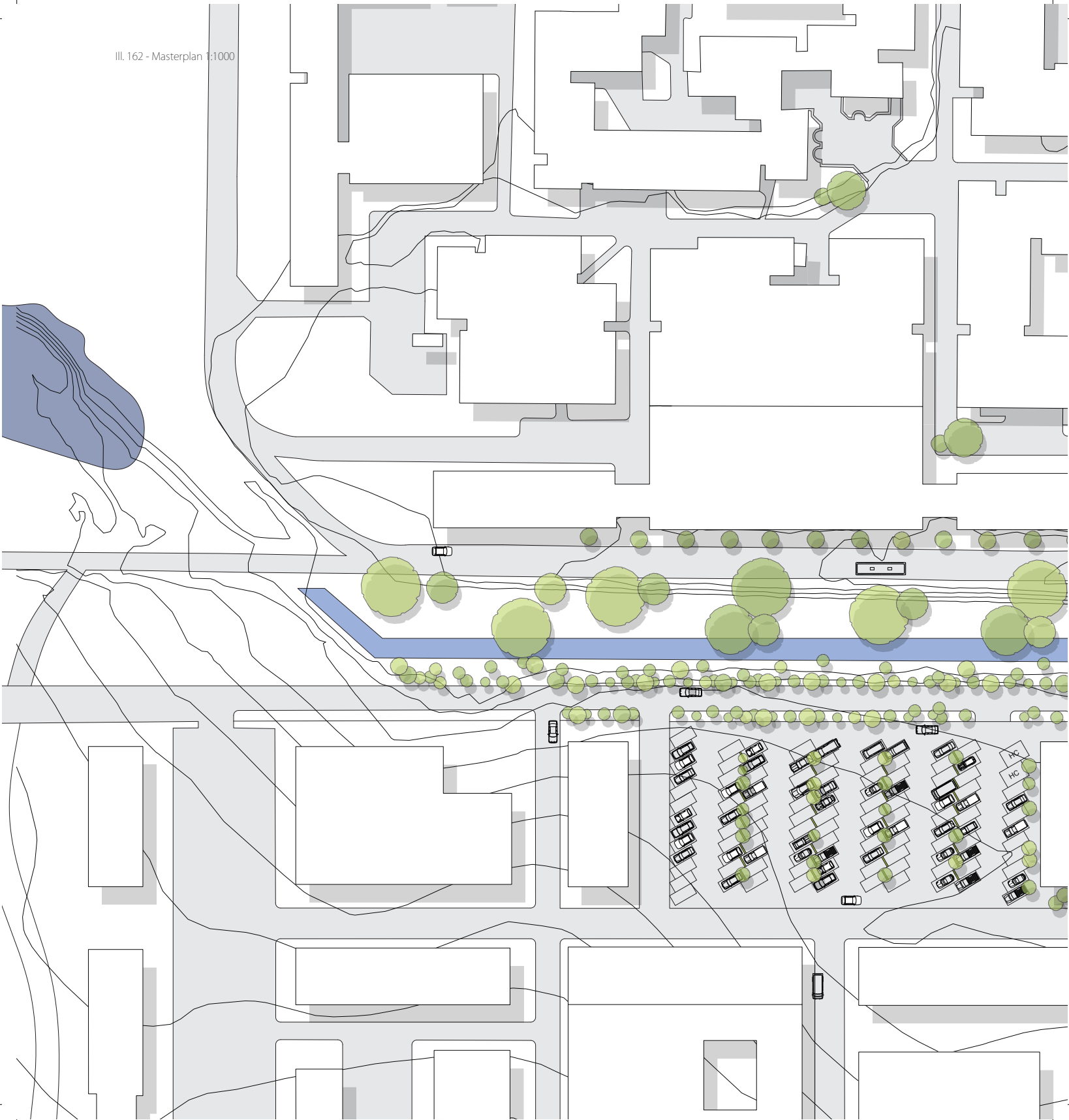
III. 160 - Test illustration of the ray-traced simulation (simplified version with 100 rays)

07 PRESENTATION.

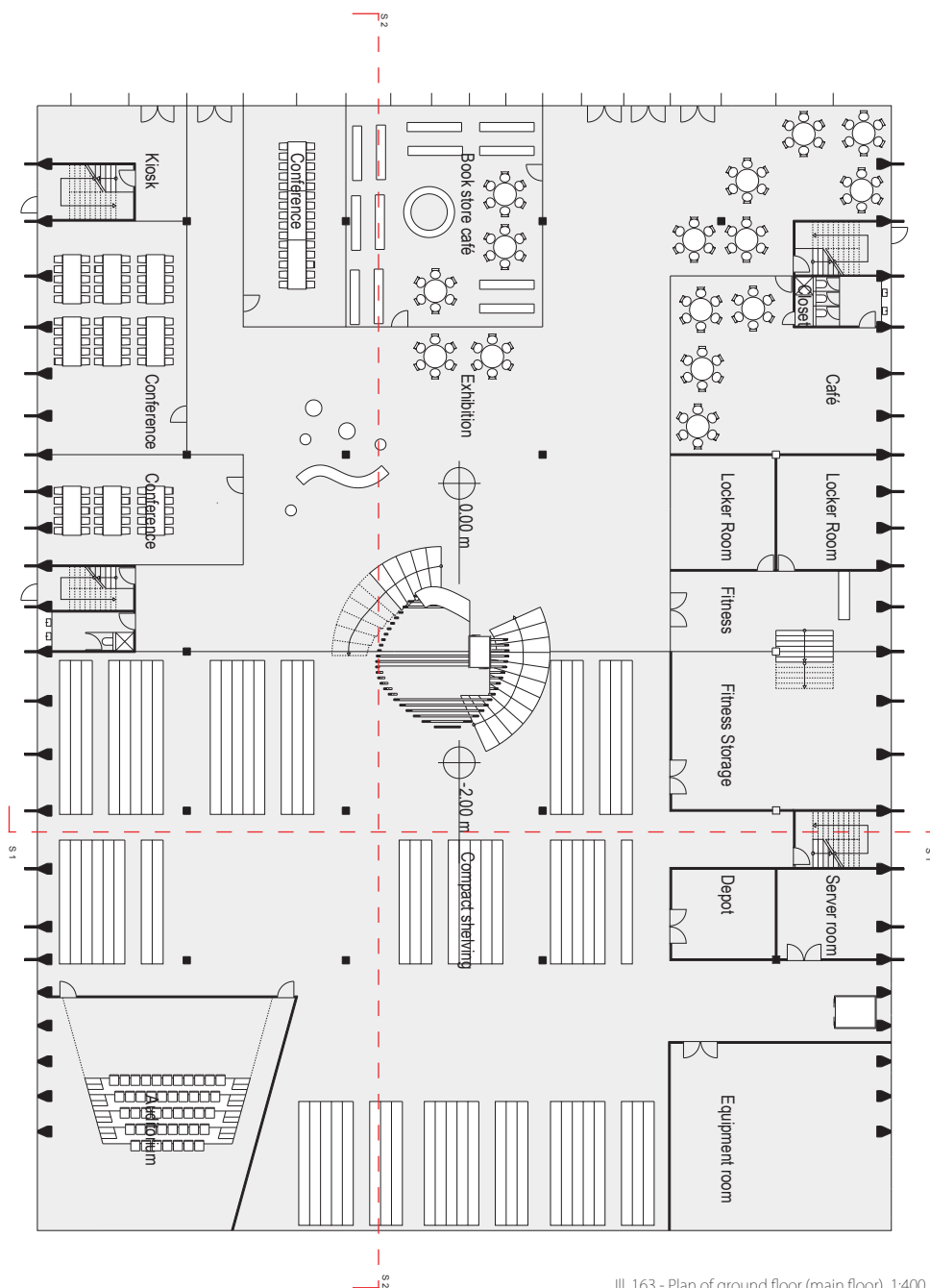
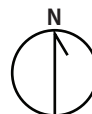




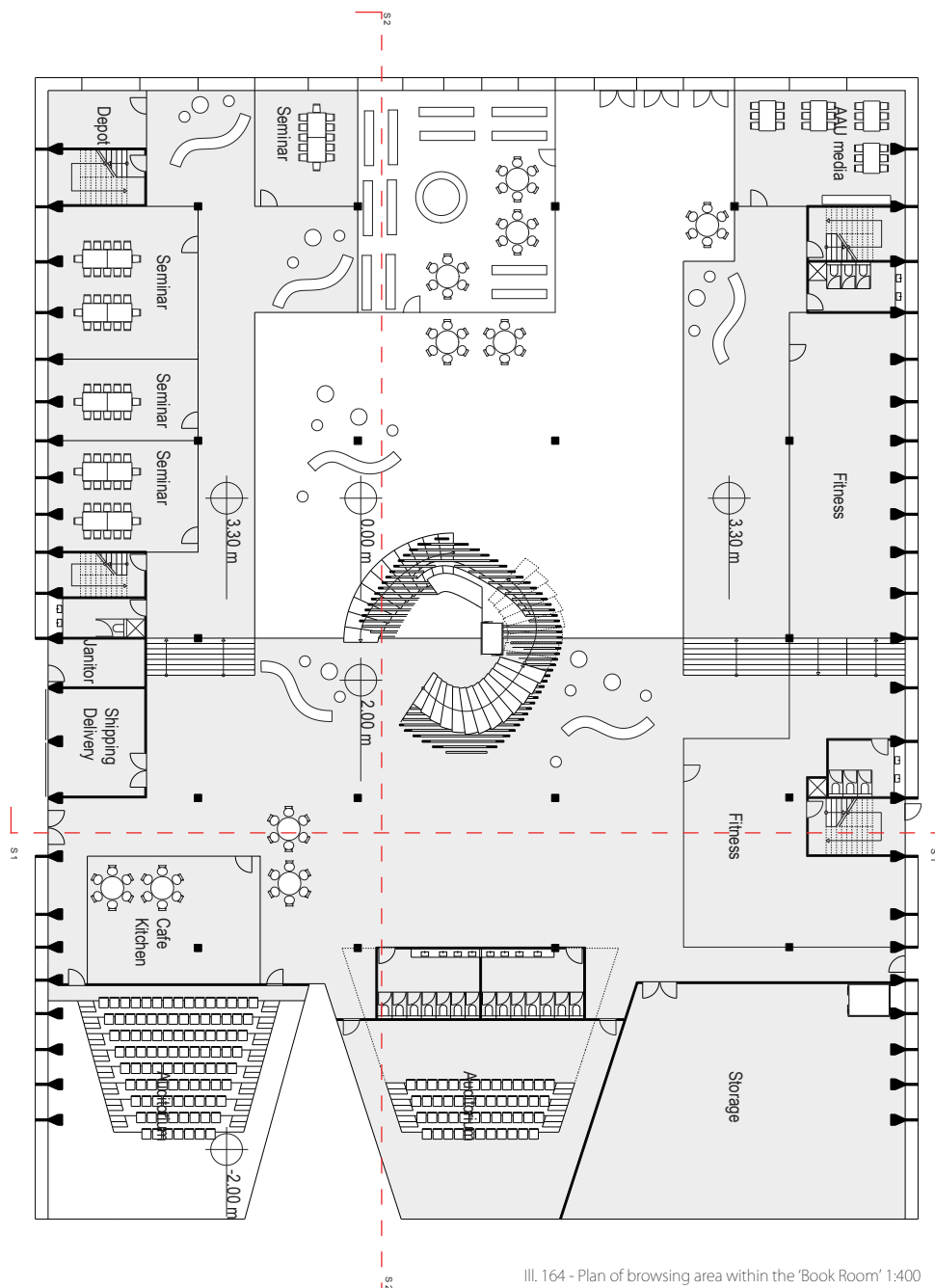
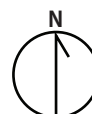
III. 161 - View inside the 'Book Room'



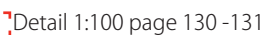




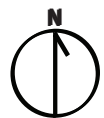
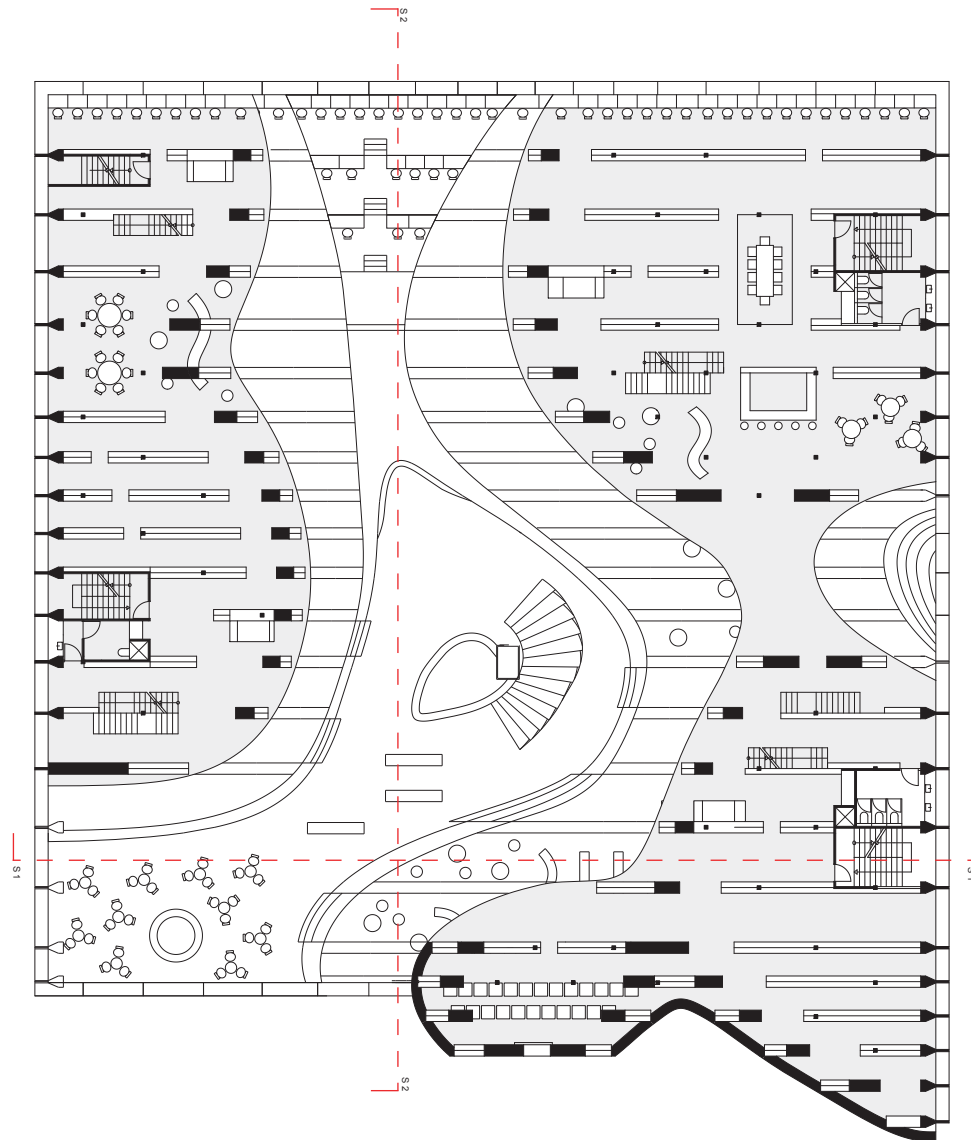
III. 163 - Plan of ground floor (main floor) 1:400



