NEW VIKING AGE MUSEUM AT BYGDØY

Audun Wold Andresen & Simon Rhode Malm

ma4-ark46 - June 2015

"The taste of the apple [...] lies in the contact of the fruit with the palate, not in the fruit itself; in a similar way [...] poetry lies in the meeting of poem and reader, not in the lines of symbols printed on the pages of a book".

(Juhani Pallasmaa, 1998, p. 17)

If the same is true for architecture, the beauty must lie in the bodily encounter; in the awakening of the human senses. Necessarily, architectural experience is grounded in the dialogue and interaction with the environment, to a degree in which a separation of the image of self and its spatial existence is impossible. According to Pallasmaa (2012) we measure the world through our bodily existence, consequently making our experiential world centered round the perception of the human body.

This is an interest of ours; the impact of architecture on our perception, on the human experience of space. And thus, this is from where the master thesis departs.

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PREFACE

THE NEW VIKING AGE MUSEUM

'New Viking Age Museum at Bygdøy' is developed by Audun Wold Andresen and Simon Rhode Malm on the 4th and final semester of the Architectural M.Sc. program at the Department of Architecture, Design and Media Technology at the University of Aalborg, Denmark.

This Master Thesis deals with the design and organization of an extension to an existing museum, located at a small peninsula near Oslo, Norway. The peninsula, named Bygdøy, is home to several museums including the Viking Ship Museum, which expectedly, within the distant future are publishing a long awaited competition for a comprehensive museum extension. The extension has been widely discussed with an official competition announcement pending for over twenty ears. In June 2013 however, steps towards concrete actions was made, with the Museum of Cultural History in Oslo drafting a set of preliminary documents intended as the foundation of the forthcoming competition. This project takes its departure in these preliminary documents, with this report presenting the results of the project development, including; competition program, process, presentation and detailing.

Exploring the notion of a tectonic architecture within the context of museums and exhibition design, this project encompasses both the theoretical discourse regarding the subjects of tectonics and museum architecture, as well as an analysis concerning the site, background and design possibilities. An essential theme throughout the report is the conflict of creating architecture that, as indicated in the introductory statement, speaks to the human body, creating interaction and spatial experiences, while simultaneously considering the exhibited objects, which should be the center of attention.

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New Viking Age Museum at Bygdøy

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SYNOPSIS

A NEW MUSEUM PROPOSAL

The guiding parameters of the project is derived from the preliminary competition documents for the forthcoming competition at Bygdøy, Oslo. The Museum of Cultural History calls for a much-needed extension, transforming the existing Viking Ship Museum into a larger Viking Age Museum.

Currently housing only a small part of the vast collection, the limited space of the museum is centered around the main attractions; the three Viking ships, which, due to the lack of space, are not exhibited as well as intended. Restrictions to the design proposal are placed in terms of the nature of the extension and transformation, as it has been requested that the essence and character of the original building should be maintained and accentuated. The function and utilization of the existing building has not been specified further than the intention to include the spaces as part of the exhibition area. However, this thesis proposes a different approach by moving the ships to new and larger spaces in the extension, reprogramming the existing building and transforming it to the main entrance space – a publically, open and inviting space, with the character and identity both intact as well as revitalized.

In the urban scale, the design proposal addresses the character and identity of the peninsula of Bygdøy, maintaining the green character of the site, and introduces a publically accessible plateau on the roof of the submerged museum extension. The extension is partially lowered into the ground to, among other aspects, preserve the nature of the site and existing building, the materiality and proportions of both site and context. The plateau is connecting the outdoor space with the museum café, and appears as a natural continuation of the landscape and main path leading up to the museum entrance.

Following the strong symmetrical layout of the existing building, different public functions are placed in the existing building, acting as the front of the museum and includes the ticket counter together with the museum shop, the museum café, an auditorium as well as a flexible activity space. Thus, within the museum doors, a multi-layered story will unfold presenting open spaces, which will lead the audience through a new telling of the old building, before submerging from the foyer, to the lower level – the extension, and the new exhibition experience.

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Shiba Ryotaro Memorial Museum
Higashiosaka, Osaka, Japan
Tadao Ando

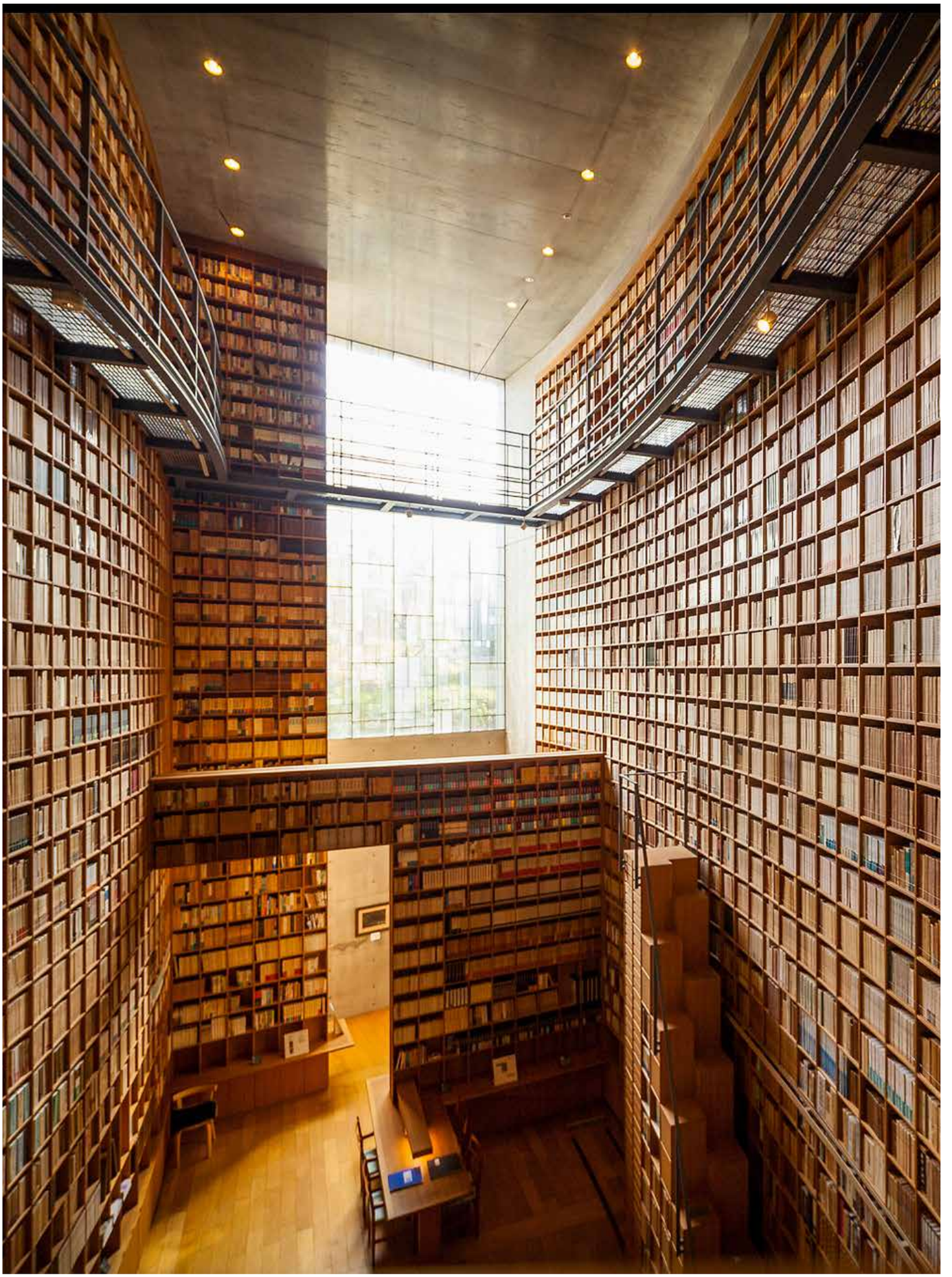
MOTIVATION
INSPIRATION AND INTERESTS

WHY A MUSEUM

Throughout our architectural education, we have had the privilege of visiting a great number of places, counting among others, Tokyo, Kyoto, Amsterdam, London, Venice and Oslo, all of which, in some form or another, featured a number of great museums. Regardless of having seen a vast amount of buildings, from the majestic and elegant Villa La Rotonda outside of Vicenza in northern Italy, by Palladio, to the immense and brutalist architecture of the Barbican Estate in the City of London, the buildings that have managed to make the biggest impression, seems to generally have been that of museums. Whether it is the seclude and refined aesthetic of Tadao Ando, seen for example in the Shiba Ryotaro Memoral Museum outside of Osaka, Japan or the contemporary art gallery of the immense Tate Modern, Britain´s national gallery of international modern art, in central London, the architecture of museums continues to impress. This somewhat elusive attractiveness connected to the experience of museums combined with our enthusiasm and interest for the subject, is something we intended to further investigate and better understand, which led to the particular choice of subject for the master thesis. Unwin states that the understanding and task of architecture "is an adventure that is best explored through the challenge of doing it" (Unwin 2003, p. 15). Thus, through the challenge of designing the museum extension, this elusive attractiveness is intended answered - and ultimately implemented in our own design.

WHY A TECTONIC SOLUTION?