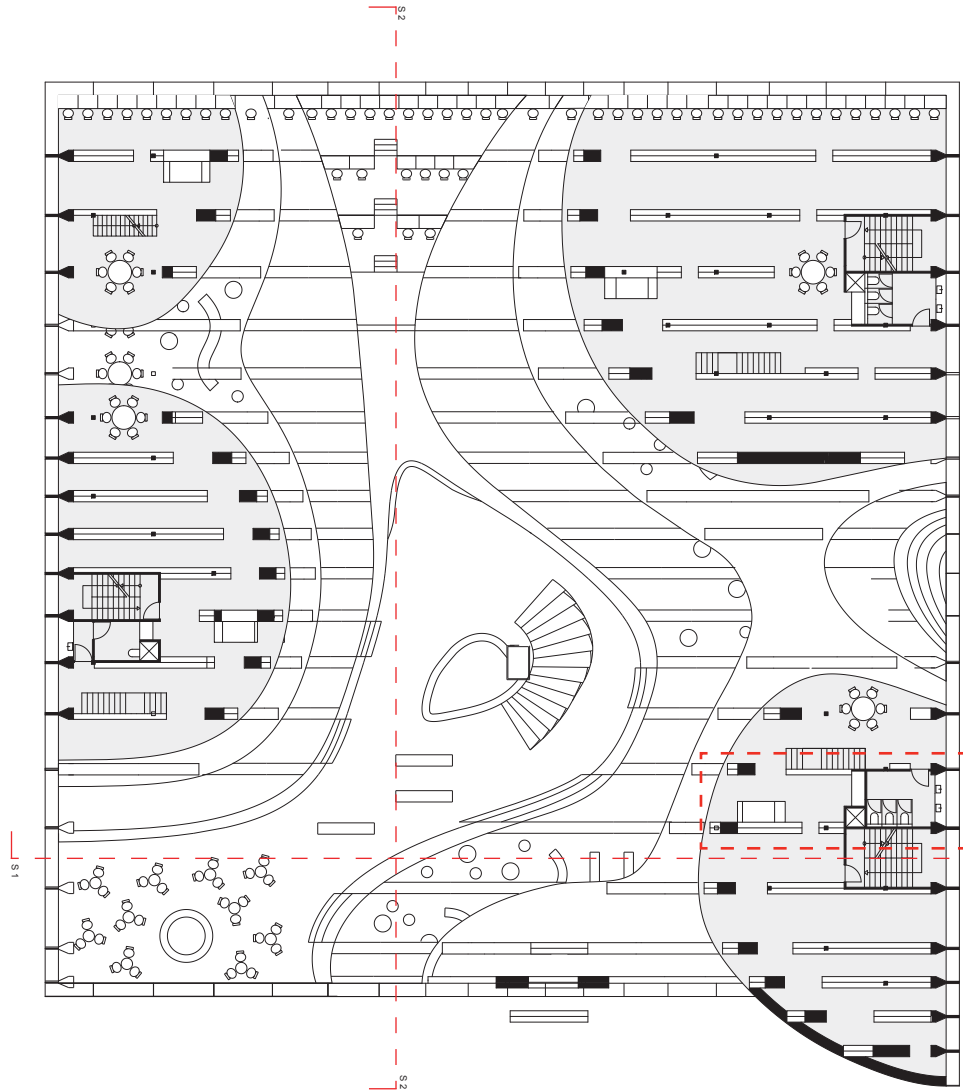
Ill. 164 - Plan of browsing area within the 'Book Room' 1:400



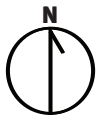
III. 165 - Plan of 2nd floor within the 'Book Room' 1:400



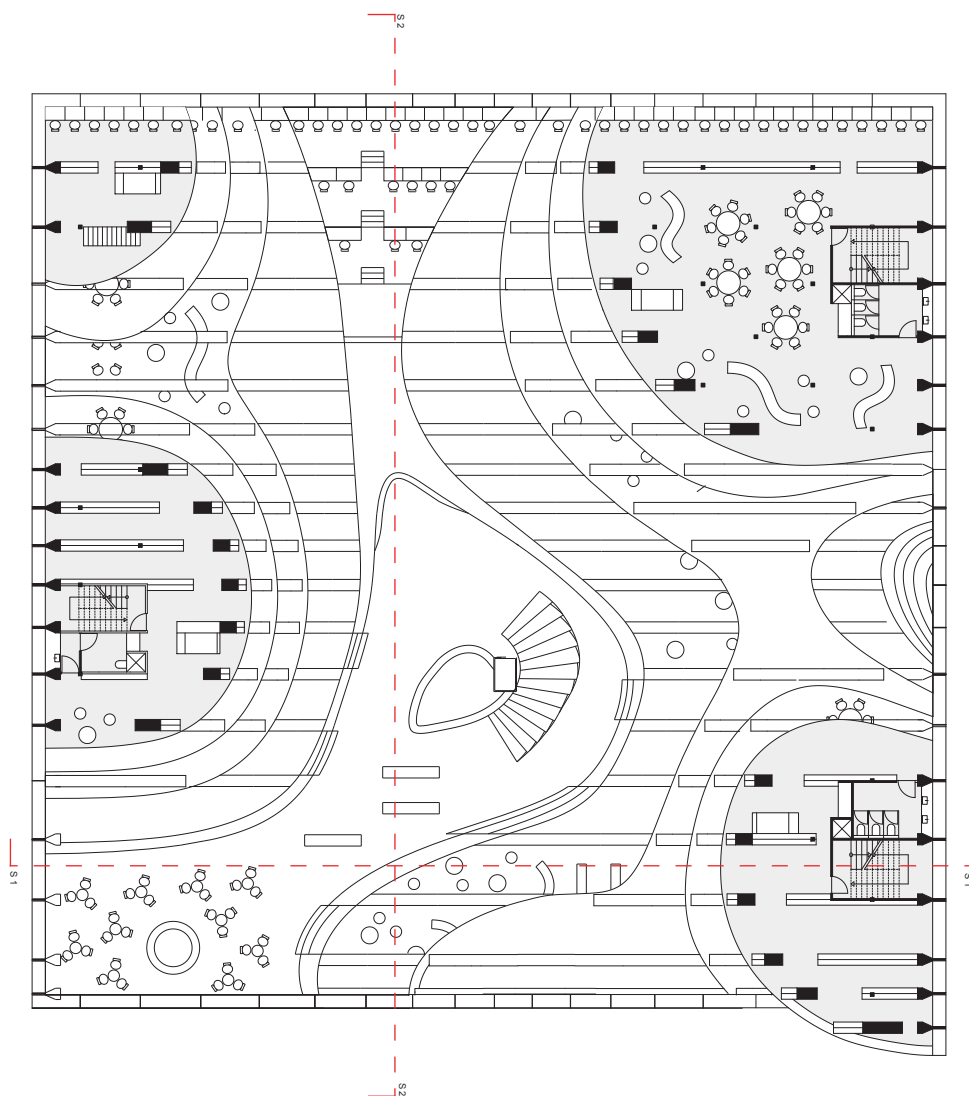
III. 166 - Plan of ground floor (mezzanine floors) 1:400



Detail 1:100 page 130 -131

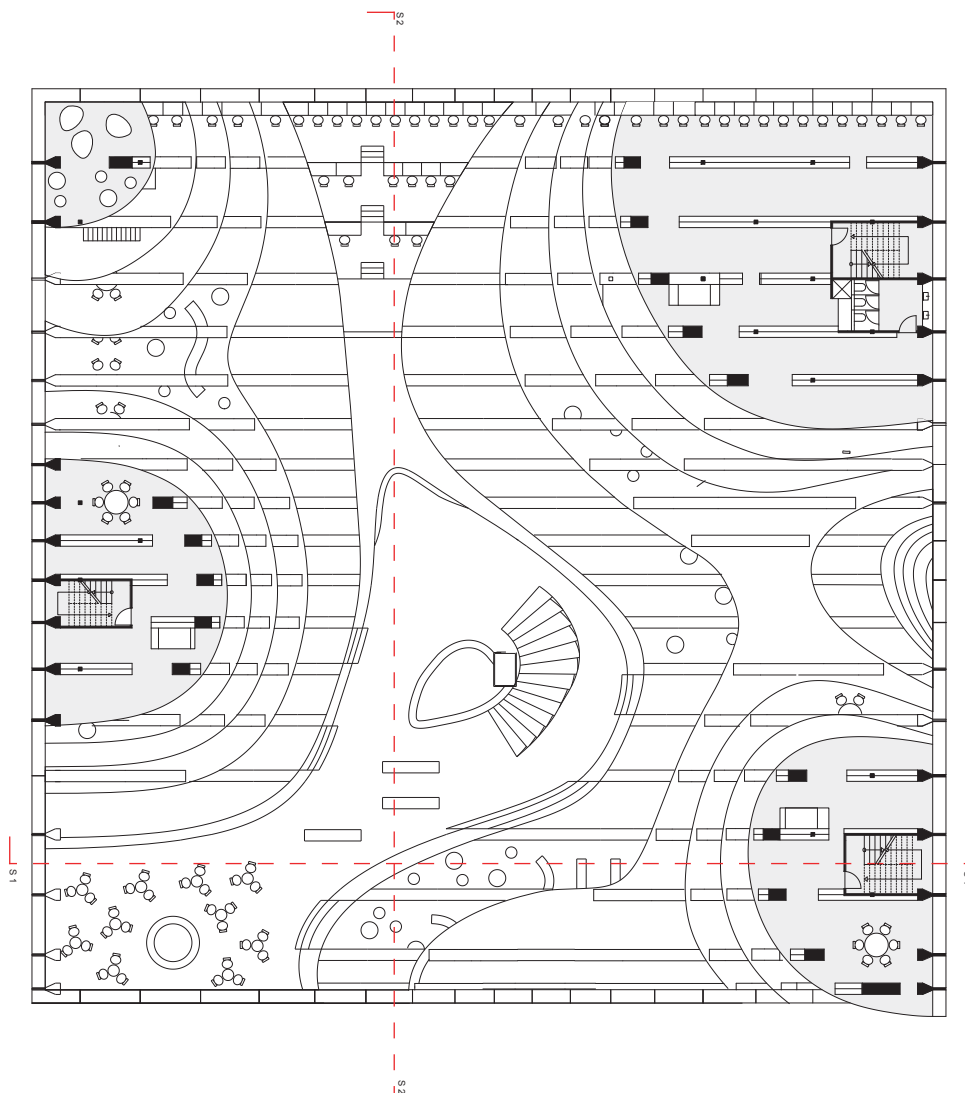


III. 167 - Plan of 3rd floor within the 'Book Room' 1:400



III. 168 - Plan of 4 th floor within the 'Book Room' 1:400

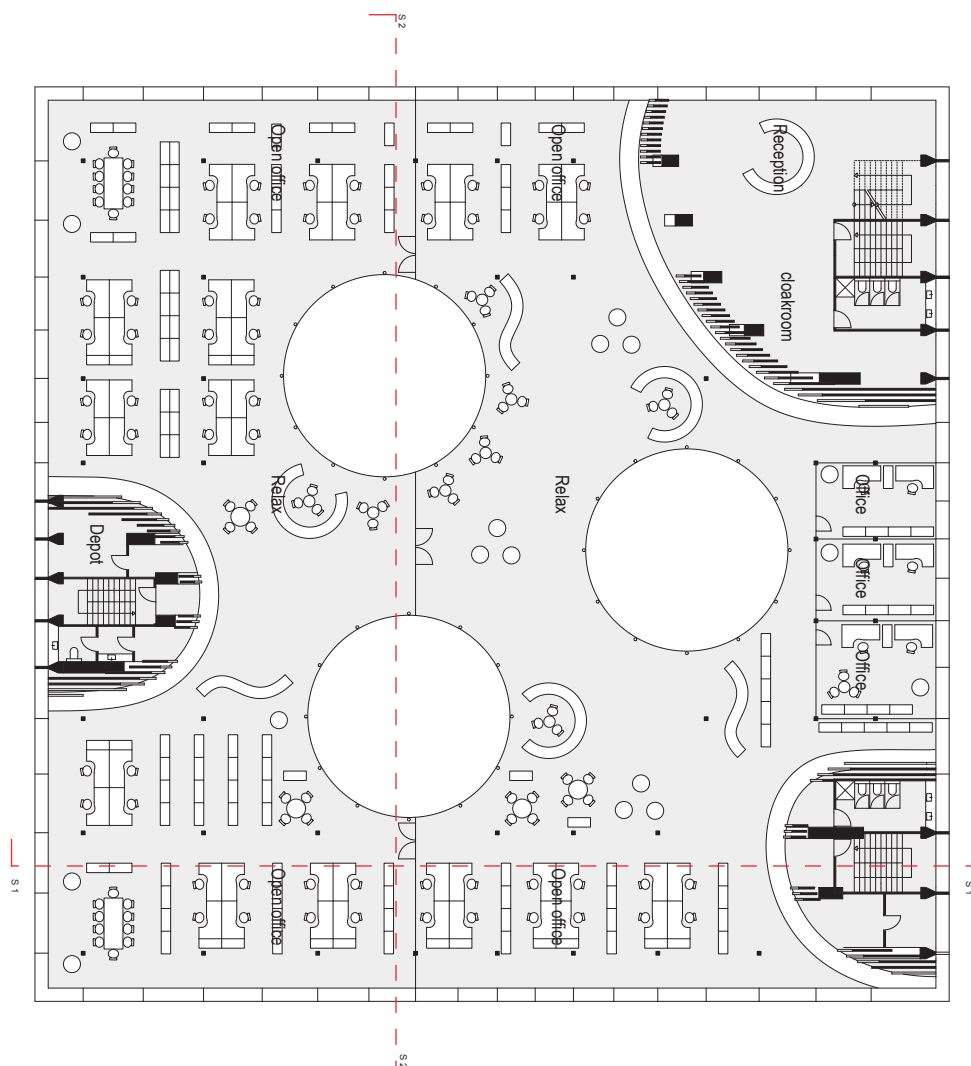


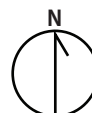


III. 169 - Plan of 5th floor within the 'Book Room' 1:400

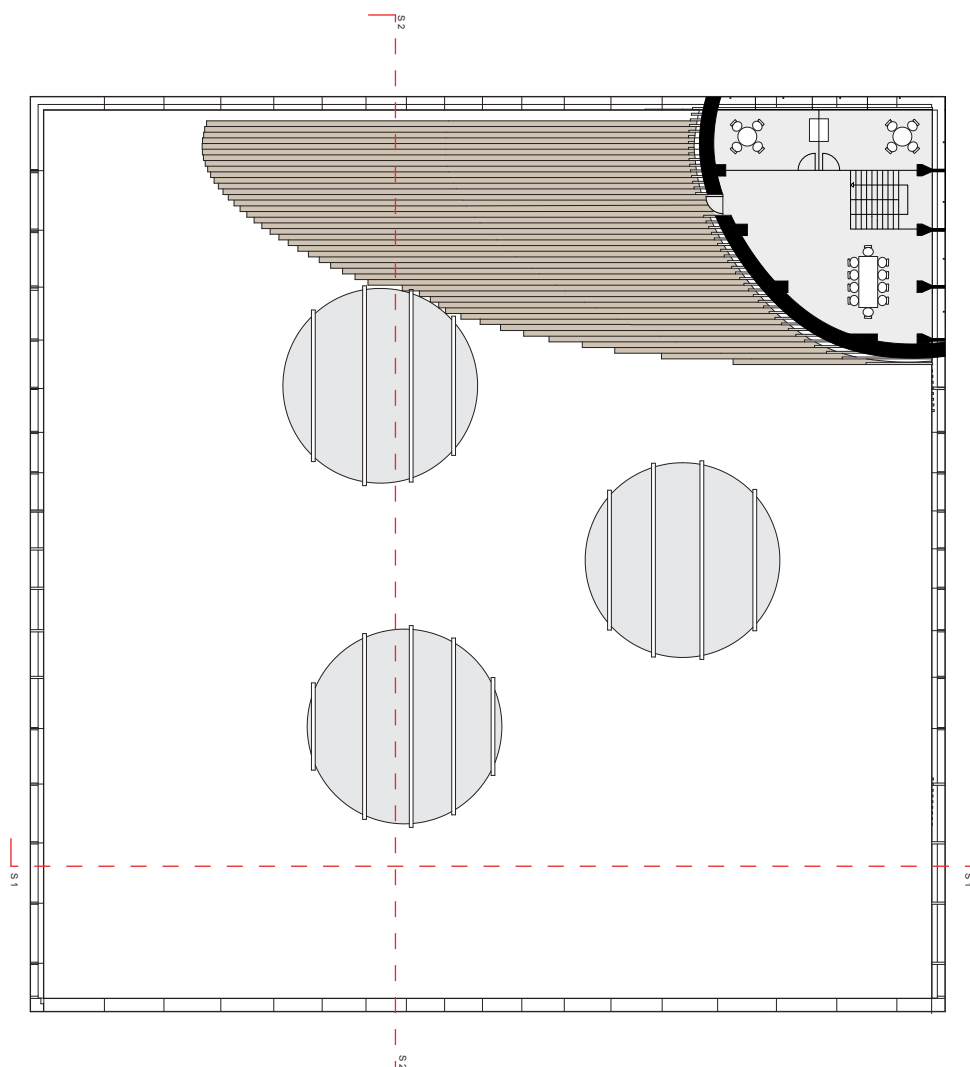


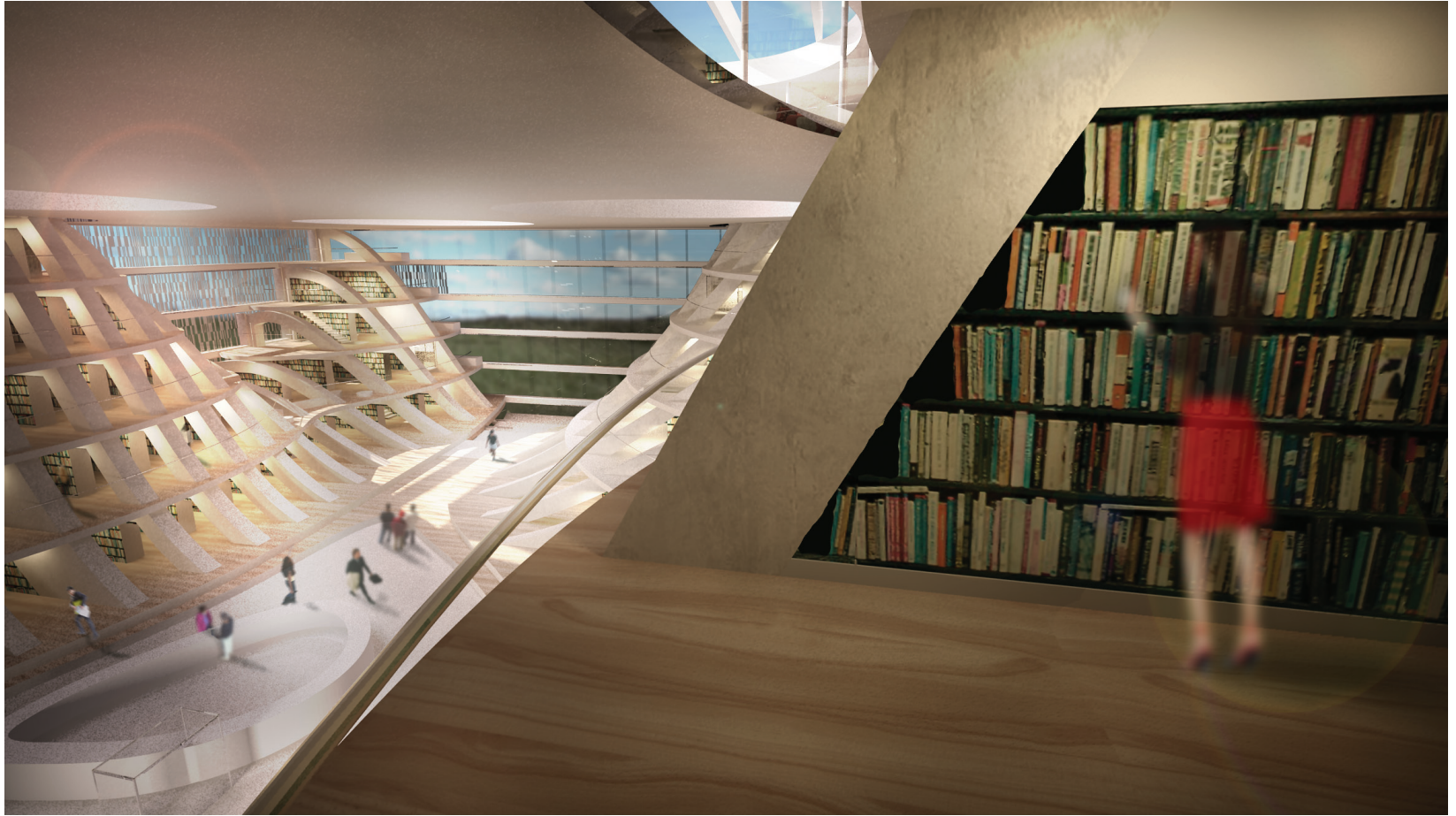
III. 170 - Plan of administration floor 1:400



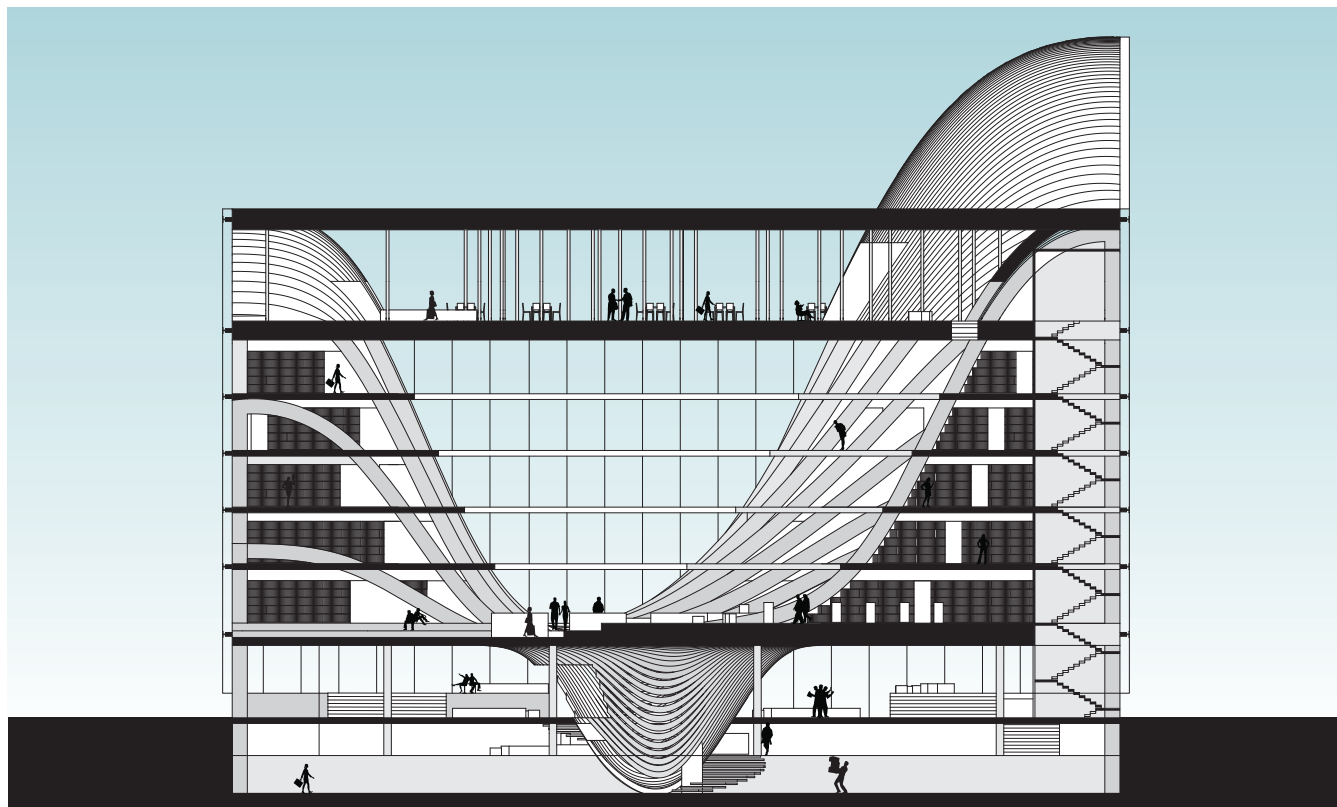


III. 171 - Plan of administration ('peak' top) 1:400

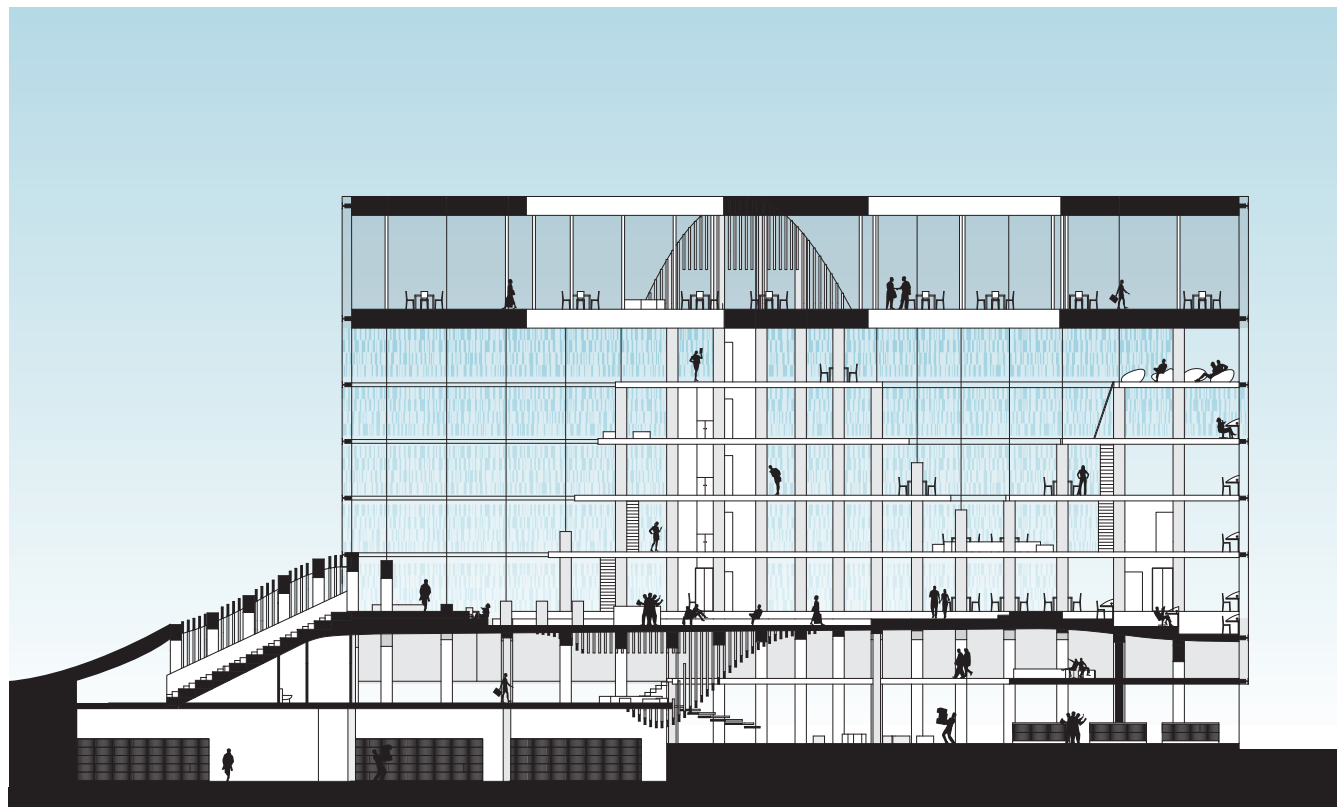




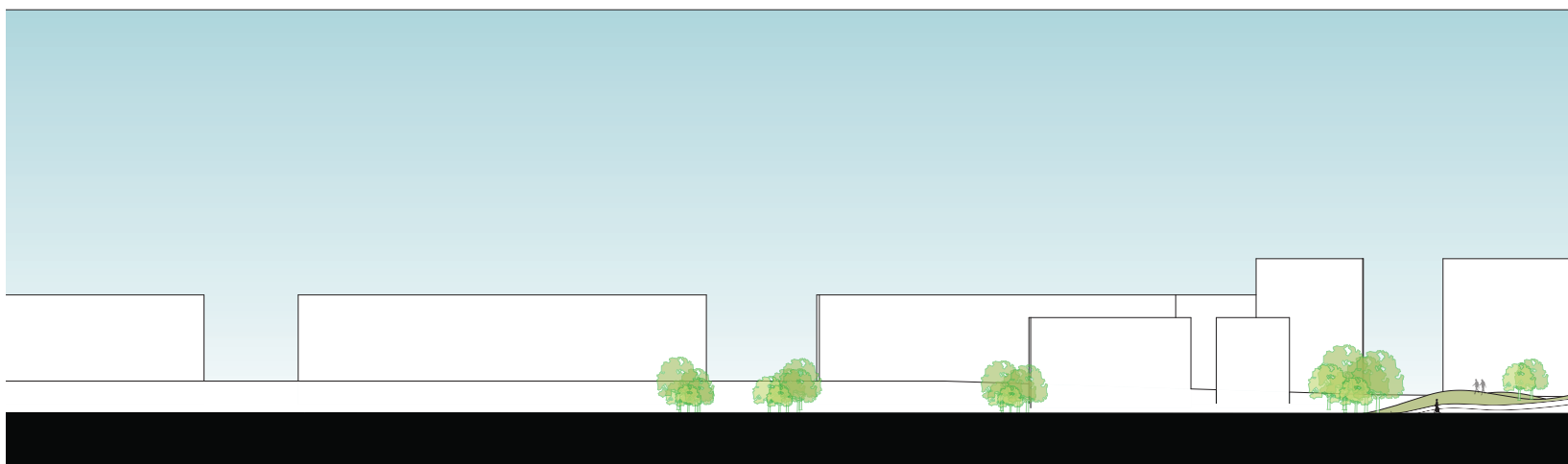
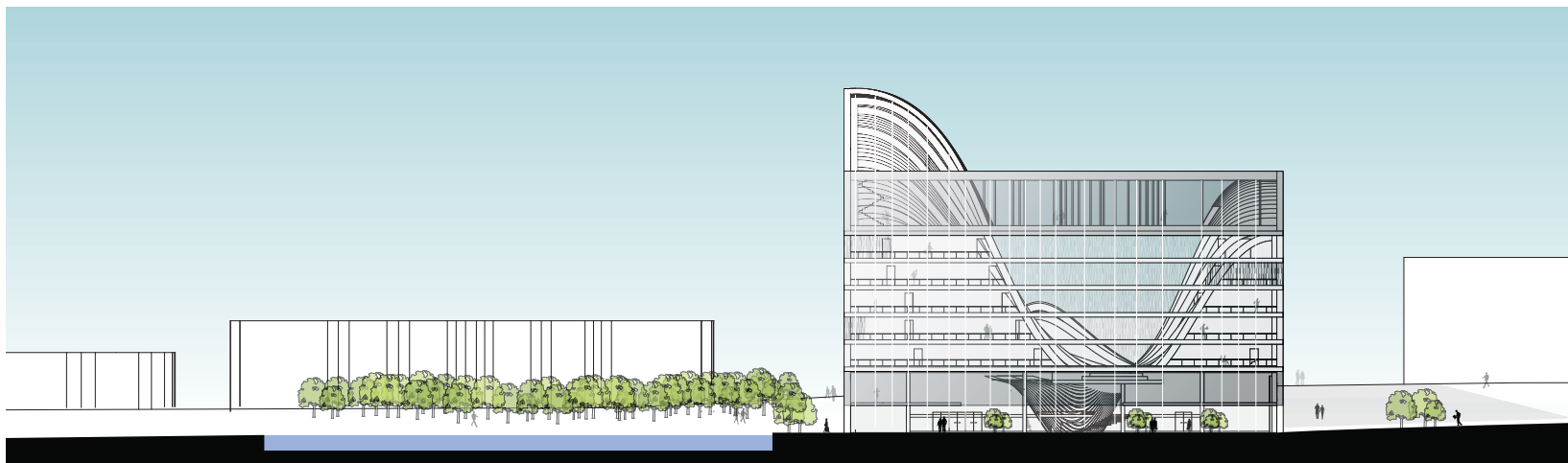
Ill. 172 - View from the 'Book Mountains'