Having both, long before embarking on our architectural education, been fascinated with craftsmanship, this was only further fueled after having learned about but a few of the countless architectural theories on the subject. Perhaps more significant, or certainly influential, is yet again our many study trips where we through our own body and perception, experienced the true qualities of architecture, be that through the touch of our hand, our sense of smell, sound and vision. The term of tectonics or tectonic architecture, deriving from the Greek word Tekton, is signifying the work of the carpenter in relation to poesies. The definition have, through the interpretation of various architectural theoretician undergone a multitude of meanings though possibly most famously described as 'the poetics of construction' by Kenneth Frampton (1995). Further divided in the specific subjects of 'poesies' and 'construction', it has been discussed how one affects the other, and how a correct balance between the two is attained. A recurring theme though, in the discussion of tectonics, and the attempt of finding a definitive truth, is the



Stone Museum in Nasu
Nasu, Tochigi, Japan
Kengo Kuma

discussion often culminating in an etymological analysis rather that one based on the architecture of the concrete world. More importantly, in certain interpretations, the human body fails to figure into the architectural theory, and through this frame of thought removes the perceptual experience from the tectonic meaning. For us, just as we on our study trips have experienced great architecture as nourishment for our senses, tectonics should likewise, be approached and evaluated through our senses. Our motivation is thus to explore how tectonics as an approach to architecture can, not only balance the 'poesies' and 'construction', the measurable and immeasurable', but likewise incorporate the human body as the center of attention. The challenge in this endeavor, beyond reaching this before mentioned, correct balance, is how exactly the human body figures into the theme of museum building, where, a balance likewise is needed between visitor and exhibited object.

THE MEETING OF THINGs
Apart from the many conflicts inherent in any architectural creation, the theme of museum architecture opens up a number of interesting clashes of interest, making the design of a museum particularly fascinating as well as equally challenging. Considering especially the particular case of a museum extension to a protected building, a series of questions are posed regarding the fusion, the meeting of old and new. Another inherent contradiction, or aspect which the architecture must face, is the meeting of artifact and architecture. Naturally, the architecture should reframe from overshadowing the exhibited item. Exactly where does the balance lie though, when one simultaneously intends to put the human body at the center things? Does the one exclude the other? Lastly, on the subject of exhibition design, how does this rather small scale figure in the bigger context of things? How does the other conflicting element of logistics and architectural intention affect the element of exhibition? Should the one subjugate to the other, or does the challenge rather inform the design process? These and many other pending questions, further fueled our interest for the subject of museum architecture, and are all elements that we have sought answered in the process of designing.

OBJECTIVES FOR THE THESIS
The primary objective for the master thesis has been the design of the new Viking Age Museum, extending the capacity of the already existing museum at Bygdøy, Norway. As the thesis takes its departure in actual competition documents, it has been the intention from the very beginning to submit our proposal to the Museum of Cultural History in Oslo, as they intend to make the building project an open international competition, should they actually go ahead with the plans. Thus, throughout the process, it has been imperative to approach the project with a very realistic framework in mind concerning the program, consequently aiming for a design proposal of an combined high architectural quality, credibility and realism. Being an academic project though, as described in the above section, the project will simultaneously be framed with the focus of tectonic architecture, which will provide the guidelines for the project in terms of scope and technical application. Thus, throughout the thesis, theoretical reflections will be implemented in the design process in order to inform and further challenge the ongoing discussion.

LIMITATIONS:
Due to the sheer size of the project, substantially surpassing any of the projects we have previously been a part of during our time at the university, the focus during the design process have naturally been restricted to a limited amount of main themes. Considering the size of the project, and the multitude of contradictory elements included, we chose early on to focus mainly on the overall coherence of the project, attempting to include all of these elements fully in the design process. Focusing on the conceptual coherence of the project, led to a natural limitation in terms of detailing. The details chosen are thus elements which has been found essential for the coherence of the project, or, elements which has specifically caught our interest.

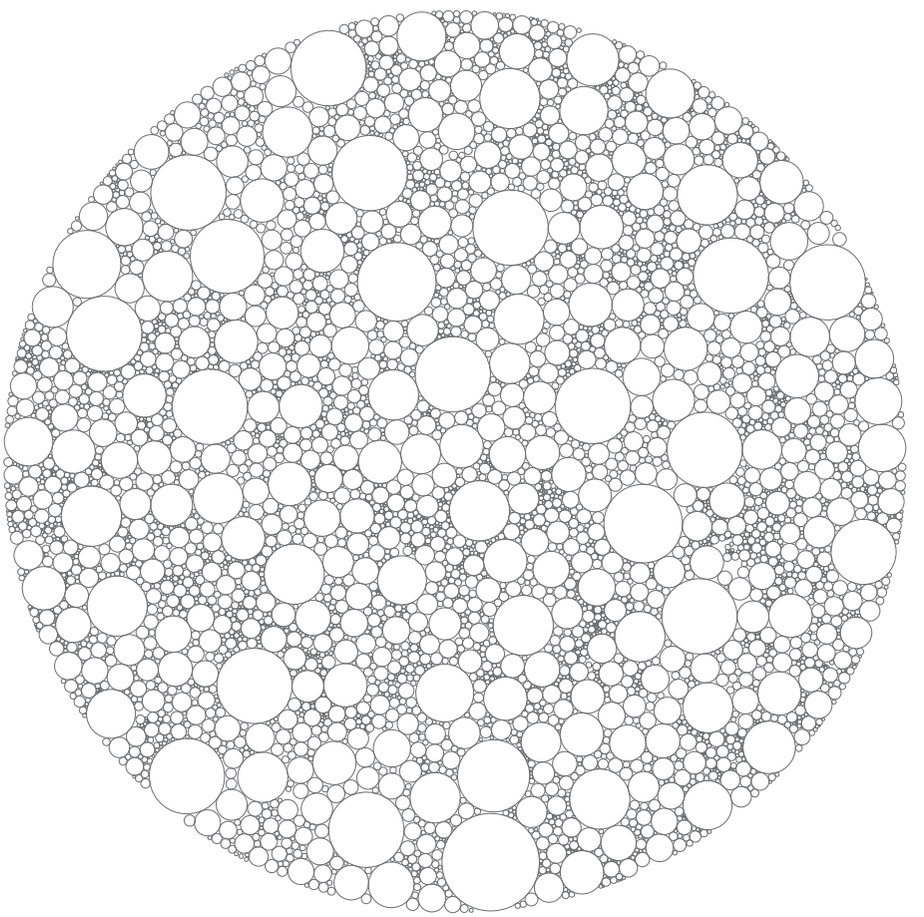
METHODOLOGY

DESIGN APPROACH

Methodology as an approach, links specific epistemological and ontological assumptions to relevant research methods, and bridges philosophical concepts with, concrete and applicable research techniques (Creswell, 2003).

The profession of architecture is a complex and multidisciplinary endeavor in which one is required to both comprehend and balance the many inherent, often contradictory, aspects in the tension between logic and perception – architectural intention and viable realization. Consequently, some aspects within the architectural practice touch upon the artistic values, with an emphasis on the subjective, emotive, and phenomenological values - whereas other aspects are distinctively placed in the measurable, objective and empirical realm. However contradictory, it seems that the unification and equilibrium of the aspects of emotion and technique is essential in the achievement of creating architectural quality. This multidisciplinary nature of architecture can be traced back to its origin, as Vitruvius articulates in 'The Ten Books on Architecture' that the ". . . architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgment that all works done by other arts is put to the test" (Vitruvious, 1914; 75 – 15 BC, p. 5). Additionally, the inherent complexities and multidisciplinary aspects present within the architectural discourse are not only evident in the practice itself, but likewise existent when dealing with architectural theory, research and methodology.

As indicated above, the diverse aspects inherent in the architectural discourse requests differing approaches of analysis ranging from the intuitive and phenomenological to the logically induced. Methodology, as defined by Creswell (2003), should link both ontological (what is knowledge) and epistemological (how we know it) approaches to a given research method to bridge the differing, possibly conflicting aspects. As argued by architectural theorist Christian Norberg-Schultz (Kjeldsen, et.al. 2012), there exists no single way to approach the topic of either architecture or methodology in architecture, as the quality as such cannot be defined by a universal rule; rather, it is rooted and derived from the specific context of the project – be that either physical or metaphysical. Departing from the awareness of the need for both an phenomenological and objective approach, this section seeks to set forth a methodological perspective which may inform and direct the discussion through the project and subsequently leading up to the concept development of the final product. As described by Unwin in 'Analyzing Architecture', the task of architecture "is an adventure that is best explored through the challenge of doing it" (Unwin



Conceptual representation of the many inherent aspects in the design process.

Ferry connection between Oslo & Bygdøy
Bygdøy, Oslo, Norway

2003, p. 15). However, Unwin goes on to argue that as in any creative discipline, describing and analyzing works of other architects is essential, and even an precondition, for one's capacity to subsequently create architecture oneself. On the topic of case studies as a methodology, Steven Holl argues that as perceptual experience, architecture is rarely understood as a totality, but rather as a series of fragmented and partial experiences. Thus, "to understand the interplay between experiential phenomena and intention, we dissect the whole and analyze our partial perceptions" (Holl, Pallasmaa and Pérez-Gómez, 1994, p. 42). This point of view is supported by Pallasmaa who goes on to stress that even though architecture is appreciated and grasped progressively by each encountered detail, the perceptual experience fundamentally depends on the contextual realm as defined by the peripheral vision. As Pallasmaa puts it the "focused vision makes us mere observers; peripheral perception transforms retinal images into spatial and bodily experience, encouraging participation." (Pallasmaa 1998, p. 193)

Hence, the case studies as a design tool are used, not in the traditional sense of studying the buildings as a whole, but rather as a series of phenomenological studies of gestures, atmospheres and details relevant to the question at hand. The cases will thus be considered as a collection of answers, which can inform and direct the design process, in which the subjects at hand will be judged, not according to the focused vision, but as spatial, bodily experiences as suggested in 'Towards an Architecture of Humility' (Pallasmaa 1998).

THE 'INTEGRATED DESIGN PROCESS'

As previously accentuated, exemplified by Christian Norberg-Schultz, no single truth or approach exists regarding the topic of architectural creation, as the process is very much dependent on an array of objective, subjective and contextual aspects. In spite of the multifold nature of architecture, several proposals for methodologies has been developed by academics and theoreticians, predominantly aimed at students, in order to provide strategies which can direct, structure and guide. A strategy similar to this is imposed at Aalborg University, with the educational approach of 'Problem Based Learning' (PBL). The approach of PBL has in this project been implemented with a point of departure in the 'Integrated Design Process' as defined by Mary-Ann Knudstrup in, for example, the article 'Integrated Design Process in Problem-Based Learning' from 2004. As emphasized in previous sections, the nature of architecture is a highly complex and intricate one, which exactly would suggest the necessity for a structured approach in order to ensure the successful implementation of all the integral parameters. Described by Knudstrup, the multifaceted process of building requires the combination of knowledge from both the field of architecture, engineering and others in order to, successfully overcome the inherent obstacles (Knudstrup 2004). This is, in a simplified manner, what is intended through the design process as suggested by Knudstrup, which, should only be seen as a mechanism to organize and direct as Hansen and Knudstrup states that "The IDP does not ensure aesthetic or sustainable solutions, but it enables the designer to control the many parameters that must be considered and integrated in the project when creating more holistic sustainable architecture in order to achieve better sustainable solutions, because all the different parameters are considered during the process" (Hansen and Knudstrup 2005, p. 894). This quote however, does not indicate that the approach applies solely to the field of sustainable architecture, but rather all architectures. The 'Integrated Design Process' as defined by Knudstrup can apply to all genres of building as they all possess multifaceted complexities which the IDP, as a guiding mechanism, can help control.

The structural mechanism of the 'Integrated Design Process' is divided by Mary-Ann Knudstrup into five separate phases consisting of; 'Problem and Idea', 'Analysis and Programme', 'Sketching', 'Synthesis' and 'Presentation'. These phases, and the progression through them is as previously indicated a gross simplification of the much more complicated structure of an actual design process, which could be argued to an higher degree to resemble that of the illustration on the previous page. The above phases however, illustrated the general phases of the project, with suggestion of which major loops the process should contain. Thus, it is stressed that the design process in no way resembles a linear one, and the approach of the 'Integrated Design Process' should therefore be considered as an iterative approach which can be applied repeatedly, until the correct synthesis is reached (Knudstrup 2004).

ARNSTEIN ARNEBERG

THE ARCHITECT

Architect Arnstein Rynning Arneberg (6 July 1882 – 9 June 1961), often considered as the leading architect of his time in Norway, had an impressive and long-lasting career that persisted throughout 50 years, in which he through his numerous projects played a significant role in shaping the Norwegian architectural tradition.

The character of Arneberg and the direction of his future career were to be shaped from a very early age. Growing up at Lysaker outside Oslo, in a predominantly working environment, his early education was limited but he was in turn greatly influenced by friends among the workers who saw to pass on their knowledge and skills. As a result, he eventually attained a natural flair for the work of the blacksmith and carpenter, and simultaneously gained an insight into the use of materials and a respect for craftsmanship – all of which would become substantial elements in his later practice (Mørch, 2006). At Lysaker he also came in contact with what would later be called 'Lysakerkretsen', The Lysaker Circle, a group of likeminded artists and intellectuals including Otto Sinding, Eilif Werenskiold, Gerhard Munthe, and Fridtjof Nansen. Common for these seminal figures where a sense of national responsibility, and they where all active contributors to the public debate. They advocated a sense of nationality that was both retrospective and contemporary oriented, a philosophy that would become one of the driving elements in Arneberg's practice.

Even though members of the Lysaker Circle was convinced that Arnstein Arneberg would have fit in among the leading Norwegian artists of the time, had he staked everything on painting, his mother insisted that he chose a more practical education. This lead to Arneberg, at the age of 16, to become a student (1899-1902) at the Norwegian National Academy of Arts and Crafts Industry in Oslo, at that time called the Royal Drawing School. Presumably for mainly economic reasons, Arneberg worked parallel to his education as an assistant for architect Alfred Chr. Dahl and later for architect Ole Sverre. Arneberg continued his education as an architect (1902-06) at the Royal Institute of Technology in Stockholm, under the professors Isaak Gustaf Clason and Erik Lallerstedt. Like previously, Arneberg worked besides his studies, this time as an assistant for Gustaf Lindgren, where he participated in various restorations and got to work on the new Stockholm police station. From 1906 he worked as an assistant for Professor Erik Lallerstedt for a year, before establishing his own architectural practice.

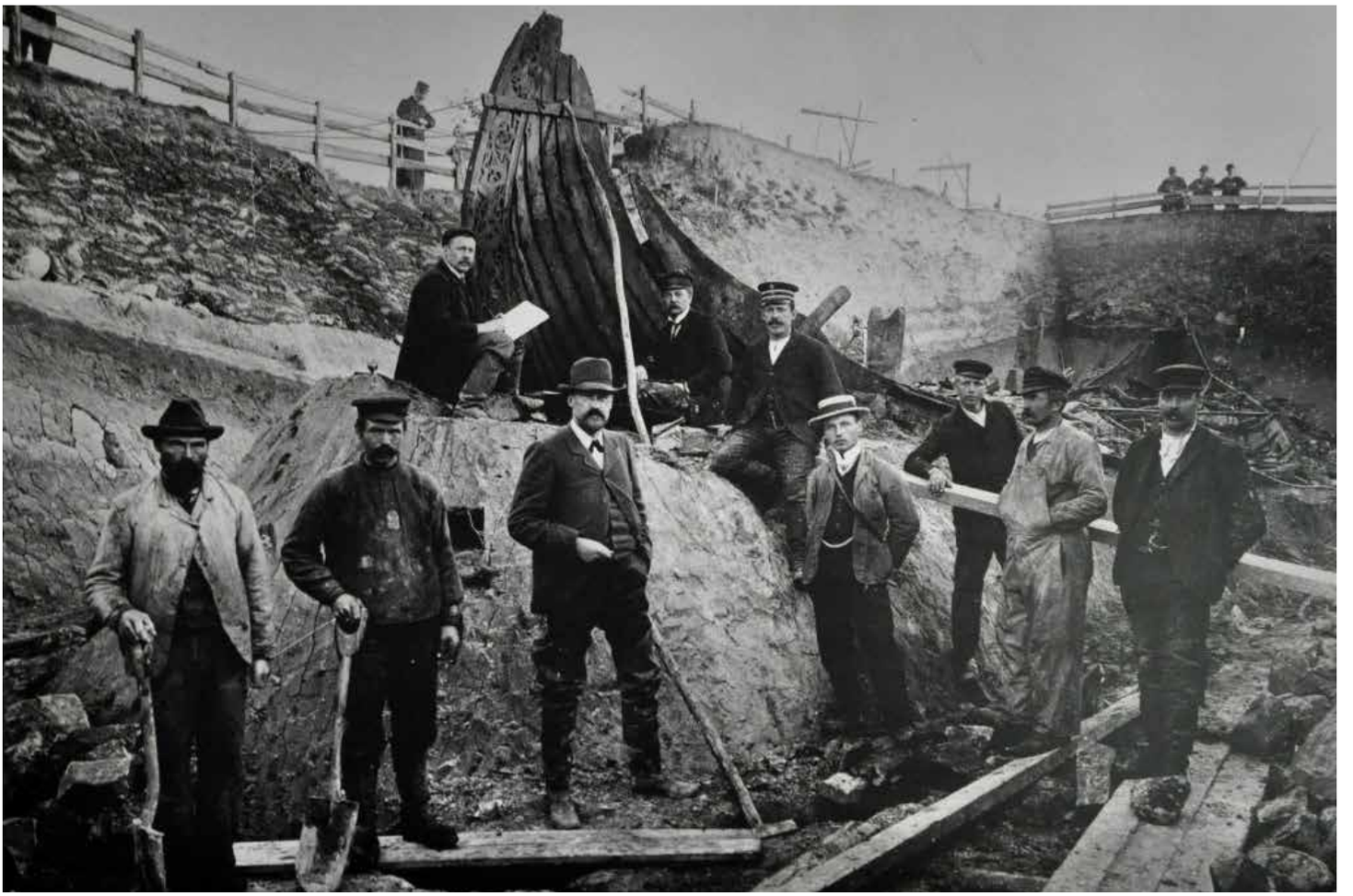
As an independent architect, his works spanned from private residences, churches, office buildings as well as interiors. Many of his earlier works are drawn in empire-style with references to the national romantic language of the time, but would later also include strong elements from modernism. Yet, the tactile approach to materials and ornamentation stands as the backbone of his practice. Among some of his most well-known projects are the Oslo City Hall, Ullensaker Church at Romerike, the Viking Ship Museum at Bygdøy, and the interior design of the UN Security Council in New York – as well as numerous significant villas.