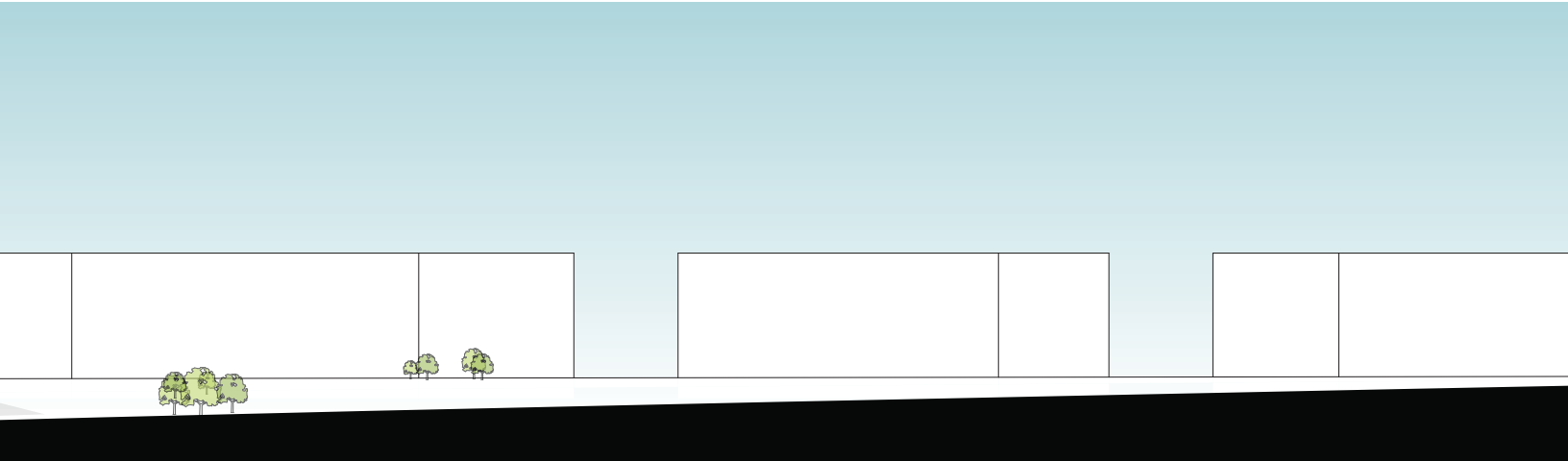


III. 173 - S1 section 1:400

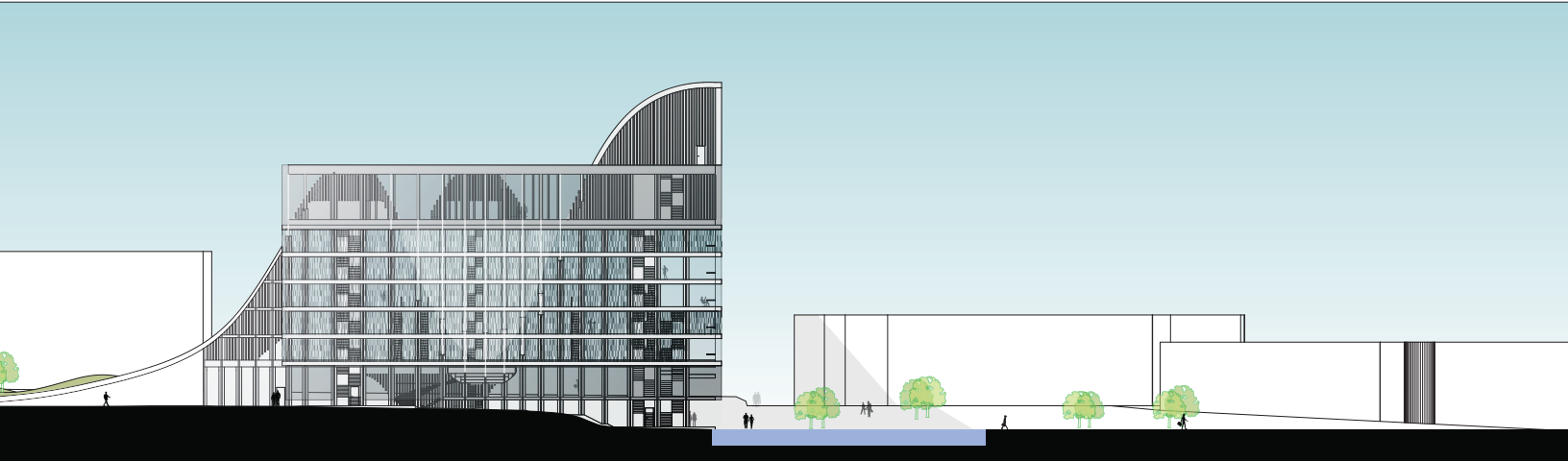


Ill. 174 S2 section 1:400

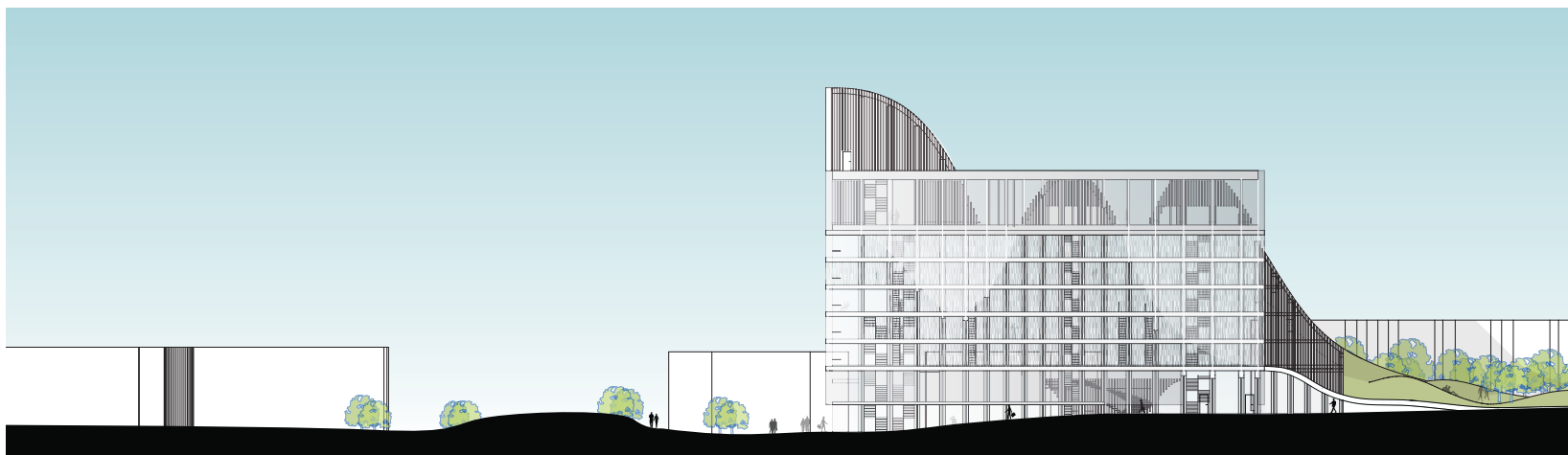
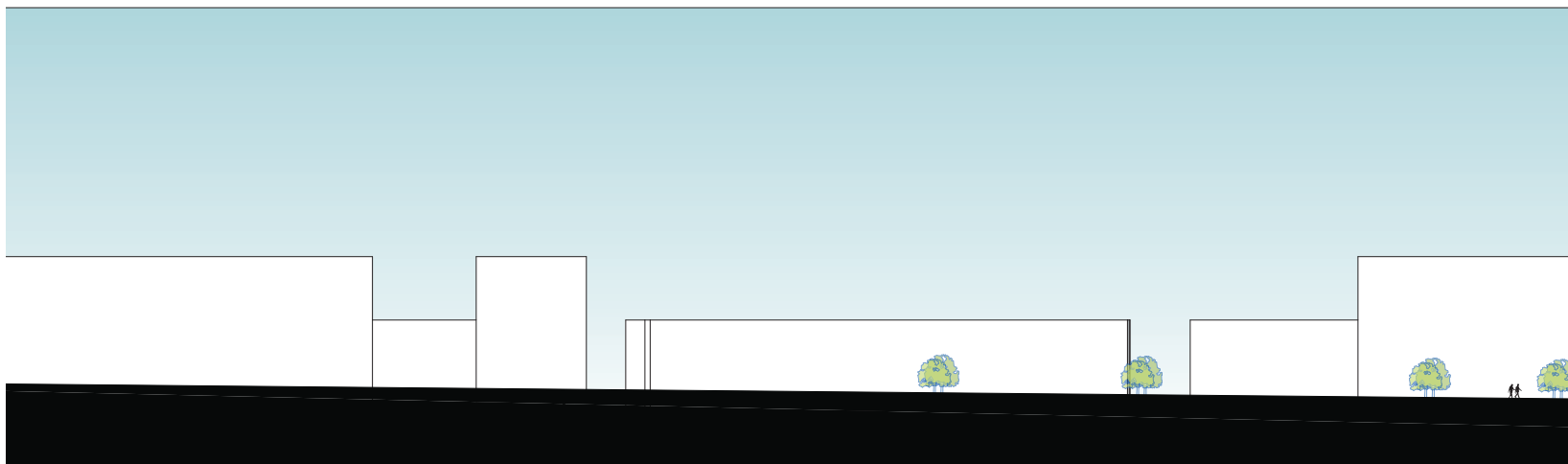


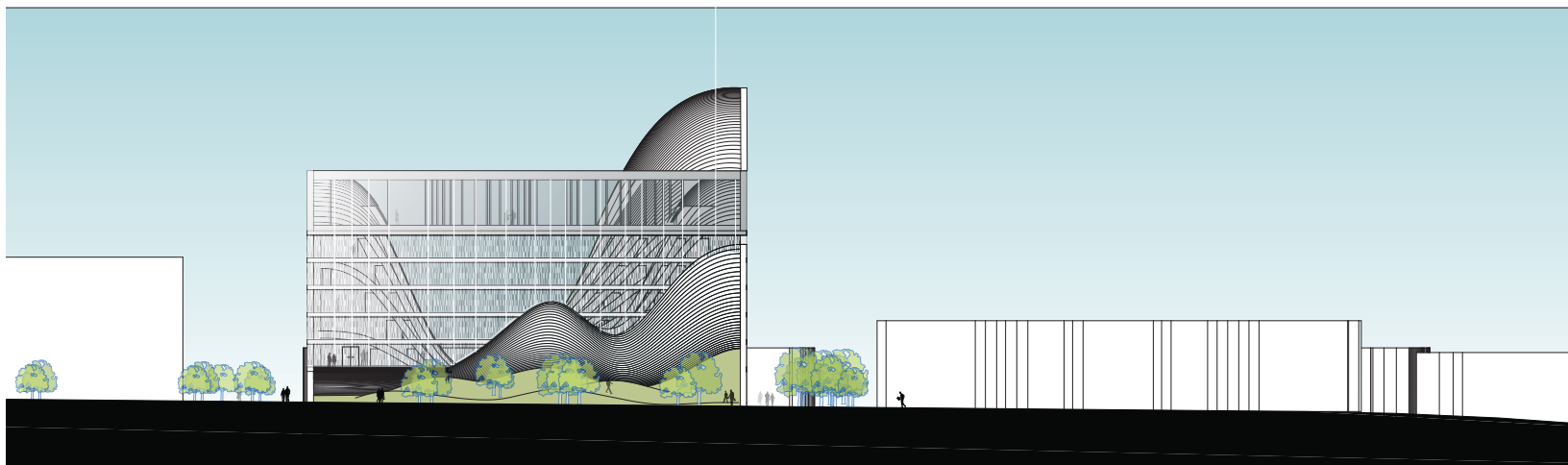


III. 175 - Northern facade elevation 1:800

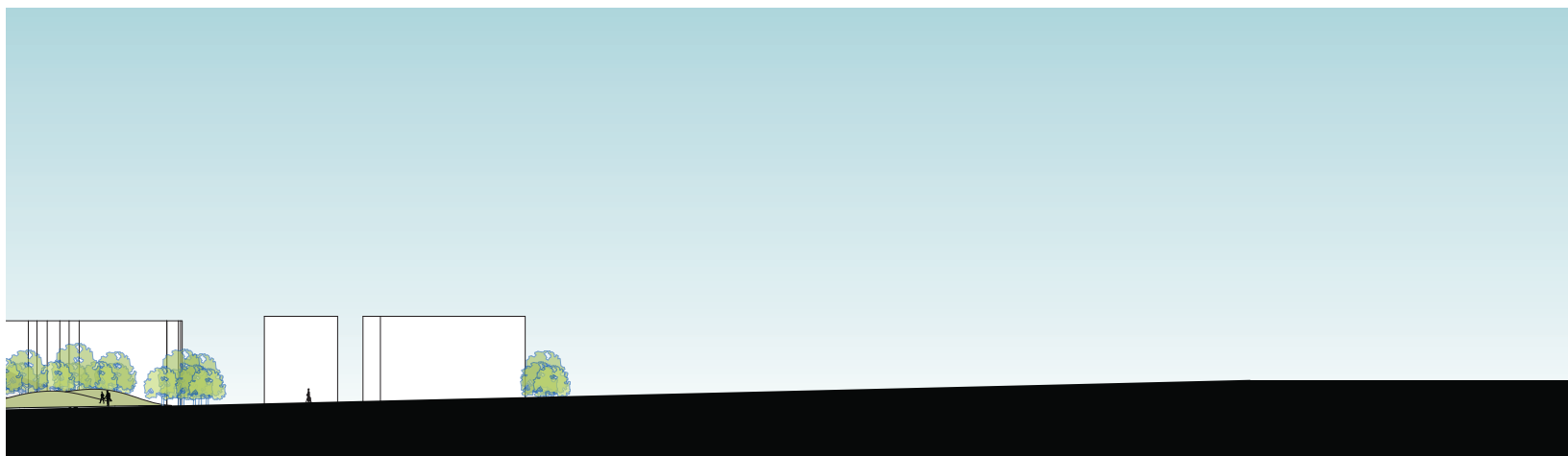


III. 176 - East facade elevation 1:800





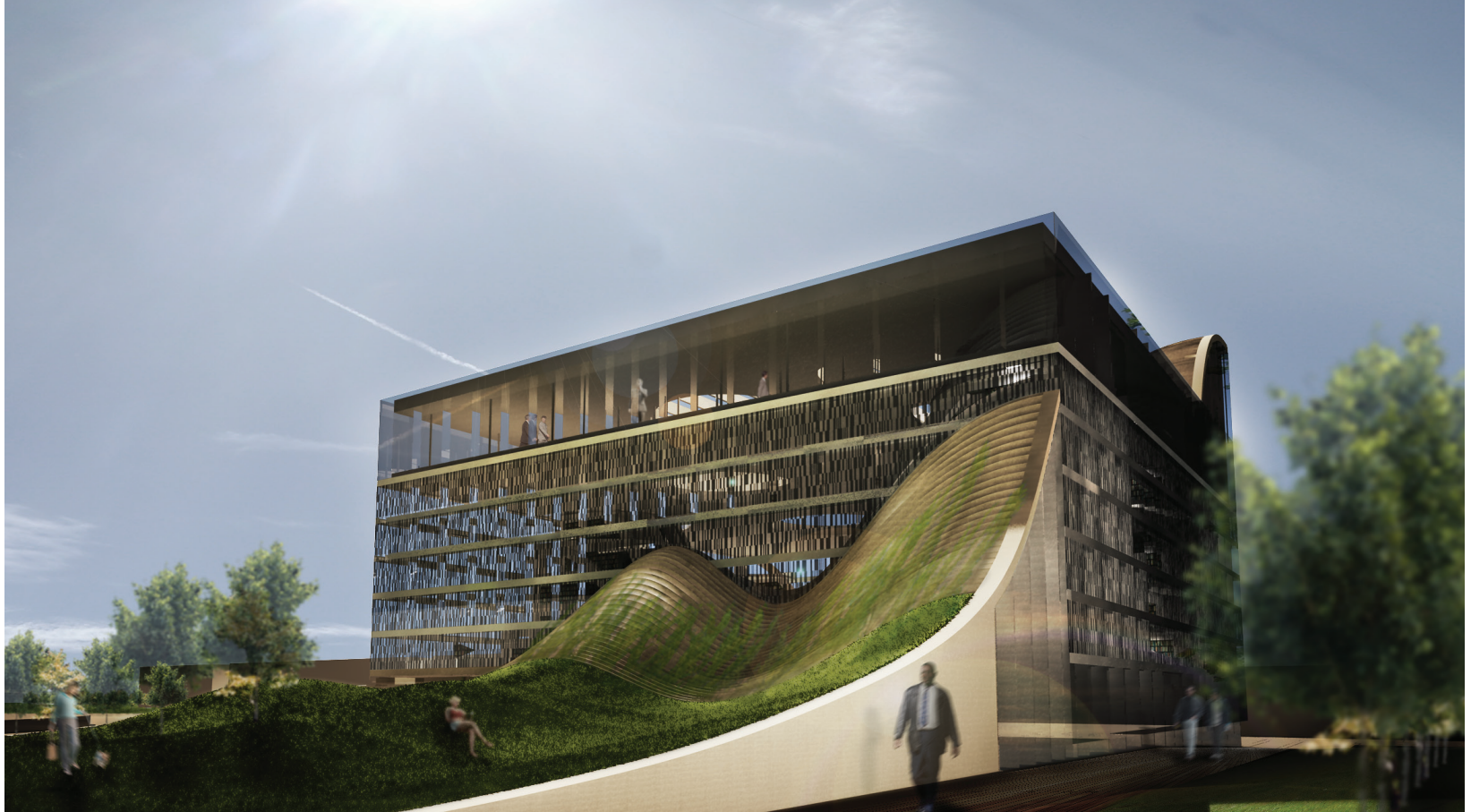
III. 177 - Southern facade elevation 1:800



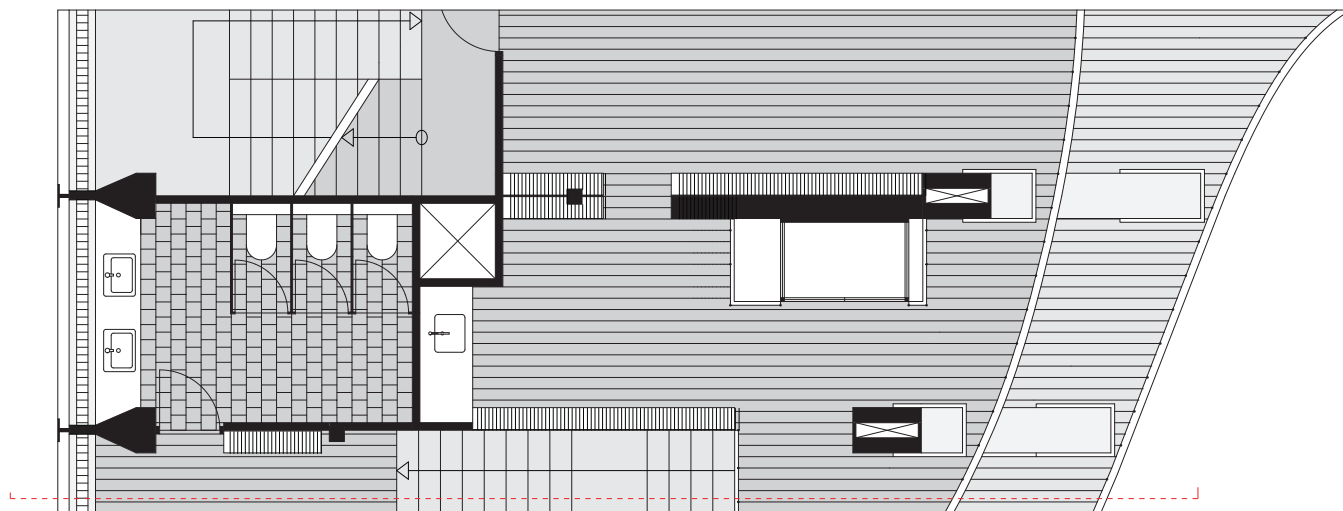
III. 178 - Western facade elevation 1:800



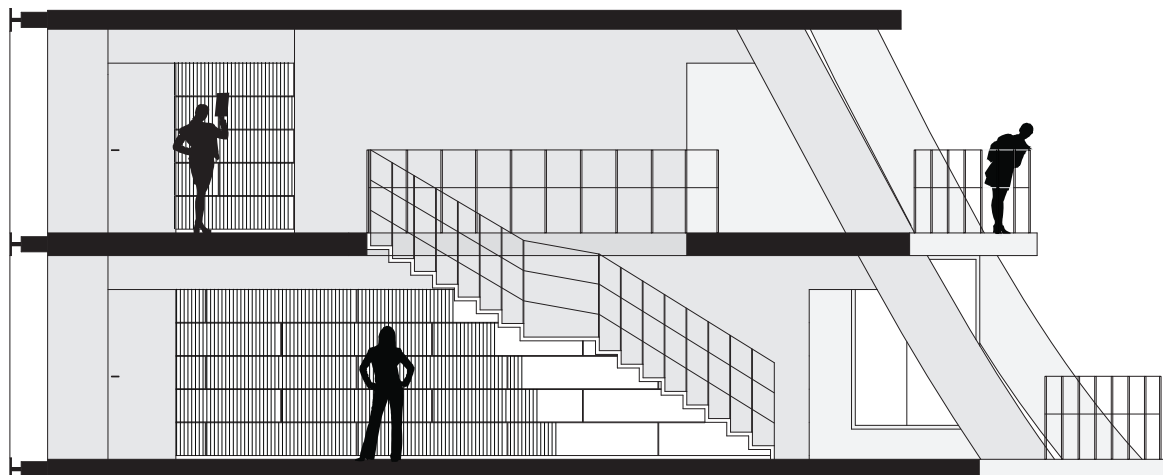
III. 179 - View towards the eastern facade



III. 180 - View towards the southern facade



III. 181 - Illustration of a selected detail within the 'Book Room' 1:100



38

CON-
CLUSION.

conclusion

In this last chapter an overall conclusion will be conducted upon the final design proposal. To do this the vision posted in the initial program will be held up against the final solutions of the design.