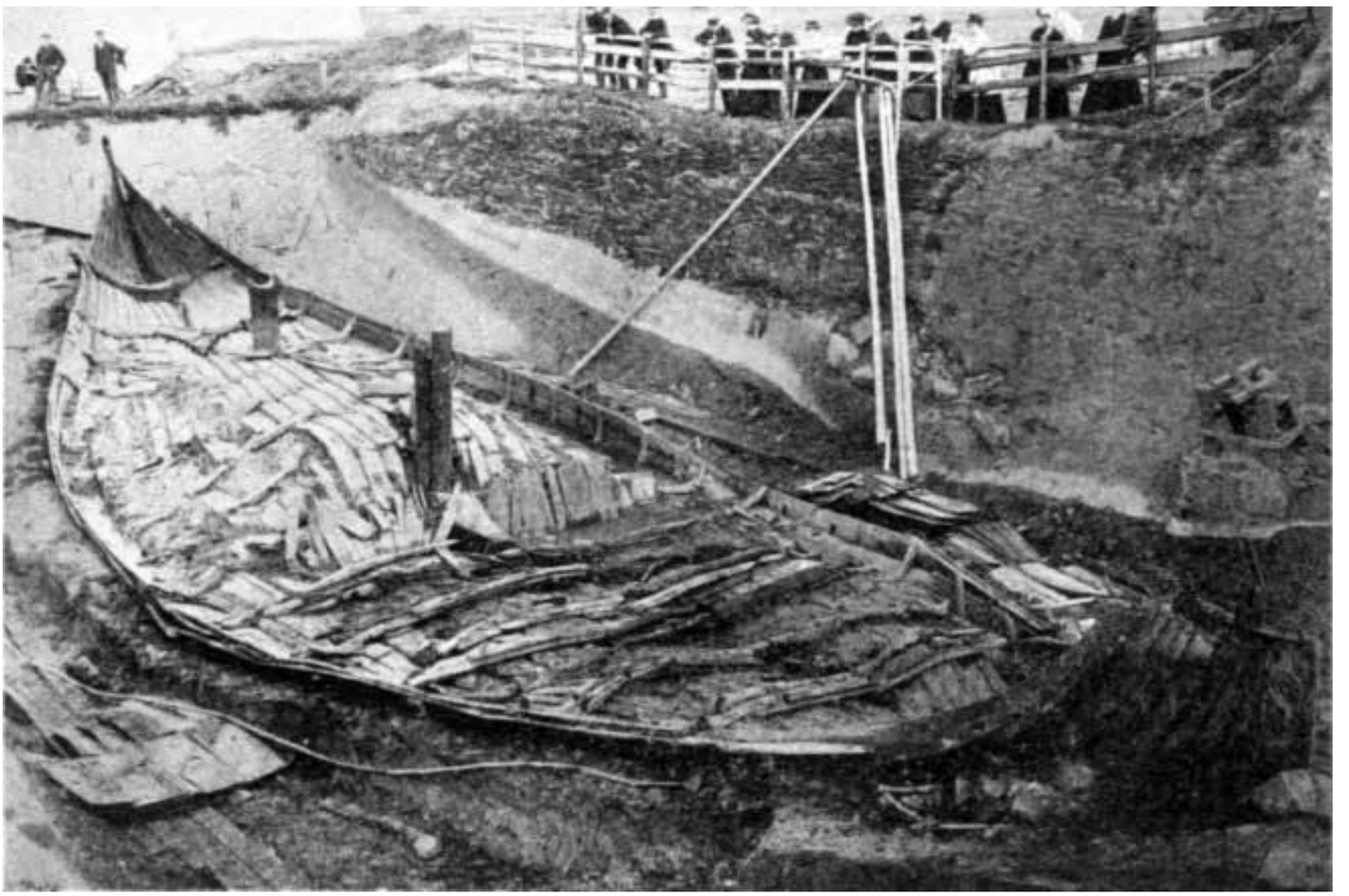
THE FINDINGS

THE BEGINNING OF THINGS

Lasting from approximately 800–1050 A.D. the Viking age was a short but eventful period. As warriors and tradesmen, the Vikings explored the world developing new trading routs connecting east and west, and founded settlements such as Dublin and Kiev (Store Norske Leksikon, 2015). Today their memories are preserved through the countless grave mounds quietly resting in the landscape, filling us with fascination and wonder. Throughout the last centuries, some of these mounds have been excavated and many of the magnificent findings can now be observed at museums around the world. Greatest among them all is the tree iconic Viking ships in Oslo, the best preserved of their kind in the world.

The first to be excavated was the Tune ship (ca. 900) in 1867, which in spite of its fragmented state is the third best-preserved Viking longboat in the world (UiO, 2015a). In 1880 the particularly well-preserved Gokstad ship was excavated, a 23 m long seagoing vessel, together with a burial chamber and an array of equipment for riding, sailing and household (UiO, 2015b). Yet when the equally big and well-preserved Oseberg ship was excavated in 1903 it completely stole the attention, and although primarily a ceremonial vessel it is for many the very definition of the Viking longboat. Together with the beautifully carved ship a series of smaller everyday objects was found, including weapons and tools, pottery and fabrics, and intricately carved wooden wagons, sledges and animal-head posts (UiO, 2015c). In addition, the Gjermundbu helmet and Hoen treasure by other findings in Norway stand as important icons in our perception of the Viking age (UiO, 2015d). Together these collections of items and the manner of which they were found provided a steadily increasing knowledge of the lives lived in a time long gone.






Café Bien
HERREEKVIPERING
ARNT AMBLE


PARFUMERI
W. B. SAMSON
CAFE HJEMLY
CAFÉ HJEMLY

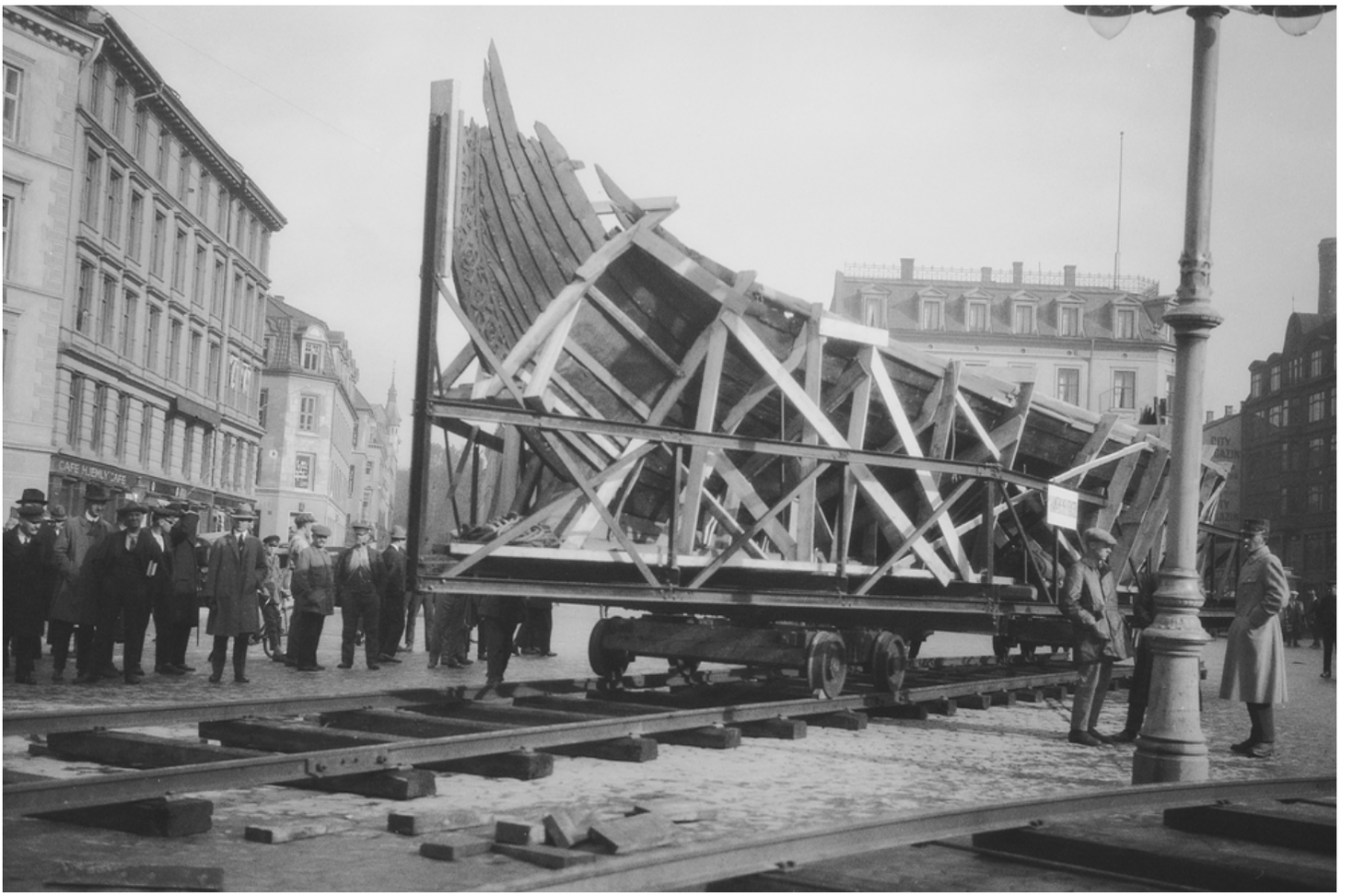
THE MUSEUM THROUGH TIME

PAST & PRESENT

After the excavation of the Oseberg findings in 1903, the long process of securing the tree ships a designated building began. When architect Arnstein Arneberg won the competition for the new Vikingship House at Bygdøy in 1915 the ships had already been temporarily located in sheds outside the Cultural History Museum at Tulinløkka for decades, which had taken its toll on their state. Work on the foundations began in 1916, but was paused for many years, and it wasn't until in 1926 that the Oseberg wing was inaugurated. The Tune and Gokstad wings were completed four years later, and finally the northern wing with the Oseberg findings in 1957. By then they had suffered badly from the damp conditions in the basement of the Cultural History Museum during the war. The Vikingship House, in the cross-shape we know today, was finally complete. Few at that point remembered the initial plans for the museum where the whole collection of ancient artefacts where to be displayed as one. (Mørch, 2006)

With a booming economy, the rapidly changing cityscape of Oslo and an age of mass tourism as a backdrop a new debate concerning the Viking age collection arose. In 1995 the Culture Minister presented a new plan – this time for a new museum complex in Bjørvika at the newly available site behind the Oslo Opera House. This initiated an almost twenty yearlong public debate concerning local and national political interests, a potentially increased platform for tourism and value creation, and of course the very perception of a modern museum and the dissemination of history. In the end science became the determining factor, after countless analyzes and reports. The current state of the ships simply didn't allow for them to be moved (NIKU, 2012).

Yet with more than 400.000 visitors a year Arnebergs Vikingship House has long ago exceeded its capacity. Even the collection itself, now the biggest from this period in the world, has outgrown its limits and is today partly stored at rented facilities, inaccessible to the public. The government therefor made the decision in 2013 to begin the process of planning a new museum at Bygdøy, comprising the entire Viking age collection, as planned in 1915. The 9.300m2 new museum will be situated at the same site as the now listed Vikingship House and partly act as an extension (UiO, n.d.). Marking the end of a long and intricate bureaucratic process an international open competition was expected announced in autumn 2014, but in the time writing nothing has yet been published (UiO, 2015e).



THE COMPETITION BRIEF

A DRAFT LAYOUT

The ambitious plan to extend Arnebergs museum at Bygdøy has attracted substantial attention and public interest, with many people eagerly awaiting the announcement for the international design competition. Even though the preliminary preparations for the competition have been complete for some time now, the initiation of the detailed planning phase relies on a final political decision regarding the construction project. As the visions for the museum at Bygdøy caught our attention like many others, and the competition announcement is still pending, the thesis will take its point of departure in the preliminary competition documents, developed by the Museum of Cultural History at the University of Oslo. The primary aim of the extension is to expand the exhibition areas, which, together with the public areas, accounts for over two-thirds of the entire competition program. In the preliminary documents, emphasis is placed upon the creation of a modern and contemporary museum, including features like conference and teaching possibilities as well as expanding on existing features like the shop and museum café. The presented goals for the museum of Bygdøy is to become an internationally recognized institution within both culture and research.

Even though the museum today is among Norway's most visited, it is the expectation of the Museum of Cultural History to increase the visitor numbers by two-fold, projecting the annual visitor number to reach 800.000. From the outset, the expectations to the museum extension have been very high, exemplified by Museum Director Håkon Glørstad who states by saying, "We have the largest collections of ships and artifacts from the Viking Age in the world, and a research and communication environment of high international standards, which is why we desire the world's finest Viking Age museum", translated from Norwegian. (UiO, 2015e).

The competition brief consists of a wide array of considerations, visions and demands. All of these subjects are, put simply, divided into a few major categories with some focusing on the purely programmatic, functional and logistically features, and others being concerned with aesthetics, exhibition and the user experience. Attention is also given to the outdoor areas surrounding the museum, as it is the intention to establish a more vibrant and lively area than the one existing today. This entails specific areas designated for activities and special events related to the exhibitions, areas directly connected to an expanded museum café, and open and inviting areas connected to the museum entrance.

The existing Viking Ship Museum is a very central aspect in the competition brief, with the utilization and integration of the existing building, to a large degree, determining the success of any design proposal. It is emphasized that Arneberg's Viking Ship House should be respected and accentuated as the famous and prominent element it is in the museum landscape of Bygdøy. Thus, the new museum should combine the values from the historic building with a modern expression of high architectural quality, and Arneberg's building is therefore an important point of departure in the design of the new facility.

ROOM PROGRAMME

INTENTIONS & VISION

The thesis will utilize the detailed room program provided in the preliminary competition documents by The Museum of Cultural History, based on preliminary investigations and recommendations by the Ministry of Education. The utilization of the provided program in the design process, presents the opportunity to create a design proposal, founded on an actual, realistic framework, and it is therefore the intention not to omit any of the elements included in the program, thus mirroring the challenges of any real architectural project. It is not excluded though, that alterations to the brief will occur in terms of the organization of functions, as appropriate solutions might be found other than the ones thought of in the brief. In the following section, parts of the detailed program will be outlined in order to highlight the most pertinent elements and objectives in the brief. The majority of the attention is placed on the exhibition areas and public functions, though substantial efforts should likewise be placed on the preservation, workshop and office facilities.

Summary of the program as provided in the competition documents

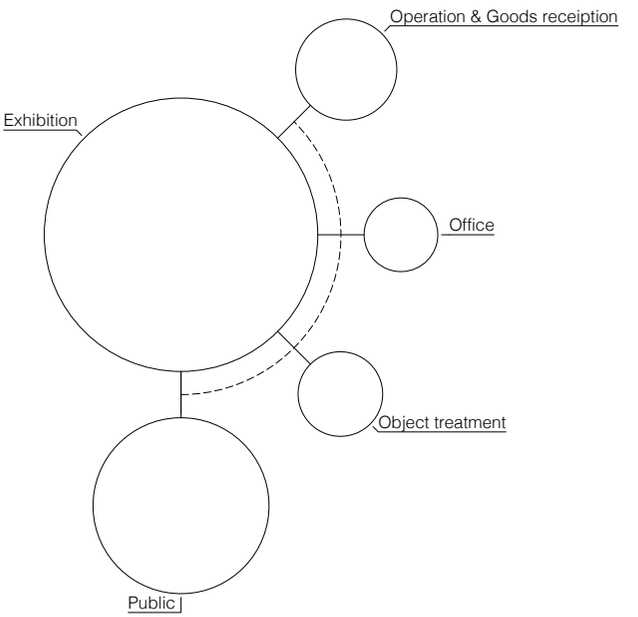
Public areas	:	1.710 m2
Exhibitions	:	4.130 m2
Office facilities	:	300 m2
Object Treatment	:	565 m2
Operation	:	395 m2
Total		7.100 m2

FOYER AND MUSEUMS SHOP:
As a museum experience begins, not at the exhibition areas, but at the entrance, it is important that the foyer is bright, open and welcoming. The space should be designed for at least 250 visitors, with areas spacious enough for guides to collect visitor groups before entering the museum. It is important that visitor information, ticket sale and wardrobe functions are naturally integrated in the entrance spaces, and that the arrangement of functions are logical and understandable. In addition, it should be possible to access the outdoor areas directly from the entrance space, and that the museum shop is integrated as an element that the visitors naturally pass on their way to or from the exhibition.

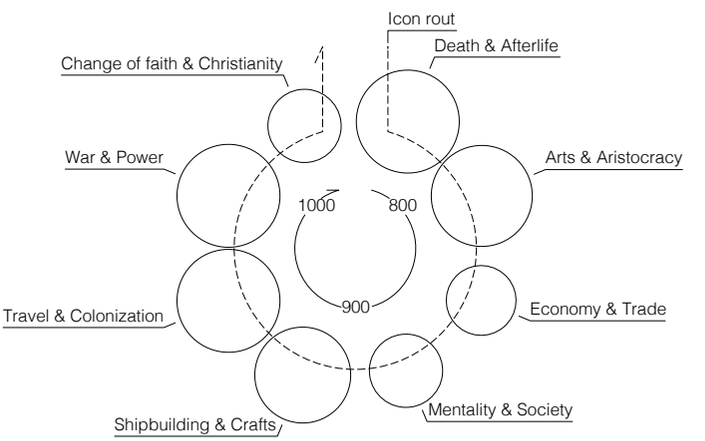
MUSEUM CAFÉ:
An open and inviting café should be established with direct connection to the foyer, and is requested to include the possibility for outdoor servings. It should be possible for the general public to access the café without having to purchase a museum ticket, and outside of ordinary opening hours of the museum. Consequently, the café has to be placed away from the secured parts of the museums so as not to pose a potential security risk.

LECTURE, TEACHING AND WORKSHOP FACILITIES:
The auditorium, used for lectures, teaching and workshops, should be arranged as an amphitheater and be able to seat 200 people. It should be situated in direct connection to the foyer, and be accessible for wheelchair users on both the upper and lower level. In close connection to the auditorium, a flexible activity zone is intended for events and activities for special groups such as school classes. This flexible activity area is requested to be in direct connection to the foyer, so as to potentially utilize both the auditorium and activity zone, yet at the same time without causing disturbances for one another. In addition, there should be an area specifically intended as activity and dining area for school classes, in which connected wardrobe facilities should be dimensioned for a capacity of 240 schoolchildren.

EXHIBITION AREAS:
With the exhibition areas consisting of more than half of the entire program, this is of main interest in the competition documents. The exhibitions includes a flexible special exhibition and the museum´s permanent main exhibi-



Overall museum layout



Overall exhibition flow & layout

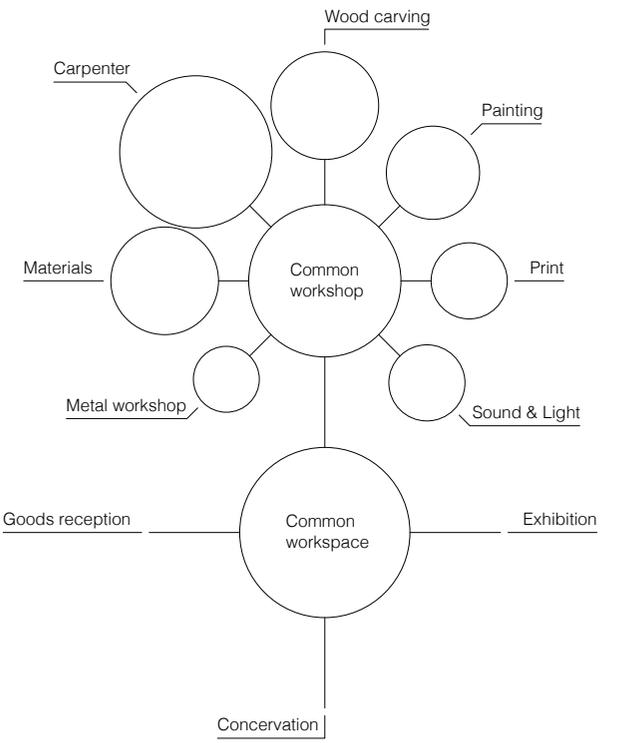
tion focusing on the Viking age as well as research on the subject. According to the competition documents, the vast museum collection is to be divided into eight thematic exhibition categories. Many of these will be subdivided further into three sections, consisting of 'The Icon Trail', 'The Immersion Space' and potential 'Activity Areas'. The 'Icon Trail' is intended to display the most prominent objects of the collection, specifically designed for groups of tourists with limited time, wanting to see the most iconic finds from the Viking Age, including the Oseberg and Gokstad ships and the Gjermundbu helmet. The 'Immersion Space' is the unique and comprehensive collection of the Museum of Cultural History and is intended to form the basis for public exploration of the Viking world. Included in this section will be the current research and subjects occupying both researchers and the public. The 'Activity Areas' are meant for families and others who intend to spend an entire day in the museum exploring and engaging in various activities. In this regard, it is intended that both indoor as well as outdoor areas be activated.