The vision was divided into five parts, one of the main criteria deduced from the study of the future library, was that the library of the future should be able to provide inspiring soundings inviting people to stay for more than just the obligatory information gathering. This criterion has been achieved by designing an informal library space, which provides many different opportunities for stays, both informally on the stairs surrounding the open area and and more focused in the work-places scattered around the library. Books have also been used as a physical element in the room to create an atmosphere of 'learning environment' surrounded by the 'knowledge' of the university. A criterion from the vision was that the building should reveal its purpose when experienced from the outside. Here the stacking defines the different elements in the building together with the use of books as an element in the facade, fulfilling this requirement. The future library should be able to cope with new technologies and develop according to the requirements of the present and the future. This design criterion has been met by making the bookshelves removable, creating the opportunity for making more open areas, or even giving the building a new purpose with time.

Today Aalborg university campus are a place without any significant

architecture, with simillare looking buildings and are by today's standards quite uninspiring, therefore the area could benefit from a significant building, which stands out, and hereby generating a symbol for the university. If the building have the ability to function as a symbol for the university are difficult to conclude upon, but the building definitely have an easy recognizable shape that stands out from the architecture in the surrounding area, and thereby possesses some of the qualities needed to generate a landmark in the area. An important aspect when designing a library is to generate well-lit spaces, here the transparent facade together with the three skylights in the roof, generates a well and evenly lit building. One of the main absences in the area is, in spite of many green areas on the university campus, quality outside spaces, therefor a part of the vision was also to work with the context and bring more interesting outside spaces to the area. This criterion has been worked with partially by moving the building site closer to the canteen, thereby strengthen the urban strip, and partially by creating an artificial landscape on the south side of the building in direct contact with an outside café area. The conclusion must be that the building does change the overall impression of the campus area, offering a dynamic architecture with the 'Book Room' while at the same time standing as a light tower overlooking the campus.

reflection

The reflection will reflect upon the design and the process as well as outer otherwise delimited parameters such as economy and the cooperation with the AUB.

Looking back on a project like this, it is of interest to reflect on the process - on which part have worked well and which part could have been done in a more efficient way. In the design phase the digital tools have been utilized to a great extent both as digital models on the computer screen and as rapid prototyping - fastly creating physical models. The parametric design software Grasshoppers (tm) has also been used to ease the work with the double-curved shape and thereby making the process much more efficient than what otherwise could have been possible. All in all the use of the digital design tools have been integrated in a very satisfying way, and have been a helpful tool in the design phase. The development of an unconventional building with complex organic shapes, has created obstacles along the way, where unconventional solutions sometimes had to be thought up, this have in many ways been a contributor to the creation of interesting spaces, but have also been a time consuming process, and therefore a greater detail could probably have been reached with a less complex building.

When reviewing the final design, an overall satisfaction are present among the group members, but as always some details are revealed in the end of the project, that could have been conducted in a better. The distance between the concrete dobbel-frames is one of the

areas that have been articulated, here the initial design proposal had a distance ranging from 2 to 4,5 meters between each other, which were changed in a further development in order to generate more space for the books, hereby changing the distances to ranging between 2 to 3,2. In the final proposal the change in distance is not as apparent as initial wanted, and seen in contrast to some of the design difficulties this caused, keeping the same distance in between all of them could have proven to be a better solution. The dimensions of the concrete frames have been changes along the way according to structural and aesthetics considerations, this is an area, where a higher degree of articulation could have been used, and in the final design proposal the dimension of the frames could have been smaller, thereby making the concrete frames less significant in the book room. An ever present parameter in architecture is economy. Without great knowledge about building economy, the assessment is that this building could become more expensive than a more conventional building, which could become an obstacle, if the project were to be further developed.

During the project the group have had correspondence with the head of the university library, Niels-Henrik Gylstorff, which together with email correspondence also have resulted in three meetings, two in the early stage and one in the last phase of the project. The collaboration with AUB has provided the project with a high degree of realism, and Niels-Henrike has been helpful to answer the questions that emerged along the way.

39

APPENDIX.

case studies

The texts below will present data about the selected libraries.

Rolex Learning Center, Lausanne, Switzerland

Client: EPFL (Polytechnic University of Lausanne)

Architect: SANAA

Completion: 2009

Gross floor area: 20,000 m²

Office space for: 100+ staff members

Study areas for: 860 students

Printed works: 500,000

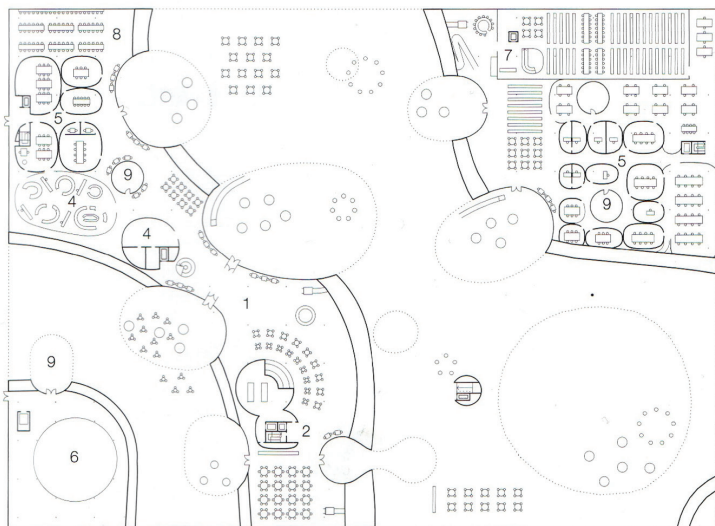
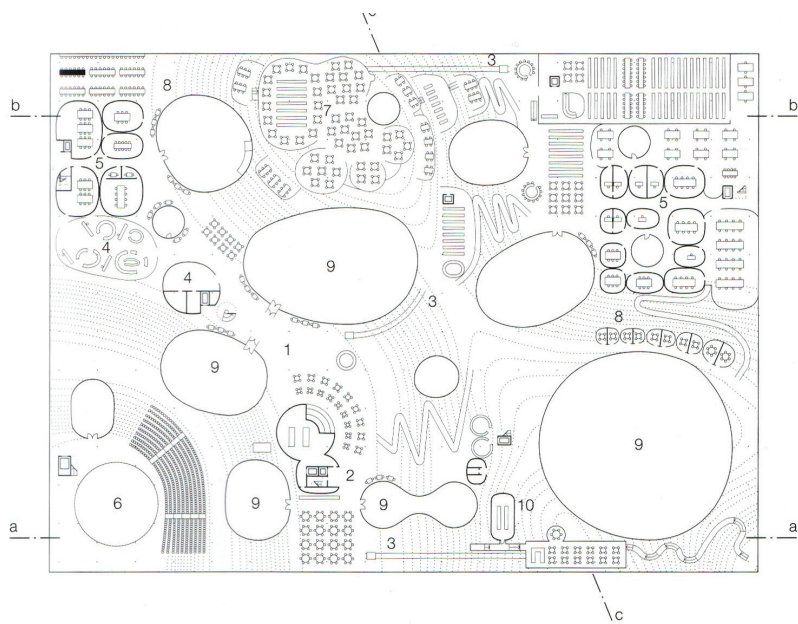
Floors: 2 (one is basement)

The Rolex Learning Center was inaugurated on May 27th 2010 and is located within the campus of the Lausanne Federal School of Polytechnics. It is by SANAA described as a "...laboratory for learning, a library and an international cultural hub for EPFL, open to both students and the public." [EPFL 2010, p. 2] It is going to integrate a whole range of different functions which has been listed below. The idea of the curved landscape is to provide a "...seamless network of services" [EPFL 2010, p. 2] including libraries and spaces to study, a restaurant and cafés plus different social students organizations. Four large areas for studying is provided, which in total can accommodate up to 8-900 students. The workspace for staff members including library staff is going to count more than 100 employees [Roth 2011]. The building also incorporates a large auditorium with 600 seats, suited for both lectures and conferences but also performances and other events. The entire house is open to the public which also grants loans of books to visitors not attached to the EPFL. It will contain more than 500,000 printed works, making it one of the largest scientific collections in Europe. Apart from this the multimedia library gives access to 12,000 online journals and over 20,000 e-books. The building will also contain an "advanced lending machines and systems for bibliographic search; a study center for use by postgraduate researchers provides access to the university's major archive and research collection, and there are learning areas including 10 'bubbles' for seminars, group work and other meetings." [EPFL 2010, p. 2]. Among these clusters of

bubbles, some are calm zones where others are reserved for workspace requiring complete silence. In the previous chapter the perspectives of the RFID-chip were laid down, and one of the exceptional aspects of the Rolex Center is that the library of books and literature already has been equipped with such chips. This makes it possible for the students to make large and fast loans – but also speeds up the process of returning the loaned material by just placing the volumes at an electronic shelf and then activate their student library card. As in the previous text the idea is that "As the technology progresses, it should also be possible to locate a book on the shelves using a smart-phone app." [EPFL 2010, p. 3]

The architecture

The typology of the center can be described as one large plane which then has been lifted up in order to create a sloping landscape. The building has only one floor which with the demarcation of the glazed façade makes up only large room – accessible from all directions. Inside the volume cuts have been made creating curved glazed interior walls which are the only ones to create spatial zones. These patios also draw in daylight and create small courtyards within the building. Pedestrian corridors run underneath where floor plans are at its highest creating a second flow underneath the building. The sloping floor plan that follows parallel to the roof structure is constructed in concrete with pre-stressed wires forming huge arches. The roof is constructed in wood and steel and held up by a large number of thin steel columns. In order to cope with the deformations created by changing temperature, each window is allowed to move inside their frame. The inside experience and movement is described by the architects as: "Inside the hills, valleys and plateaus formed by the undulation often make the edges of the building invisible, though there are no visual barriers between one area and the next. Instead of steps and staircases, there are gentle slopes and terraces. Clearly, but without dividing walls one area of activity gives way to another. Visitors stroll up the gentle curves, or perhaps move around the space on one of the specially designed 'horizontal lifts', elegant glass boxes, whose engineering is adapted from everyday lift design." [EPFL 2010, p. 4]



III. 182 - Plan of the Rolex Learning Center by SANAA

Seattle Central Library, Seattle, USA

Client: The Seattle Public Library

Architect: OMA/LMN

Completion: 2004

Gross floor area: Total 38,300m² (incl. 4,600 m² of parking)

Printed works: 780,000 (on opening 2004)

Work space with computers: 400+

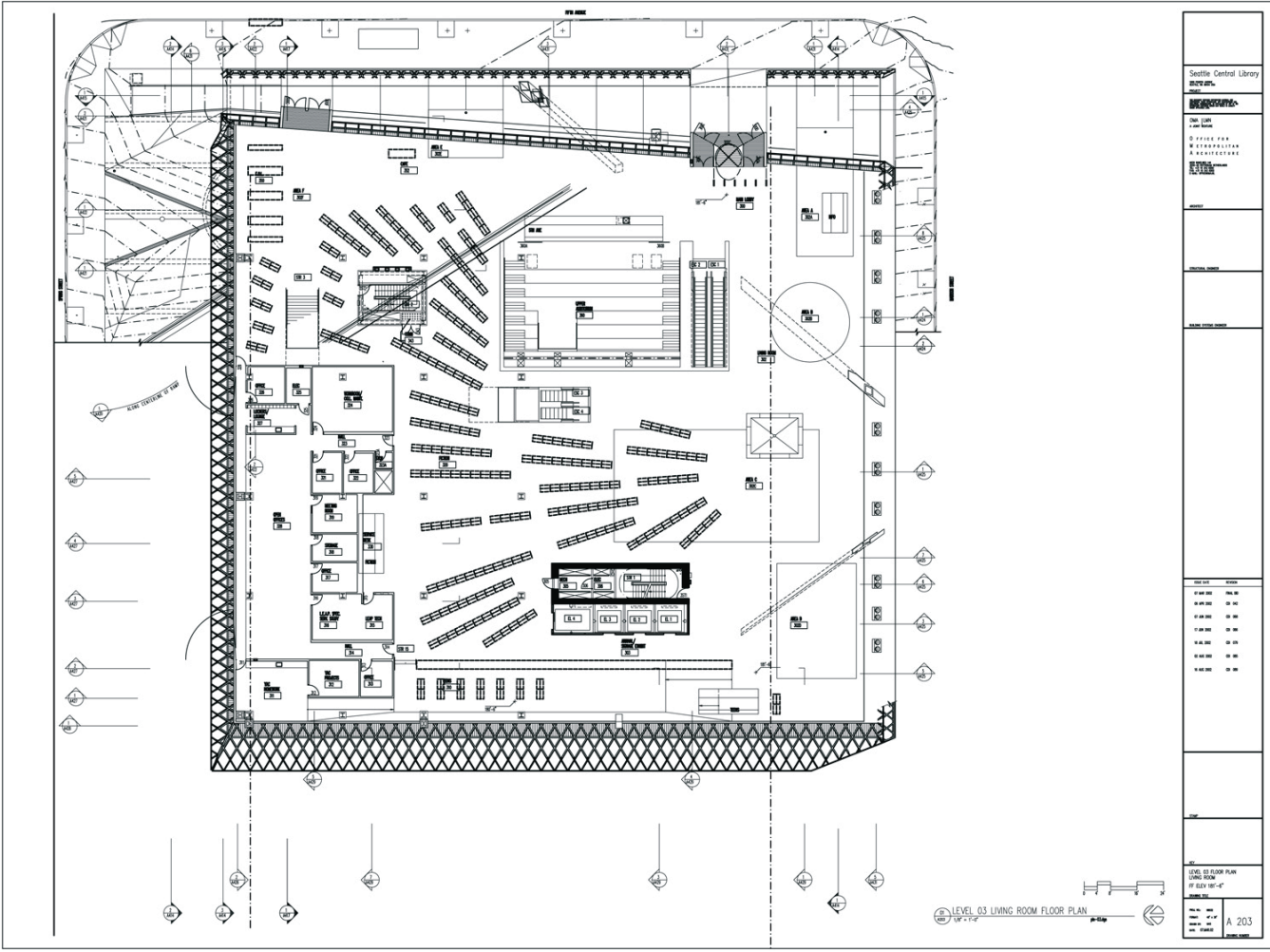
Floors: 11

The New Seattle Central Library opened in 2004. It functions as the main library within the group of Seattle libraries and consists of five 'floating' platforms. These platforms is a condense of a long range of programs that OMA has merged together representing clusters of parking, staff, meeting, a book spiral and a main headquarter. Interstitially the negative space between these five functions is used to accommodate four other functions; Kids area, living room, mixing chamber and reading room. The concept was to conceive the library as a redefinition of an institution not only devoted to books but with an equal respect to all types of media, with that in mind, that books still makes up the essential element around libraries. The so called Mixing chamber is located on the third floor and is mend to be an area where the librarians active meets the patrons and provide these with the knowledge and tips to engage the four floor tall 'Book spiral' - which holds the nonfiction collection of the library. The idea of the spiral was both to exhibit the collection but also to keep a continuous move around without splitting up the book classification system used. The spiral's 6,233 bookcases possess the capability of no less than 1,450,000 books – leaving plenty of room for the library to grow. The 'Living Room' is the library reading room thought to accommodate patrons by comfortable furniture and a 'cozy' environment. The library also incorporates a large sponsored auditorium and the so called "Mixing Chamber" functions as a reception area with reference desks, providing the service of interdisciplinary staff members. Linking together all the above mentioned functions is a large stair and escalator arrangement reaching through the entire eleven floors. Lately an automated book sorting and conveyance system has been integrated together with the possibility of self-checkout and loans for the more than 2.3 million annual visitors. [W. 4] and [OMA.eu]

The architecture

The Seattle Library is an example with a rational approach, letting the functions of the building dominate the outer appearance completely. The division of the functions creates interesting negative spatial constellations with large halls providing overviews inside the building

from different angles. These open areas is naturally created and found all the way up the building. The typology is almost of an urban city scape; divided into main streets, squares, high rise buildings and small niches, and the obvious thing would be to compare this with a shopping mall typology. The functions are provided with daylight through the skin of the building. This skin is made up by a large grid-structure working as an enormous plate consisting of large steel trusses. Where the daylight is not required the openings have been blinded and in order to protect the overall building against overheating, the glazing has been covered with a reflective folio – providing view to the outside but not from outside in. The experience inside is characterized by the Dutch origin of the architects, resulting in the use of super-sized graphic and colorful prints on the floor between the book cases. Finally the mix between traditional library functions and the creation of an 'urban event space' by the strict separation of functions expands the idea of visiting the library from purely gathering knowledge and into a social aspect [The Architecture of Knowledge, p. 62]



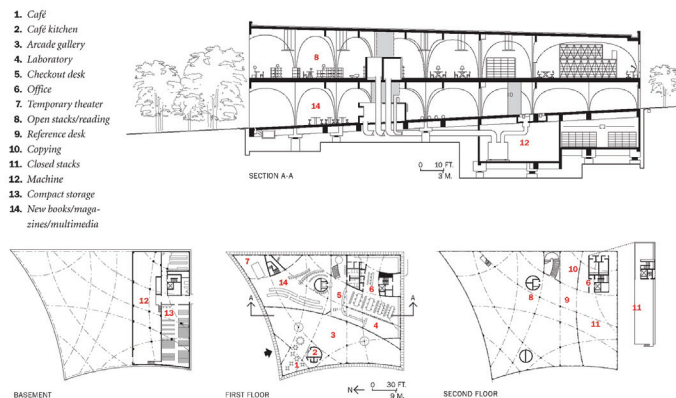
III. 183 - Selected plan of the Seattle Public Library by Office of Metropolitan Architects (OMA)

Tama Art University Library, Hachioji City, Tokyo, Japan

Client: Tama Art University
 Architect: Toyo Ito & Associates
 Completion: 2007
 Gross floor area: 5,639 m²
 Printed works: 100,000 books
 Floors: 2 above ground

The Tama Art Library is located on the ground which used to house the University cafeteria. This fact resulted in the architect trying to recapture the public area for meeting between students and supervisors, by creating a large open area in the ground floor of the building – housing a gallery. The concrete arches are used to divide the otherwise open floor plan into smaller sections for more intimate areas. The ground floor follows the sloping ground of the outside continuing the outdoor areas into the houses and into the reception entrance of the library. Where first floor has a main focus on written materials, the ground floor also incorporates an area reserved to digital Medias, providing an area with soft furniture for computer and television usage. The open ground floor also incorporates a multi-purpose space for gallery exhibitions which also acts as place for events and theaters due to the installation of a big screen. [tamabi.ac.jp]

On the upper level the arrangement of the book shelves follows the lines drawn by the characteristic arches, resulting in different and spatial interesting curving roads of book cases. As a typology the building hovers above the sloping landscape, providing direct access from all sides, and then gathering visitors at the reception area which acts as a check point for the staircase to first floor. [tamabi.ac.jp] + [Dezeen.com] + [modernhomeidea.com]



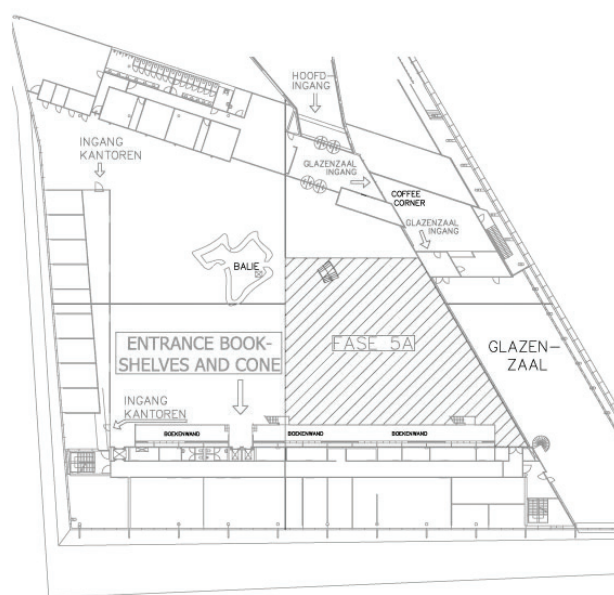
III. 184 - Tama Art University Library by Toyo Ito

TU Delft Library, Delft University of Technology, Delft, the Netherlands

Client: ING Real Estate
 Architect: Mecanoo Architects
 Completion: 1998
 Gross floor area: 15,000 m²
 Workstations: 1000 +
 Floors: 4

Being one of the largest libraries in Europe when it comes to its collection of volumes, the TU Delft has the capacity of accommodating more than 3000 students a day. Instead of a large regular library volume the architects has incorporated a landscape element which has been drawn up upon the building creating a large grass covered hill for recreation. Inside the complex offers an enormous open space centered around a reception area located in the middle. This space both provides access to the many workstations but also act as a space for meeting, relaxation and immersion. Seen from the old central campus cantina building, the opening of the entrance in the middle of the grass carpet opens up like a cave entrance. Behind the entrance the large concrete cone - which acts as the trademark for the library - rises up, piercing the green slope. Inside the building the cone acts as low roof for the reception area creating an intimate atmosphere. Down through the cone, three floors of student work stations is located making use of the natural daylight drawn in around the sides of the cone. On the opposite sides of the green sloping roof large glazed curtain walls encloses the volume providing the workstations placed around here with sufficient light. As with the Library of Stockholm's three secluded rows of book cases, the back wall in the TU Delft form an demarcating end wall augmented by stairs and ladders as a display of the book collection.

[The Architecture of Knowledge, p. 38] and [mimoa.eu]



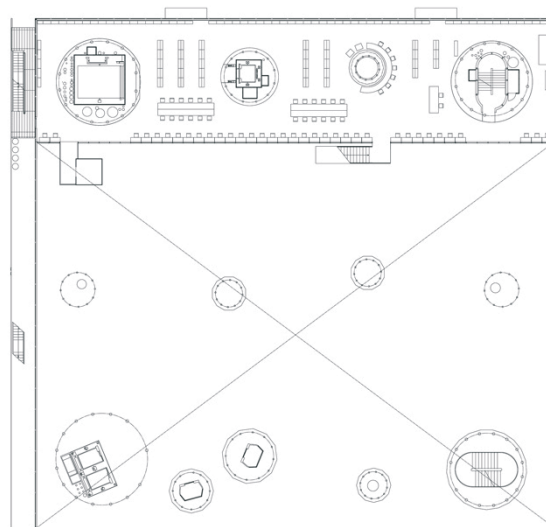
Ill. 185 - Ground plan of TU Delft by Mecanoo Architects

Sendai Mediatheque, Sendai, Japan

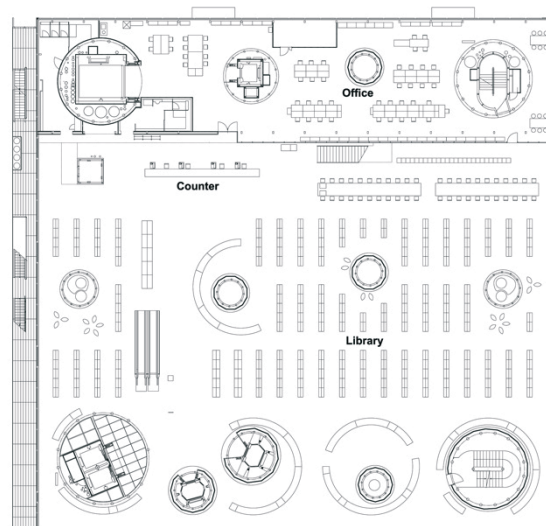
Client: Sendai City
 Architect: Toyo Ito & Associates
 Completion: 2001
 Gross floor area: 21,682.15 m²
 Floors: 6

Located in a trafficked area of the central Sendai, the Mediatheque reveal it's inside activities through the glazed transparent screen of the façade. The floors of the six-storied building are held on place by 13 steel tube-towers. The height of the floors differs due to which function they occupy and the simple glass façade creates a sense of the floors hovering inside. The tubes run horizontally through the entire building functioning as both transportation with staircases and lifts but also loadbearing construction and utility corridors. The entrance of the compound houses a large open space implementing both a retail shop and a café along with the reception area. The hall acts as a public square guiding visitor deeper into the complex. As different functions are scattered around the open plans, each floor has its own decoration done by different designers. The ground floor, also housing administrative functions and staff, has been designed by Kazuyo Sejima from Sanaa. Here the workstations of the staff have been enrolled in semi-transparent curving walls allowing a certain light and movement to be visual within the screen. The main library can be found on the two upper floors providing book shelves and internet access for the patrons. As an interesting function, two entire floor-plans (4th and 5th) have been reserved for gallery space. The one is created to allow for maximal movement allowing the walls and screens to be moved where the other has a more permanent layout allowing for larger exhibitions to be displayed.

Going to the top level, this area serves as a library for multimedia. As with the Tama Art library, effort has been made to provide visitors with comfortable furniture, allowing them to investigate a long range of media technologies. The 6th floor also houses a cinema for 180 persons. Just like the Seattle Library the diverse programming in the Mediatheque creates different spatial rhythms which again due to the many different functions and spaces both serves a knowledge based aspect but also indeed a social aspect, which has resulting in a large public roof terrace for resting and relaxation, open during summertime. [pushpullbar.com] and [galinsky.com]



4F Library



3F Library

III. 186 - 3rd and 4th floor within the Sendai Mediatheque by Toyo Ito

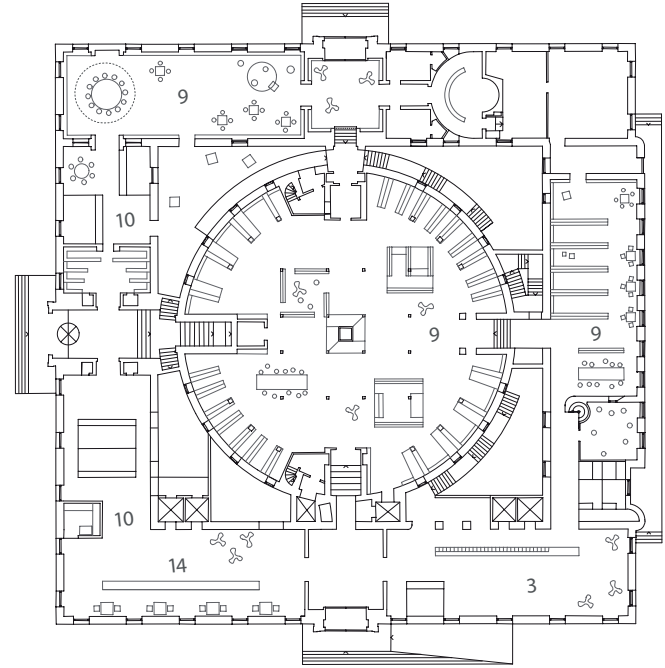
Stockholms Stadsbibliotek, Stockholm, Sweden

Client: Stockholm City
Architect: Erik Gunnar Asplund
Completion: 1928
Items: 4.400.000 (2.000.000 books)
Gross floor area: 3.700 m²
Floors: 4 stories

The library of Stockholm makes up the doyen of this case study. It has been chosen in order to provide ballast to case study due to the neo-classicistic architecture and because it was the first public library in Sweden to apply the principle of open shelves. This meaning, that patrons from that on were able to choose books without the need to ask the librarian for assistance.

The building consists of two major volumes; a squared box functioning as reading rooms and service rooms and then a large centered cylinder placed upon. This simple constellation together with the placement of the building upon a pedestal creates an impressive arrival to the library. Around the library open squares provide recreational areas and squares. Through a range of stairs the visitor is taken up and into the building. Inside the reception area is located along with the children's department. Moving further inside the library, stairs takes the patron up to the main hall created by the rotunda of the cylinder. Here the main collection is stored, on a range of circular secluded book shelves. At the floor different magazines and popular-readings is located together with service counters. Access to the surrounding reading rooms is provided by four openings across each other. Here book shelves are stabled in classic rows augmented by lounge furniture. Different staircases and ladders provide access up and inside the augmented shelves opening up for an adventure between small narrow outer corridors placed behind the circular shelves.

[W. 5] + [arch.kth.se]



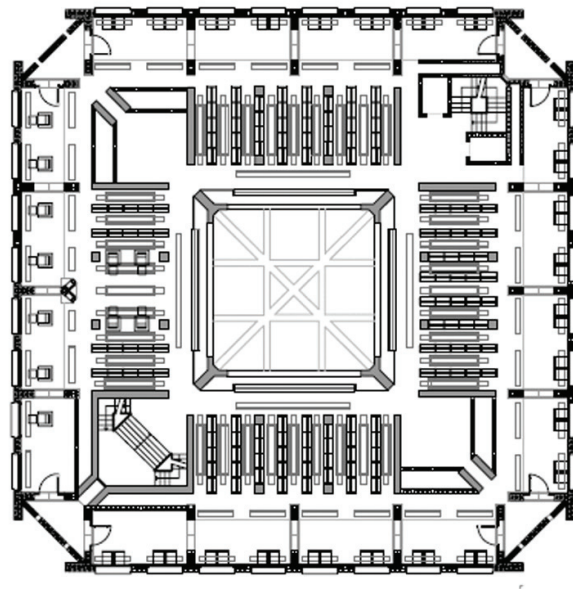
III. 187 - Plan of main hall within the Stockholm Public Library by Erik Gunnar Asplund

Phillips Exeter Academy Library, Exeter, New Hampshire, USA

Client: Phillips Exeter Academy
Architect: Louis Kahn
Completion: 1971
Total floor area: 6.861 m²
Items: 160.000 books
Floors: 9

As the Library of Stockholm represents state-of-the-art-libraries from the first part of the 20th century, the Philips Exeter Academy Library stands as one of the classics of the post-world-war era. Being the largest secondary school library in the world, the visitor is greeted by a circular double staircase and taken into the very central hearth of the building. Upper floors house a student computer lab and a media-scape for digital visual Medias. At the center of the building a large squared hall raises more than 15 meters into the air. Each wall holds a large circular opening revealing the many floors of book shelves behind. This overview makes it clear to navigate around the building. There are nine levels in the building and the layout is divided into three main components; first the centralized atrium containing access staircases, reception and staff, then the collection of books which acts as a shielding for the carrels which has been placed towards the outer perimeter of the building. This division can also be seen in the use of materials going from the concrete atrium to the wood clad book shelves (construction is concrete) and finally load-bearing red bricks creating the area for the carrels. The division in functions going from public, to semi-public ending up at the more private carrels acts to possibilities of different stages of concentrated work and relaxation. The placement of the 210 carrels can be found due to the use of natural daylight provided by windows increase in size as the levels rise. At the basement a large special facility containing micro-films and bound periodicals is located – being the largest for secondary schools. Overall the Exeter holds more than 450 seats all types comprised including a lounge area on third floor with comfortable furniture and a fireplace.