SPECIAL EXHIBITION:
The special exhibition area is a flexible exhibition space for temporary exhibitions relevant to the museum's ongoing research on the Viking Age and excavation activities. The space will, in addition to exhibitions designed by the museums itself, house touring, international exhibitions, and must therefore have a general layout, which facilitates various exhibition possibilities. The special exhibition should optimally, be arranged in the overall museum layout to be easily accessible for visitors who have seen the permanent exhibition before, and are mainly interested in the special exhibition.

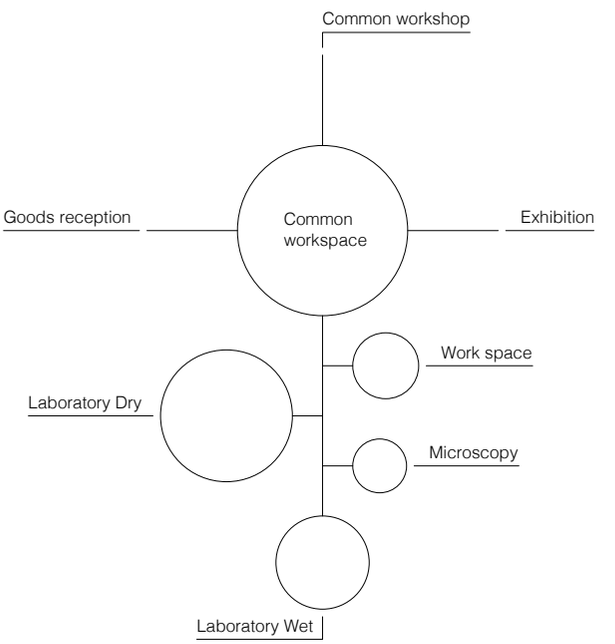
WORKSHOPS AND OBJECT TREATMENT:
Included in the museum functions are a number of facilities such as areas for object treatment and various workshop functions; painting, woodcarving, carpentry, metal workshop etc. It is imperative the many workshop facilities are arranged as physically separate functions, so as any activity can be carried out in the individual spaces, without interfering or disturbing activities carried out in other spaces. The workshop functions must be arranged logically and in close connection with both exhibition, object treatment and goods reception. The same applies for the areas of object treatment, which likewise must have direct access to the exhibition and arrival of goods and artefacts. Generally, door- and hallways must be high, wide and without thresholds, and the geometry of the main communication between the exhibitions, workshops, object treatment and goods reception, must be designed for easy transportation of large objects.

OFFICES AND ADMINISTRATION:
The office and administration facilities should be placed together, easily accessible from workshops, exhibition production, conservation, as well as linked to the public spaces of the museum. The administration areas should include informal relaxation and meeting places along with kitchenettes incorporated into the area. In addition, the area should contain both dining and meeting rooms, which are to be used by all staff members, and must therefore be easily accessible.

OUTDOOR AREAS:
The outdoor areas connected to the museum is to be used as both a publically accessible area and an extension to the interior exhibition space. The area will thus be used for display of reconstruction models, while also functioning as a workshop area for the production of such reconstructions. Additionally, the area could contain for example an outdoor scene, be the setting for museum events and markets, or an Viking playground for the children. As the area will house these activities, it should be placed within some sort of defined area and ticket barrier, while access to the museum café should still be accessible for the general public, including the outdoor areas.



Exhibition production & workshops



Conservation & object handling

THE ROOM PROGRAMME

THE DRAFT IN DETAIL

The above program is derived from the preliminary competition documents which are attached in the accompanying appendix files.

Function					Properties
	Amount	*Size*	*Area sum*	*Total area*	
Public Areas				- 3078 m2	
Foyer	1			- 730 m2	
- Foyer & entrance area	1	- 280 m2	- 280 m2		The main entrance space should appear bright and open, and should be dimensioned for 250 people in order to ensure space for guided tours.
- Info, tickets	1	- 50 m2	- 50 m2		
- Museum shop	1	- 320 m2	- 320 m2		Located so visitors naturally pass the shop, with direct access to foyer. Arranged for an easy flow of tourists. Preferably with dedicated area.
- Storage	1	- 80 m2	- 80 m2		Dedicated storage with easy access from goods reception.
Museum café	1			- 450 m2	
- Café	1	- 240 m2	- 240 m2		Situated adjecent to the foyer, with possibility of outdoor seating. Should be possible to access outside of the museum opening hours.
- Kitchen	1	- 100 m2	- 100m2		Easy access from the goods reception.
- Dining room for classes	1	- 60 m2	- 60 m2		Located adjecnt to, but seperate, from the foyer. Generally accessible.
- Wardrobe for classes	1	- 50 m2	- 50m2		Adjecent to the dining room for classes.
Wardrobe	1				Located adjecent to the foyer, with lockers for the visitors.
Flexible activity area	1	- 200 m2	- 200m2	- 200 m2	Located close to, but seperate, from the foyer. The space should be able to accommodate events such as workshops and seminars.
Auditorium	1	- 250 m2	- 250 m2	- 250 m2	Seating for 200 people, with wheelchair accessibility to both levels.
Toilets, etc.				- 80 m2	
Other				- 1380 m2	
Exhibition Area				- 6608 m2	
Permanent exhibitions			- 3700 m2	- 3700 m2	
- Viking Icons					Should facilitate large groups of visitors with a limited amount of time.
- In depth exhibition					Exhibitions changing according to the latest findings and research.
- Activity space					Whole-day experience, activating both indoor and outdoor spaces.
Special Exhibition				- 400 m2	A flexible space for changeable exhibitions of international scale.
Outdoor Exhibition					Area for reconstructions and various event.
Toilets, etc.				- 30 m2	
Other				- 2478 m2	
Office Area				- 540 m2	
Office				- 180 m2	
- Office space	16	- 10 m2	- 160 m2		Should be situated together, with good access to the common areas, workshops, exhibition production and conservation. Daylight required.
- Informal meeting place	1	- 10 m2	- 10 m2	-	
- Print, copy, archieve	1	- 10 m2	- 10 m2		
Dining & Meeting				- 90 m2	
- Meeting space	1	- 20 m2	- 20 m2		To be used by all employees, and should be easy accessible.
- Dining area	1	- 70 m2	- 70 m2		To be used by all employees, and should be easy accessible.
Toilets, etc.				- 30 m2	
Other				- 240 m2	

Function	*Amount*	*Size*	*Area sum*	*Total area*	Properties
Object Treatment				- 1026 m2	
Workshops & Exhibition prod.				- 325 m2	
- Carpentry workshop	1	- 80 m2	- 80 m2		For the production of exhibitions. Connection to Shared Workspace.
- Woodcarving Workshop	1	- 40 m2	- 40 m2		For the production of replicas. Connection to Shared Workspace.
- Material storage	1	- 40 m2	- 40 m2		Storage for wood, glas, metal, etc. Connection to Shared Workspace.
- Common Workshop	1	- 80 m2	- 80 m2		Flexible shared workspace for exhibition production.
- Printing & foil cutting	1	- 20 m2	- 20 m2		Room for plotters, printer etc. Connection to Shared Workspace.
- Storage: Sound, light	1	- 80 m2	- 80 m2		Sound and light equipment for use in exhibitions.
- Painting Workshop	1	- 30 m2	- 30 m2		Painting and finishing of replicas and exhibition items.
- Metal Workshop	1	- 15 m2	- 15 m2		Working area including forge.
Conservation				- 165 m2	
- Object handeling	1	- 50 m2	- 50m2		Should be in direct connection to delivery bay and exhibition.
- Laboratory, dry	1	- 60 m2	- 60 m2		Close to the Shared Workspace. Fitted with laboratory benches.
- Laboratory, wet	1	- 30 m2	- 30 m2		Close to the Shared Workspace. Fitted with laboratory benches.
- Workspace	1	- 15 m2	- 15 m2		For preventive conservation, in relation to Conservation Laboratories.
- Microscopy	1	- 10 m2	- 10m2		Situated in relation to Conservation Laboratories.
Shared Workspace					Shared space for; object handeling, conservation, workshops and exhibition production.
Storage Security		- 60 m2	- 60 m2	- 60 m2	Temporary storage of objects to/from the museum. Should have access to Shared Workspace and exhibition areas.
Toilets, etc.				- 20 m2	
Others				- 456 m2	
Goods Reception & Operation				- 711 m2	
Common Area				- 75 m2	
- Wardrobe, toilet, shower	2	- 25 m2	- 50 m2		Close connection to the staff entrance, goods reception and meeting.
- Relaxation Space	1	- 10 m2	- 10 m2		
- Management & cleaning	1	- 15 m2	- 15 m2		
Security Office	1	- 10 m2	- 10 m2		
Operations				- 35 m2	
- Storage equipment	1	- 15 m2	- 15 m2		
- Storage Utilities	1	- 10 m2	- 10 m2		
- Storage Operation	1	- 10 m2	- 10 m2		
Cleaning				- 75 m2	
- Cleaning central	1	- 15 m2	- 15 m2		
- Cleaning machines	1	- 15 m2	- 15m2		
- Dry storage	2	- 15 m2	- 30 m2		Distributed throughout the building
- Cleaning room	3	- 5 m2	- 15 m2		Distributed throughout the building
Good reception & waste	1	- 200 m2	- 200 m2	- 200 m2	Common good reception for objects processing and operation of the building, where object handeling should be treated separately from or isolated from handeling goods and waste.
Other				- 316 m2	isolated from handeling goods and waste.
Total				- 11963 m2	Gross Area Factor: 1.8

A SENSE OF PLACE

A PHENOMENOLOGICAL APPROACH

Between heaven, earth, and horizon, our place is defined – or so Christian Norberg-Schulz states, referring to Heidegger's phenomenological definitions of the earth and sky. (Norberg-Schulz, 1992, pp. 21-22) Together they create the boundaries of the landscape, the boundaries of a place, similar to how floor, wall, and ceiling define a built space. (Norberg-Schulz, 1980, p. 13) Sometimes the landscape appears as if extending endlessly, while other times, it is clearly defined as in a valley or a clearing. (Norberg-Schulz, 1992, p. 22) This is the spatiality of a place, which forms a totality made up of concrete things having material substance, shape, texture and colour. (Norberg-Schulz, 1980, p. 13) These elements – what we walk on and between, what we hear or see – determine the character of a place. (Norberg-Schulz, 1992, p. 21) In the boundary, character and space come together.