Characteristic for the Exeter Library is that it is a school library, limiting the functions inside as to those of service and studying. A dining hall also designed by Kahn is placed near by the library, when refreshments are required. [Exeter.edu 1 and 2] and [W. 6]



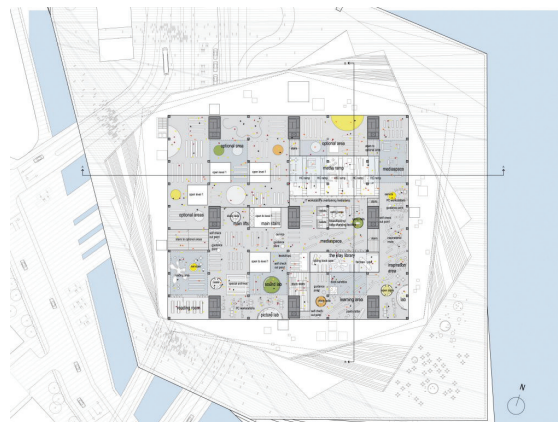
III. 188 - 4th floor library section within the Phillips Exeter Library

Multimediehuset, Aarhus, Denmark

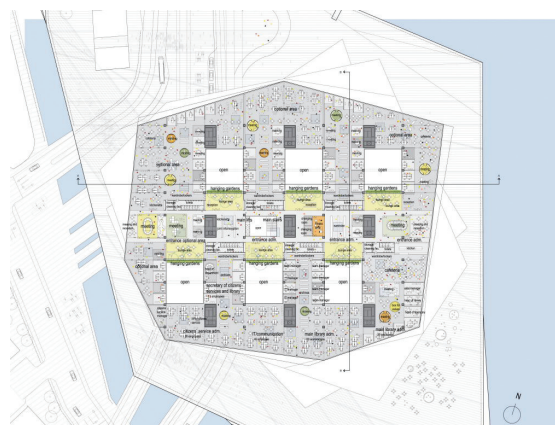
Client: Municipality of Aarhus and Realdania
Architect: Schmidt-Hammer-Lassen Architects
Completion: Planned 2011 - 2014
Gross floor area: 30.000 m²
Floors: 4

The Multimedia has been selected as it is not even build yet, but depicts a promising level of interesting mixes between library aspects combined with urban city-event-landscapes. The house is planned to be the largest public library in Scandinavia and is going to represent a new generation of modern hybrid libraries, containing multiple ways of usage. Placed next to central Aarhus the complex is thought to revitalize the historic industrial harbor area. The main concept is a covered cityscape filled with a range of different functions. A large poly edged roof structure is going to hover above a more pragmatic box shape in where the library is going to be placed. Offices and administration will be located in the roof part pierced by large vegetated openings providing daylight to the underneath library. The outside area will incorporate different levels of recreational areas and stairs providing access to the building. The squared box will have its façade completely glazed in order to provide the surroundings glimpse of what is going on inside and on the other side the curtain wall will provide a large view over the entire city. The main library will hold departments in different secluded levels, housing different offers of media and culture. This will range from literature and media departments, exhibitions, and children's departments with theaters, different events, a restaurant and a café. Underneath the house a large facility for parking will be placed augmented by a tram station providing instant access to other parts of the city.

[shl.dk]



III. 189 - Ground floors of the Multimediahouse by SHL



III. 190 - Administration wing of the Multimediahouse by SHL

room program

	Floor nr.	Section	Application purpose	Net area	Direct access to	Proximity requirements	Daylight
1	Level 0	Internal areas	Storage	37	-	Compact shelving	No
2	Level 0	Internal areas	Server room & machine room	35,5	-	-	No
3	Level 0	Internal areas	Storage	17,4	-	-	No
4	Level 0	Internal areas	Bath & toilet	9,1	-	-	No
5	Level 0	Collections	Compact shelving	164,3	-	Freight Elevator	No
6	Level 0	Collections	Compact shelving	158,5	-	Freight Elevator	No
7	Level 0	Collections	Compact shelving	61	-	Freight Elevator	No
8	Level 0	Other areas	Storage & Paper Warehouse	14,5	-	-	No
9	Level 0	Other areas	Washroom & material warehouse	16,7	-	-	No
10	Level 0	Other areas	Blackboard room	13,7	-	-	No
11	Level 0	Other areas	Technical room (sprinkler room)	17,4	Direct from the outside	-	No
12	Level 0	Other areas	Technical room	164,4	Direct from the outside	Blackboard room	No
13	Level 1	Internal areas	Building Valet	10,3	-	Shipment & Warehouse	Yes
14	Level 1	Internal areas	Shipment & Warehouse	55,8	Garage	Building Valet	No
15	Level 1	Public spaces	Foyer	560	To the out side	-	Yes
16	Level 1	Public spaces	Exhibition	59,9	-	Foyer	Yes
17	Level 1	Public spaces	Video Cinema	58	Foyer	Colonial Storage, dishwashing, pers, fridge / freezer	No
18	Level 1	Other Purposes	Canteen inc. Kitchen	464,7	To the out side	Foyer	Yes
19	Level 1	Other Purposes	Auditorium	206,9	To the out side	Foyer	No
20	Level 1	Other Purposes	Auditorium	100,6	To the out side	Foyer	No
21	Level 1	Other Purposes	Seminarroom	35,5	To the out side	Foyer	Yes
22	Level 1	Other Purposes	Seminarroom	35,5	To the out side	Foyer	Yes
23	Level 1	Other Purposes	Conference	107,2	To the out side	Foyer	Yes
24	Level 1	Other Purposes	Seminarroom	35,8	To the out side	Foyer	Yes
25	Level 1	Other Purposes	Seminarroom	50	To the out side	Foyer	Yes
26	Level 1	Other Purposes	Seminarroom	49,7	To the out side	Foyer	Yes
27	Level 1	Other Purposes	Conference	107,2	To the out side	Foyer	Yes
28	Level 1	Other Purposes	Seminarroom	49,7	To the out side	Foyer	Yes

III. 191 - Room program of the Kjær & Richter proposal (next four illustrations)

	Floor nr.	Section	Application purpose	Net area	Direct access to	Proximity requirements	Daylight
29	Level 1	Other Purposes	Conference	107,4	To the out side	Foyer	Yes
30	Level 1	Collections	Compact shelving	248,2	-	Freight Elevator	Yes
31	Level 1	Other areas	Cleaning room	11,3	-	-	No
32	Level 1	Other areas	Colonial dry store	8,9	-	Kitchen	No
33	Level 1	Other areas	Staff	7,3	-	Kitchen	No
34	Level 1	Other areas	Dishwashers	11	-	Kitchen	No
35	Level 1	Other areas	Cooling freezer room	3,6	-	Kitchen	No
36	Level 1	Other areas	Intersect & blackboard room	9,3	-	-	No
37	Level 1	Other areas	Storage	7,8	-	-	No
38	Level 1	Other areas	Disabled Toilet	6,6	-	Public spaces	No
39	Level 1	Other areas	Intersect & blackboard room	3,9	-	-	No
40	Level 1	Other areas	Cleaning room	13	-	-	No
41	Level 1	Other areas	Toilets	89,1	-	-	No
42	Level 2	Collections	Compact shelving	233,5	-	Freight Elevator	Yes
43	Level 3	Public spaces	Coffee Shop	10,2	-	Roof terrace	Yes
44	Level 3	Public spaces	Newspapers etc.	51,7	-	Student Facilities	Yes
45	Level 3	Public spaces	Sluice	228,6	-	-	Yes
46	Level 3	Public spaces	Open group rooms	51,2	-	Student Facilities	Yes
47	Level 3	Public spaces	Teaching	51,2	-	Student Facilities	Yes
48	Level 3	Public spaces	Teaching	51,2	-	Student Facilities	Yes
49	Level 3	Public spaces	Master	38,2	-	Student Facilities	Yes
50	Level 3	Other Purposes	Student Facilities	328,1	-	Sluice	Yes
51	Level 3	Collections	Compact shelving	349,2	-	Freight Elevator	Yes
52	Level 3	Other areas	Intersect & blackboard room	9,1	-	-	No
53	Level 3	Other areas	Cleaning room	8,1	-	-	No
54	Level 3	Other areas	Disabled Toilet	6,6	-	Public spaces	No
55	Level 3	Other areas	Toilets	7	-	-	No

	Floor nr.	Section	Application purpose	Net area	Direct access to	Proximity requirements	Daylight
56	Level 4	Internal areas	Meeting Room	19,5	-	Administration	Yes
57	Level 4	Internal areas	Quiet rooms	13,2	-	Administration	Yes
58	Level 4	Internal areas	Quiet rooms	13,2	-	Administration	Yes
59	Level 4	Internal areas	Administration	283,3	-	-	Yes
60	Level 4	Internal areas	Copy & little kitchen	21,2	-	Administration	No
61	Level 4	Internal areas	Internal workplaces	56	-	Lending Collection	Yes
62	Level 4	Public spaces	Reading hall	53,9	-	Lending Collection	Yes
63	Level 4	Public spaces	Reading hall	82,8	-	Lending Collection	Yes
64	Level 4	Public spaces	Workplaces	227,1	-	Lending Collection	Yes
65	Level 4	Other Purposes	Student Facilities	269	-	Lending Collection	Yes
66	Level 4	Collections	Lending Collection	140,5	-	-	Yes
67	Level 4	Other areas	Checkroom	7,5	-	-	No
68	Level 4	Other areas	Intersect & blackboard room	9,1	-	-	No
69	Level 4	Other areas	Cleaning room	8	-	-	No
70	Level 4	Other areas	Disabled Toilet	6,6	-	Public spaces	No
71	Level 4	Other areas	Toilets	12,4	-	-	No
72	Level 5	Internal areas	Meeting Room	20,9	-	Administration	Yes
73	Level 5	Internal areas	Quiet rooms	6,5	-	Administration	Yes
74	Level 5	Internal areas	Administration	246,3	-	-	Yes
75	Level 5	Internal areas	Copy & little kitchen	21,2	-	Administration	No
76	Level 5	Public spaces	Workplaces	131,4	-	Lending Collection	Yes
77	Level 5	Public spaces	Workplaces	139,1	-	Lending Collection	Yes
78	Level 5	Other Purposes	Student Facilities	256,2	-	Lending Collection	Yes
79	Level 5	Collections	Lending Collection	309,4	-	-	Yes
80	Level 5	Other areas	Checkroom	7,5	-	-	No
81	Level 5	Other areas	Intersect & blackboard room	9,1	-	-	No
82	Level 5	Other areas	Cleaning room	8	-	-	No
83	Level 5	Other areas	Disabled Toilet	6,6	-	Public spaces	No
84	Level 5	Other areas	Toilets	12,4	-	-	No

	Floor nr.	Section	Application purpose	Net area	Direct access to	Proximity requirements	Daylight
85	Level 6	Internal areas	Meeting Room	20,9	-	Lending Collection	Yes
86	Level 6	Internal areas	Quiet rooms	6,5	-	Lending Collection	Yes
87	Level 6	Internal areas	Administration	246,3	-	-	Yes
88	Level 6	Internal areas	Copy & little kitchen	21,2	-	Lending Collection	No
89	Level 6	Public spaces	Reading hall	66,8	-	Lending Collection	Yes
90	Level 6	Public spaces	Workplaces	131,4	-	Lending Collection	Yes
91	Level 6	Other Purposes	Student Facilities	261,8	-	Lending Collection	Yes
92	Level 6	Collections	Lending Collection	309,4	-	-	Yes
93	Level 6	Other areas	Checkroom	7,5	-	-	No
94	Level 6	Other areas	Intersect & blackboard room	9,1	-	-	No
95	Level 6	Other areas	Cleaning room	8	-	-	No
96	Level 6	Other areas	Disabled Toilet	6,6	-	Public spaces	No
97	Level 6	Other areas	Toilets	12,4	-	-	No

structural chapter

First the different loads that the library will be exposed to are found. These load cases represent the dead load of the structure itself, the live load applied by persons, inventory etc. together with natural loads such as wind and snow applying forces to the building. Afterwards this data is implemented into a finite element program (FEM) that is going to reveal forces and stresses within the structure. A correct deployment of the parameters is important in order to make the system function correct. A simplification of a vertical section of the concrete double-frames was drawn in the Staad-Pro computational software and here the different structural parameters were incorporated. That included the main concrete double-frames along

with concrete floor slabs and columns within the Book Mountains. The load impact created by the administration is also found below in the calculations and this load is then together with the rest of the loads applied to this section of the system.

As a standard the "Eurocodes" are incorporated into the program, but the main intent with the structural analysis is only to get an insight view of the corresponding forces and stresses and will not further investigate the possibility to optimize structural elements along with material properties.

To fulfill the technical data requirements the newest Teknisk Ståbi vol. 21 along with DS-409-2006 is used for reference.

NB: Spreadsheets and graphs from the FEM can be found in large resolution on the enclosed CD-ROM.

load cases

Determining the load cases:

Consequence class: Library = CC3 (high risk class)
Application class: 1 (indoor construction)

[Teknisk Ståbi p. 162 4.2.3]
[Teknisk Ståbi p. 314 7.2.2]

Load of the administration:

Live load – payload Q:

Office Space payload (category B): $2,5 \text{ kN/m}^2 \cdot 1 \text{ m} = 2,5 \text{ kN/m}$

[Teknisk Ståbi p. 167 Tabel 4.7]

Dead Load – permanent load G:

Roof terrace payload (category C5): $5,0 \text{ kN/m}^2 \cdot 1 \text{ m} = 5,0 \text{ kN/m}$

[Teknisk Ståbi p. 167 Tabel 4.7]

Density of materials in administration:

5 mm Asphalt roof cover: ($\sim 0,05 \text{ kN/m}^2$)

[Icopal.dk]

500 mm insulation (rockwool): ($0,8 \text{ kN/m}^3$)

[Rockwool.dk]

1800 mm GL32h roof construction: ($5,1 \text{ kN/m}^3$)

[Teknisk Ståbi p. 314 Tabel 7.1]

Steel column (Ø150 mm) S355: ($78,50 \text{ kN/m}^3$)

[Teknisk Ståbi p. 227 6.1]

1000 mm reinforced concrete floor slab: ($\sim 25 \text{ kN/m}^3$)

[Staad pro FEM program]

Payloads:

Asphalt roof: $0,05 \text{ m} \cdot 0,05 \text{ kN/m}^2 \cdot 1 \text{ m} = 0,0025 \text{ kN/m}$

Insulation: $0,5 \text{ m} \cdot 0,8 \text{ kN/m}^3 \cdot 1 \text{ m} = 0,4 \text{ kN/m}$

GL construction: $\frac{1,8\text{m} \cdot 5,1\text{N} / \text{m}^3}{0,4\text{m}} \cdot 1\text{m} = 3,672 \text{ kN/m}$

Steel columns: $V = \pi \cdot r^2 \cdot h = \pi \cdot 0,152 \text{ m}^2 \cdot 5,0 \text{ m} = 0,35325 \text{ m}^3$
 $\sim 78,50 \text{ kN/m}^3 \cdot 0,35325 \text{ m}^3 = 27,73 \text{ kN}$ pr. column
 0,3 columns pr. Meters = $0,3 \text{ m} \cdot 27,73 \text{ kN} = 8,319 \text{ kN/m}$

concrete slab: $1 \text{ m} \cdot 25 \text{ kN/m}^3 \cdot 1 \text{ m} = 25 \text{ kN/m}$

Summarized dead and live load of the administration: $\sim 42,4 \text{ kN/m} + 2,5 \text{ kN/m} = 44,9 \text{ kN/m}$

Variable loads:

Snow load - S:

The snow load on a roof is determined by $s = \mu_i C_e C_t s_k$

[Teknisk Ståbi p. 168 4.6.1 (4.1)]

Where:

μ_i = form factor (if roof pitch angle α is $0^\circ - 30^\circ$, $\mu_i = 0,8$)

C_e = exposing factor (C_e is set to 1,0 unless other specific topography is required)

C_t = thermic factor (unless thermic transfer of roof $> 1 \text{ W/m}^2\text{K}$, $C_t = 1,0$)

s_k = Characteristic terrain value = $0,9 \text{ kN/m}^2$

Resulting in $0,8 \cdot 1,0 \cdot 1,0 \cdot 0,9 \text{ kN/m}^2 = 0,72 \text{ kN/m}^2$

$0,72 \text{ kN/m}^2 \cdot 1 \text{ m} = 0,72 \text{ kN/m}$

Wind load - W:

Terrain category: III (ex. villages, suburbs, or forest)

[Teknisk Ståbi p. 169 Tabel 4.9]

Terrain factor: $k_r = 0,19 \cdot (z_0 / z_{0,II})^{0,07}$

[Teknisk Ståbi p. 168 4.7.1 (4.2)]

Basic wind speed $v_b = 24 \text{ m/s}$

[Teknisk ståbi p. 169 fig. 4.2 ill. 1]

Building geometry: simplified as a box shape:

Height = 28 m

Length = 47 m

Width = 47 m

Maximal characteristic wind speed:

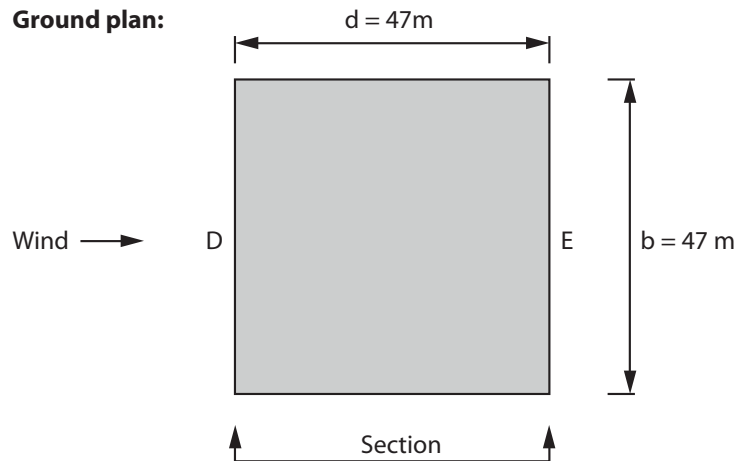
Load read off graph: $q_p(z) = 0,9 \text{ kN/m}^2$ (height $z = 28 \text{ m}$)

[Teknisk ståbi p. 169 fig. 4.2 ill. 1]

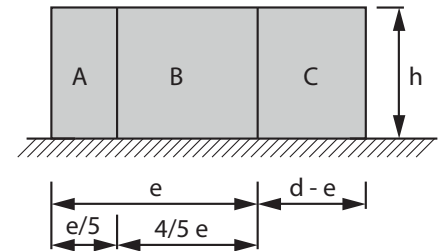
b = dimension across the direction of the wind

Form factors for facades:

Ground plan:



Section for $e < d$:



III. 192 - Form diagram for wind

e = the smallest value of b or $2h$ ($b = 47\text{ m}$ and $2h = 56\text{ m}$)

$e = 47\text{ m}$

$e/5 = 9,4\text{ m}$

$d - e = 47\text{ m} - 47\text{ m} = 0\text{ m}$

Recommended form factors, $c_{pe,10}$, for outer wind pressure on vertical walls:

$h/d = 28\text{m} / 47\text{ m} = 0,595$

For buildings where $h/d \leq 1$, the correlation between the pressure on wall D and E (the resulting force D - E) can be multiplied by a correlation factor $\rho = 0,85$. Resulting in $(0,8 + 0,5) \cdot 0,85 = 1,11$.

Resulting in form factors, $c_{pe,10}$:

Zone:

A = -1,2

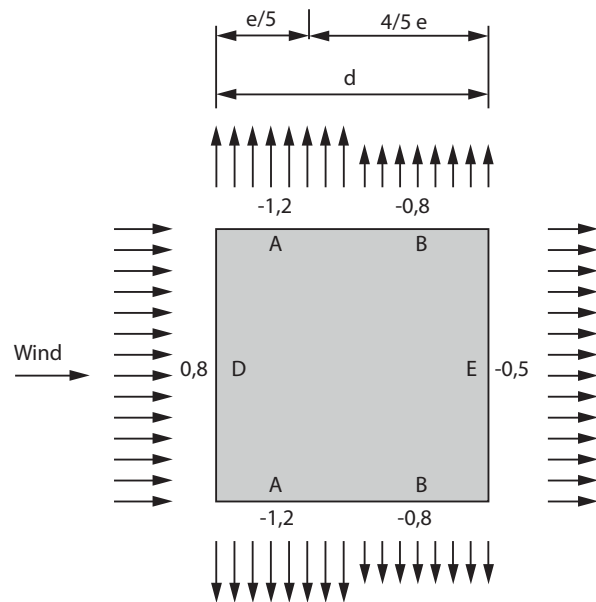
B = -0,8

C = -0,5 (not relevant when $d - e = 0$)

D = +0,8

E = -0,5

[Teknisk stâbi p. 170 Tabel 4.10]



III. 193 - Planar diagram for wind form factors

Outer wind load $w_e = q_p \cdot c_{pe,10}$, where $c_{pe,10}$ is dependent of the placement to the wind direction:

Pressure on wall D: $0,9 \cdot 0,8 = 0,72 \text{ kN/m}^2$

Suction on wall E: $0,9 \cdot (-0,5) = -0,45 \text{ kN/m}^2$

Suction on wall A: $0,9 \cdot (-1,2) = -1,08 \text{ kN/m}^2$

Suction on wall B: $0,9 \cdot (-0,8) = -0,72 \text{ kN/m}^2$

Suction on wall C: $0,9 \cdot (-0,5) = -0,45 \text{ kN/m}^2$

Load pr. Running meter:

Pressure on wall D: $0,72 \text{ kN/m}^2 \cdot 1 \text{ m} = 0,72 \text{ kN/m}$

Suction on wall E: $-0,45 \text{ kN/m}^2 \cdot 1 \text{ m} = -0,45 \text{ kN/m}$

Suction on wall A: $-1,08 \text{ kN/m}^2 \cdot 1 \text{ m} = -1,08 \text{ kN/m}$ (largest load for use in wind load)

Suction on wall B: $-0,72 \text{ kN/m}^2 \cdot 1 \text{ m} = -0,72 \text{ kN/m}$

Suction on wall C: $-0,45 \text{ kN/m}^2 \cdot 1 \text{ m} = -0,45 \text{ kN/m}$

Load combinations:

Load combination 2A, dimensioning, ultimate limit state (ULS):

[DS 409-2006 p. 59 Tabel 6.6a]

2A: γ_G , sup = 1,0 used together with γ variable load = 1,5)

(2B is shown and used afterwards because the dead load is considerably larger: DS 409-2006 p. 59)

1) $S_d = 1,0 g_k + 1,5 q_k$	only live load
2) $S_d = 1,0 g_k + 1,5 q_k + 1,5 \psi_0 s_k$	dominating live load + snow
3) $S_d = 1,0 g_k + 1,5 \psi_0 q_k + 1,5 s_k$	dominating snowload + live load
4) $S_d = 1,0 g_k + 1,5 q_k + 1,5 \psi_0 w_k$	dominating live load + wind
5) $S_d = 1,0 g_k + 1,5 \psi_q q_k + 1,5 w_k$	dominating wind + live load
6) $S_d = 1,0 g_k + 1,5 q_k + 1,5 \psi_0 s_k + 1,5 \psi_0 w_k$	dominating live load + snow + wind
7) $S_d = 1,0 g_k + 1,5 \psi_0 q_k + 1,5 s_k + 1,5 \psi_0 w_k$	dominating snow load + live load + wind
8) $S_d = 1,0 g_k + 1,5 \psi_0 q_k + 1,5 \psi_0 s_k + 1,5 w_k$	dominating wind + live load + snow

ψ_0 for Q (live load): Category B, office area: 0,6

[Teknisk ståbi p. 166 Tabel 4.6]

ψ_0 for S (snow load): 0,6 w. dom. live load, by dom. wind: 0 or else 0,3.

ψ_0 for W (wind load): 0,6 w. dominating live load or else 0,3.

1) $S_d = 1,0 \cdot 42,2 + 1,5 \cdot 2,5 =$	45,95 kN/m
2) $S_d = 1,0 \cdot 42,2 + 1,5 \cdot 2,5 + 1,5 \cdot 0,6 \cdot 0,72 =$	46,598 kN/m
3) $S_d = 1,0 \cdot 42,2 + 1,5 \cdot 0,6 \cdot 2,5 + 1,5 \cdot 0,72 =$	45,53 kN/m

The negative wind load is made positive in order to place loads in FEM: (-1,08 kN/m ~ 1,08 kN/m)

4) $S_d = 1,0 \cdot 42,2 + 1,5 \cdot 2,5 + 1,5 \cdot 0,6 \cdot 1,08 =$	46,922 kN/m
5) $S_d = 1,0 \cdot 42,2 + 1,5 \cdot 0,6 \cdot 2,5 + 1,5 \cdot 1,08 =$	46,07 kN/m

Dominant live load:

$$6) S_d = 1,0 \cdot 42,2 + 1,5 \cdot 2,5 + 1,5 \cdot 0,6 \cdot 0,72 + 1,5 \cdot 0,6 \cdot 1,08 = 47,57 \text{ kN/m (most 2A unfavorable)}$$

With dominant snow load:

$$7) S_d = 1,0 \cdot 42,2 + 1,5 \cdot 0,6 \cdot 2,5 + 1,5 \cdot 0,72 + 1,5 \cdot 0,3 \cdot 1,08 = 46,016 \text{ kN/m}$$

With dominant wind load:

$$8) S_d = 1,0 \cdot 42,2 + 1,5 \cdot 0,6 \cdot 2,5 + 1,5 \cdot 0 \cdot 0,72 + 1,5 \cdot 1,08 = 47,07 \text{ kN/m}$$

Load combination 2B: is to be used because of the weight of the dead load:

(Variable loads are not to be taken in – instead the dead load is multiplied by 1,2)

$$S_d = 1,2 g_k$$

$S_d = 1,2 \cdot 42,2 = 50,64 \text{ kN/m}$ (most 2B unfavorable) = (most unfavorable overall)

Dead load of largest “book mountain”:

Concrete double frame construction: 1000 mm x 400 mm (2 x 200 mm): 25 kN/m (used earlier)
(Alternatively made hollow to save material and incorporate electrical cable routes)

Dead load of a floor slab in the book room: 400 mm concrete floor slab: 25 kN/m

Live load of floors in “book mountain”:

Together with 2,5 kN/m² from the office space the weight of books are incorporated:

Book load estimation ~ 600 kg/m²: ~ 6,0 kN/m² + 2,5 kN/m² = 8,5 kN/m²

8,5 kN/m² · 1 m = 8,5 kN/m

Hand calculation of moment created in the vierendeel truss constructed administration box
(As a cantilever above the café):

M_d = dimensioning given moment (N · mm)

R_A = reaction in point A measured in N

$R_A = q \cdot L = 50,64 \text{ kN/m} \cdot 47 \text{ m} = 2380,08 \text{ kN}$

[HFB 2:2 p. 490 no. 3]

$M_d = - M_A = \frac{1}{2} \cdot q \cdot L^2 = \frac{1}{2} \cdot 50,64 \text{ kN/m} \cdot (47 \text{ m})^2 = 55931,88 \text{ Nmm}$

FEM analysis on CD-ROM

All the loads and forces calculated above is then entered in the finite element program Staad.pro, which is computational software designed for FEM calculation.

On the CD-rom a folder containing both the software file along with diagrams of the entire analysis can be found in order to document the process of the FEM analysis in detail:

The six steps underneath is the step-wise way that the FEM system has been build and analyzed - the enclosed data on the CD-ROM depicts the stepwise approach.

- **Section of structure is drawn in 2D in the FEM program**
- **Material properties and structural dimensions are entered**
- **Supports are added – in this case all columns reaching to the floor are defined as fixed joints**
- **Loads are entered – dead load, live load, wind, snow and a unfavorable load combination**
- **Loads are added on the respectful places – fx live load on the floor slabs, wind suction on the façade**
- **Analysis is run and the data outcome printed**

acoustic chapter

reverbation times used in analysis

Absorption coefficients						
Acoustic tiled ceiling:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,06	0,20	0,75	1,00	1,00	0,94	0,95
0,74	0,70					
Wooden floor:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,05	0,05	0,07	0,13	0,17	0,18	0,18
0,24	0,26					
Concrete:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,13	0,10	0,07	0,02	0,02	0,02	0,03
0,02	0,03					
Acoustical panels:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,06	0,20	0,75	1,00	1,00	0,94	0,95
0,74	0,70					
Glass:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,11	0,09	0,05	0,03	0,02	0,02	0,02
0,03	0,03					
Bookshelves:						
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000
Hz	8000 Hz	16000 Hz				
0,60	0,70	0,70	0,60	0,65	0,55	0,55
0,60	0,50					

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- III. 2 Illustration based on Knudstrup M. 2004, Integrated Design Process in Problem Based Learning – integrated design
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- III. 4 Own photography
- III. 5 Own photography
- III. 6 Own photography
- III. 7 Own photography
- III. 8 Own photography
- III. 9 Own photography
- III. 10 Own photography
- III. 11 Sketch by Kjær & Richter Architects, Presentation CD-ROM from AUB
- III. 12 http://www.aalborgkommune.dk/Om_kommunen/kort-over-kommunen/luftfotos/Documents/2010.html (composed picture)
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- III. 24 Own Photography
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- III. 26 http://lh5.ggpht.com/_QEzsgC-Zv5s/R_P5I3YSE5I/AAAAAAAAAkg/Anm9Phusyk/DSC_0471.JPG
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- III. 28 http://lh4.ggpht.com/_m-uGpg8lO8/R9wChmipVXI/AAAAAAAAACZw/2Cjh2wJQupM/DSC_7232.JPG
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- III. 40 Own illustration (Meeting with AUB)
- III. 41 Own illustration (Meeting with AUB)
- III. 42 Own photography (composed panoramic view)
- III. 43 Own photography (composed panoramic view)
- III. 44 Own illustration
- III. 45 Own illustration
- III. 46 Own illustration
- III. 47 Own illustration
- III. 48 Own illustration
- III. 49 Own illustration (data from DMI.dk)
- III. 50 Own illustration (data from DMI.dk)
- III. 51 Own illustration (data from DMI.dk)
- III. 52 Own illustration (data from DMI.dk)
- III. 53 Own illustration (data from DMI.dk)
- III. 54 Own photography
- III. 55 Own illustration
- III. 56 Own illustration
- III. 57 Own illustration
- III. 58 Own photography
- III. 59 Own photography
- III. 60 Own photography
- III. 61 Own photography
- III. 62 Own photography
- III. 63 Own photography
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- III. 68 Own illustration
- III. 69 Own illustration
- III. 70 Own illustration
- III. 71 Own illustration
- III. 72 Own photography
- III. 73 Own photography
- III. 74 Own photography
- III. 75 Own photography
- III. 76 Own photography
- III. 77 Own photography
- III. 78 Own photography
- III. 79 Own photography

III. 80 Own photography
III. 81 Own illustration
III. 82 Own photography
III. 83 Own illustration
III. 84 Own illustration
III. 85 Own illustration
III. 86 Own illustration
III. 87 Own illustration
III. 89 Own illustration
III. 90 Own illustration
III. 91 Own illustration
III. 92 Own illustration
III. 93 Own illustration
III. 94 Own illustration
III. 95 Own illustration
III. 96 Own illustration
III. 97 Own illustration
III. 98 Own illustration
III. 99 Own illustration
III. 100 Own illustration
III. 101 Own illustration
III. 102 Own photography
III. 103 Own photography
III. 104 Own photography
III. 105 Own illustration
III. 106 Own illustration
III. 107 Own photography
III. 108 Own sketch
III. 109 Own sketch
III. 110 Own sketch
III. 111 Own illustration
III. 112 Own sketch
III. 113 <http://musicmeetsgirl.files.wordpress.com/2010/05/book-shelves1.jpg>
III. 114 Own illustration
III. 115 Own sketch
III. 116 Own sketch
III. 117 Own sketch
III. 118 Own sketch
III. 119 Own sketch
III. 120 Own sketch
III. 121 Own illustration
III. 122 Own illustration
III. 123 Own illustration
III. 124 Own illustration

- III. 125 Own illustration
- III. 126 Own illustration
- III. 127 Own illustration
- III. 128 Own illustration
- III. 129 Own illustration
- III. 130 Own illustration
- III. 131 Lended by 3XN Architects
- III. 132 Own illustration
- III. 133 Own illustration
- III. 134 http://www.meetinireland.com/BusinessTourism/media/main_site/image_library/large/Venues/MIV_0183.jpg?width=2600&height=1733&ext=.jpg
- III. 135 Own photography
- III. 136 Own sketch
- III. 137 Own sketch
- III. 138 Own sketch
- III. 139 Own sketch
- III. 140 Illustration from Staad.pro
- III. 141 Illustration from Staad.pro
- III. 142 Illustration from Staad.pro
- III. 143 Illustration from Staad.pro
- III. 144 Illustration from Staad.pro
- III. 145 Illustration from Staad.pro
- III. 146 Spread sheet from Staad.pro
- III. 147 Spread sheet from Staad.pro
- III. 148 Spread sheet from Staad.pro
- III. 149 Illustration from Staad.pro
- III. 150 Illustration from Staad.pro
- III. 151 Illustration from Staad.pro
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- III. 155 www.ebst.dk/bygningsreglementet.dk/br10_00/0/42)
- III. 156 Illustration from Autodesk Ecotect
- III. 157 Illustration from Autodesk Ecotect
- III. 158 Illustration from Autodesk Ecotect
- III. 159 Graph from Autodesk Ecotect
- III. 160 Picture from Autodesk Ecotect
- III. 161 Own illustration
- III. 162 Own illustration
- III. 163 Own illustration
- III. 164 Own illustration
- III. 165 Own illustration
- III. 166 Own illustration

- III. 167 Own illustration
- III. 168 Own illustration
- III. 169 Own illustration
- III. 170 Own illustration
- III. 171 Own illustration
- III. 172 Own illustration
- III. 173 Own illustration
- III. 174 Own illustration
- III. 175 Own illustration
- III. 176 Own illustration
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- III. 178 Own illustration
- III. 179 Own illustration
- III. 180 Own illustration
- III. 181 Own illustration
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- III. 190 <http://plusmood.com/2009/09/urban-mediaspace-schmidt-hammer-lassen-architect/>
- III. 191 Spread sheet translated from Kjær & Richter Architects (CD-ROM from AUB)
- III. 192 Own illustration based on '4.7.2 Formfaktorer på facader' p. 170 [Teknisk ståbi]
- III. 193 Own illustration based on '4.7.2 Formfaktorer på facader' p. 170 [Teknisk ståbi]



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