This might all appear trivial and self-explaining, but at the same time the descriptions by Norberg-Schulz are among the first and only of its kind. Breaking space and landscape down into their basic elements, he has created an architectural tool, connecting built structures with their surroundings. Yet, as he points out, the character of a place is not constant, but changes whit the seasons, even during the course of the day. This does not necessarily mean that our sense of place is changing. (Norberg-Schulz, 1980, p.14) It is defined by our perception, and its changing character over time becomes a part of its identity. This becomes highly evident when examining the Nordic countries, which despite their widely different topography and landscape, are brought together by the ever-changing sky and low winter sun. The changing character is defining the sense of place.

Bygdøy & Oslo in the larger context
The various connections
Scale - 1:40.000

BYGDØY

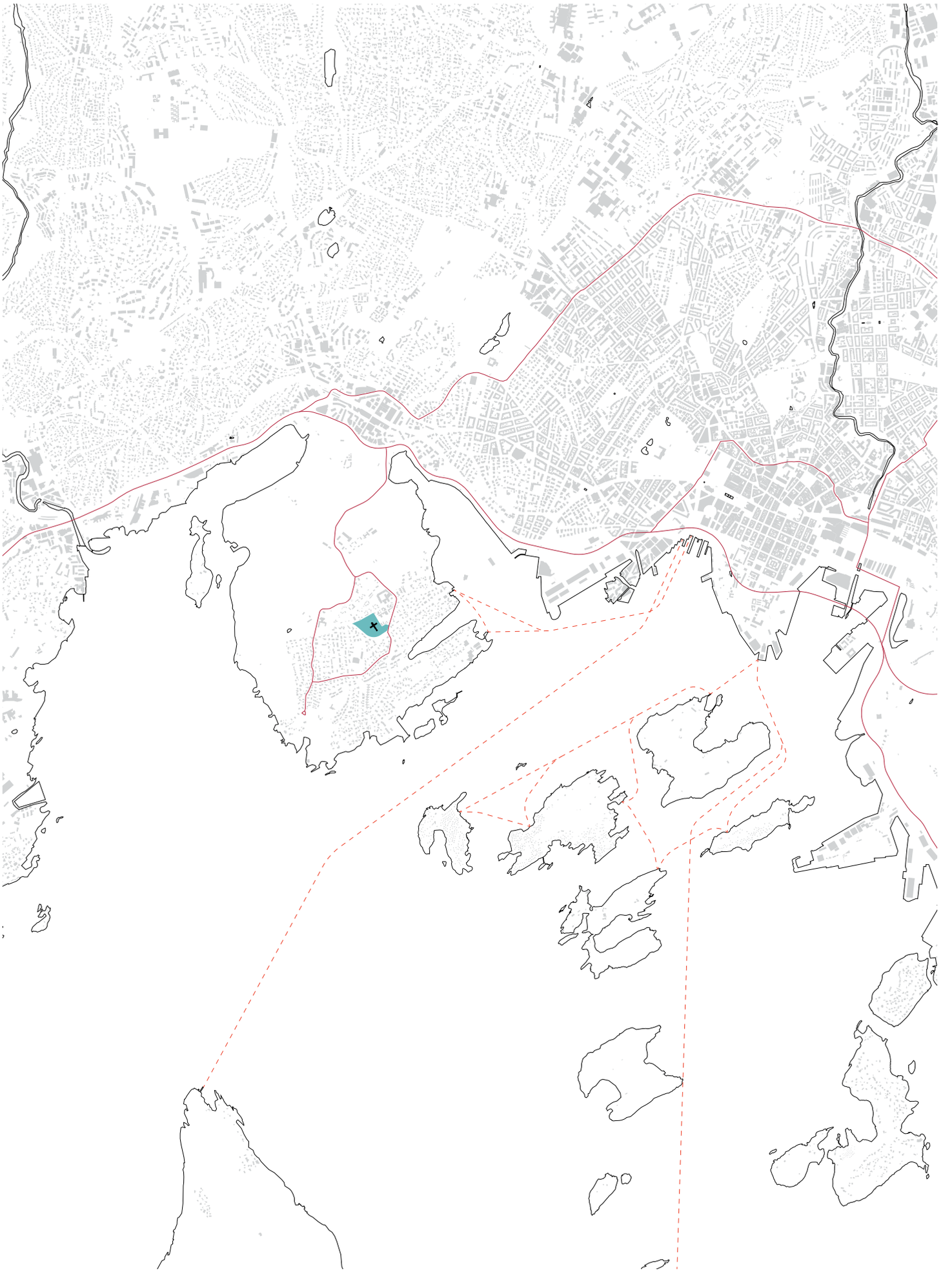
THE PENINSULA OUTSIDE OSLO

The 3,6 km2 Bygdøy peninsula has for hundreds of years acted as a refuge from the noise and chaos of the city of Oslo. In the 1200s it was given as a gift to queen Eufemia as a summer retreat, and although ownership of the peninsula has varied throughout history, the royal family's summer residence are still located here. Most of the built areas were planned around 1900 according to the ideals of the time, with large villas and spacious gardens for the wealthy and fortunate. Today around 3400 people are living at Bygdøy. Yet, the State is by far the biggest landowner and as of 2012 about two thirds of the peninsula is protected, including the Hengsåsen nature reserve. Thus, the recreational quality and potential of this scenic area is both as important and apparent as ever before. Bygdøy is also on of Norway's main tourist destinations with a large number of significant museums, counting the Norwegian Folk Museum, Norwegian Maritime museum, the Kon-Tiki museum, the Fram Polarship Museum, the Holocaust Centre, and the Viking ship House (Store Norske Leksikon, 2013).

With only a narrow connection to the mainland, Bygdøy stretches out into the Oslo fjord. The topography appears flat, but the vegetation is lush, with grand old trees and open fields. Here and there traces of the past is visible in heavy stone fences and fragmented alleys, lost of their former function. A network of paths meanders around in the landscape, from forest, through fields to the shore. Some places the forest extends to the water, others the smooth bedrock, polished by glaciers ten thousand years ago, creates sheltered coves with coarse sand.

Bygdøy can be reached by one bus line, forming a loop that connects all the museums, including the Viking ship House. Its close proximity to the city centre also makes the peninsula a desired destination for hiking and cycling, and many Oslo citizens are regularly going for a run or visit one of the restaurants. For many tourists the ferry, departing from the Oslo town hall, is the most convenient as a natural part of a whole day trip.

In summer the area is full of life, with young and old flocking to the beaches. Even in winter the hiking trails are popular, and ones in a while even the Queen might be found running along the water. As much as Bygdøy is a relatively small peninsula with its seasonal events, it also stands as a childhood memory of exploration and warm summer days – one of the features that makes Oslo as a whole more than a small town in the northernmost corner of the world.



The connection point at Bygdøy between the peninsula and the mainland.

Historical urban development at the Folk Museum at Bygdøy.

Traditional cottages and farm houses displayed at the Folk Museum, just next to the Viking Ship House.

One of the many public trails cutting through the landscape of Bygdøy.

The site in its context

The museum and the surrounding buildings

Scale - 1:2.000

SITE

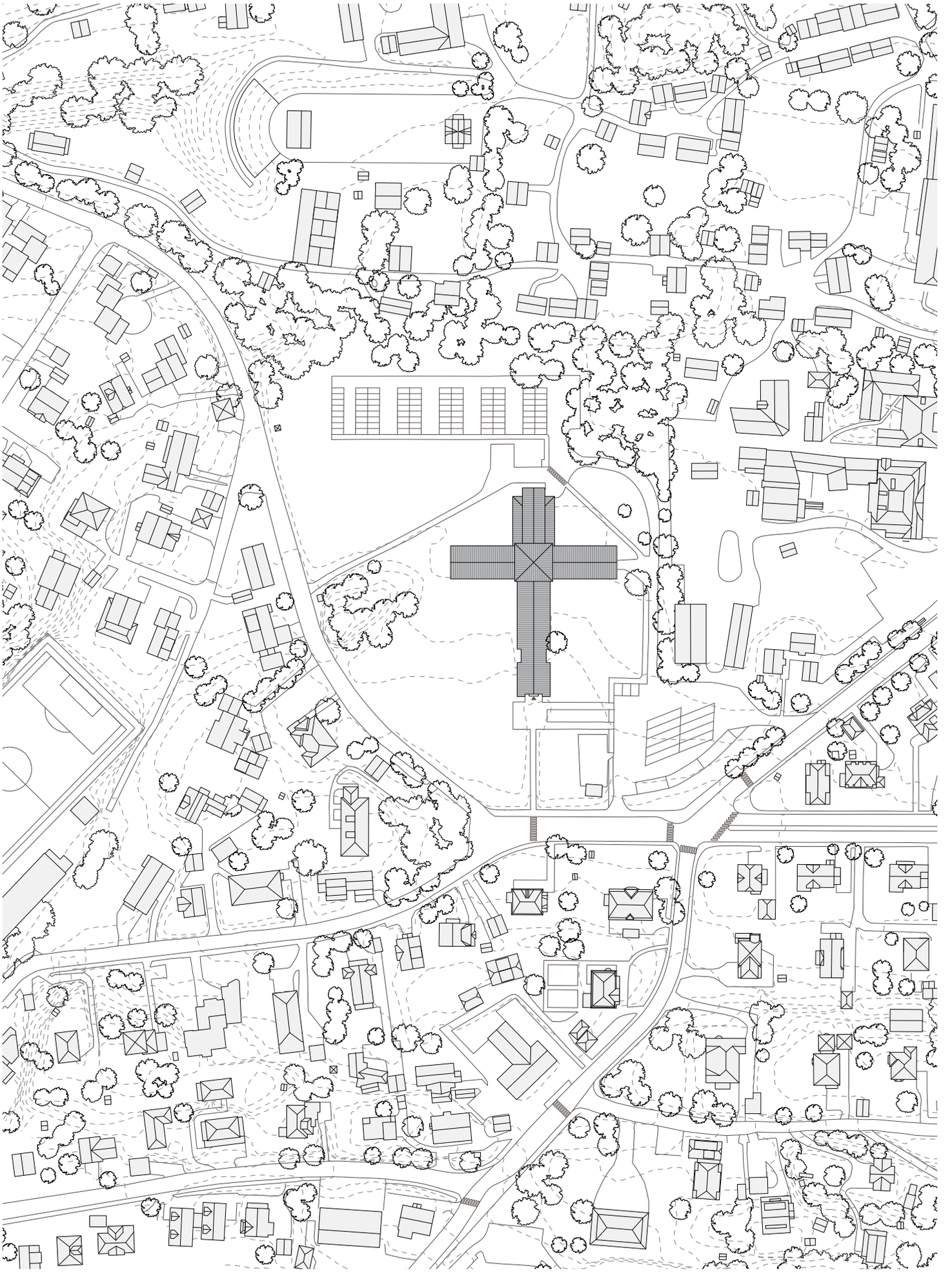
STUDIES & ANALYSIS

The Vikingship House is located at Huk Aveny 35, an open green area of approximately 30.500 m2 (Statsbygg, 2015). To the south and west grand old villas are firmly situated along the main road, facing the fjord below. Some sporadic contemporary villas can be found as minimalistic volumes among the fruit trees. To the north and east the Norwegian Folk Museum envelope the site, and through the tall trees townhouses and dark brown log cabins can be seen as fragmented stories from the past.

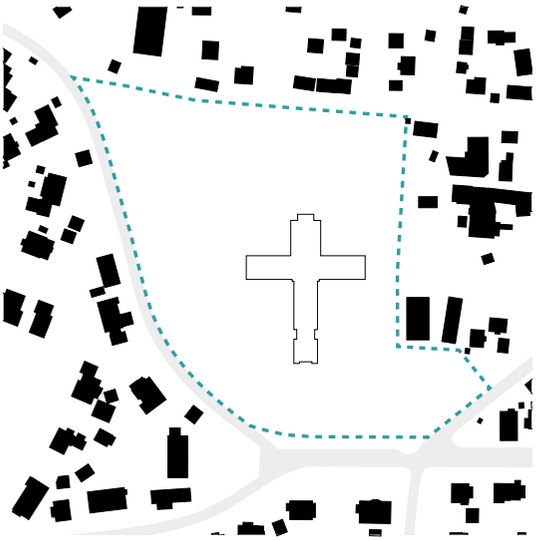
The site has a slight bowl shape, sloping gently downwards with about 4-5 meters towards north, as if being pushed down by the pure weight of the large Vikingship House. Both firmly anchored and reaching for the sky, the cross-shaped building stands as an artifice in the landscape – a heavy medieval church.

For those arriving by bus, bike or on foot, a handrail tall hedge draws up the line of the entrance axis from the main road. The tourist bus parking in the eastern corner of the site seams a bit cut of from the strong entrance situation, but offers a nice axial view of the building. The parking area only provides space for 11 busses at the time. At the back of the building there is parking spaces for approximately 90 vehicles. From the car parking there is some interesting vies to the Folk Museum, but the area as a whole appears as little more than a backside at the time being. Especially the entrance situation from the car parking appears untreated.

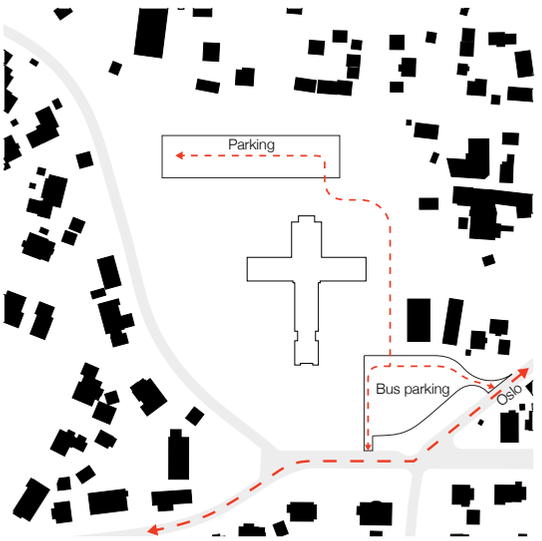
Towards the southwest and southeast the large area surrounding the building opens up, with good sun conditions and limited disturbance from the adjacent road. Yet hedges, elevations, and other landscape features makes the area appear partly cut of and without a real function. In front of the building tables for outdoors dining and a small café, not more than a kiosk, is situated. Also here the sun conditions are good throughout the hours the museum is open. Although the site as a whole appears slightly fragmented and untreated, the open character of the space seems as a natural element in it´s surrounding and a continuation of landscape found at Bygdøy.



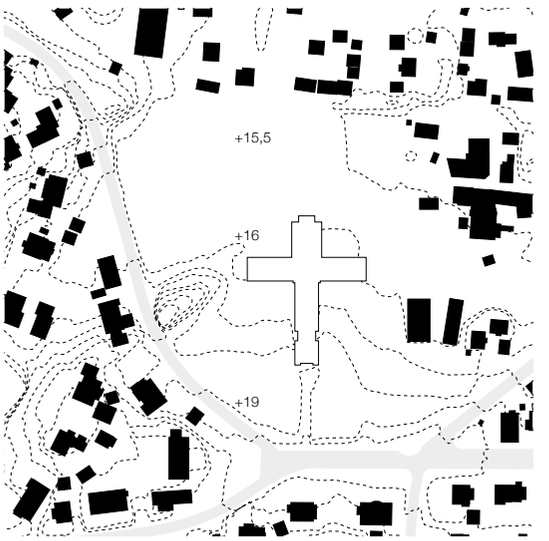
SITE
STUDIES & ANALYSIS



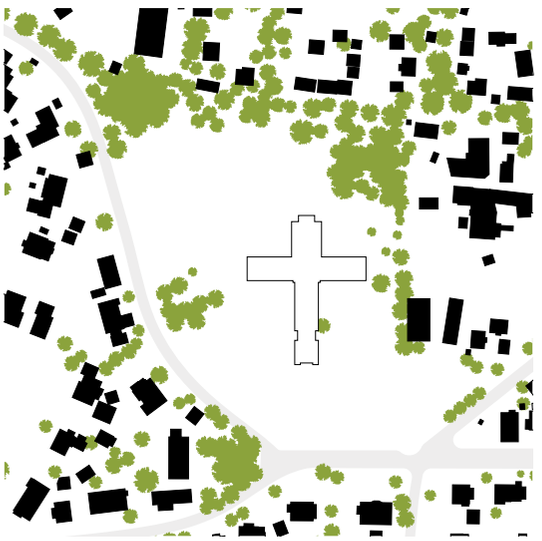
The site covers an area of approximately 30.500 m2, largely consisting of open green landscape.



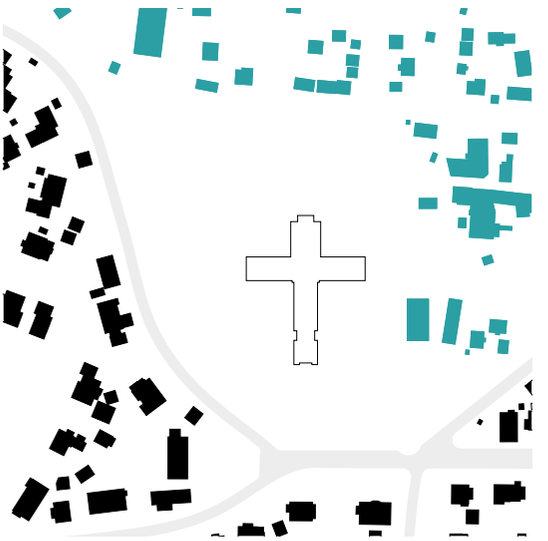
From the main street, connecting Bygdøy to the mainland, two connection points lead to the bus parking and further to the visitors parking at the back of the museum.



The site is sloping downwards towards North with about 4 meters.



Just like the peninsula as a whole, large trees and dense vegetation dominate the edges of the site.

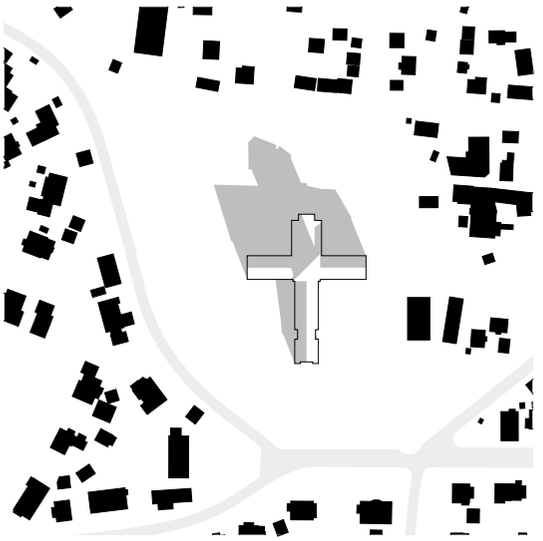


To the northeast of the site the Folk Museum, where original buildings from the whole country is gathered, is situated, continuing the history from the Viking age to the modern .

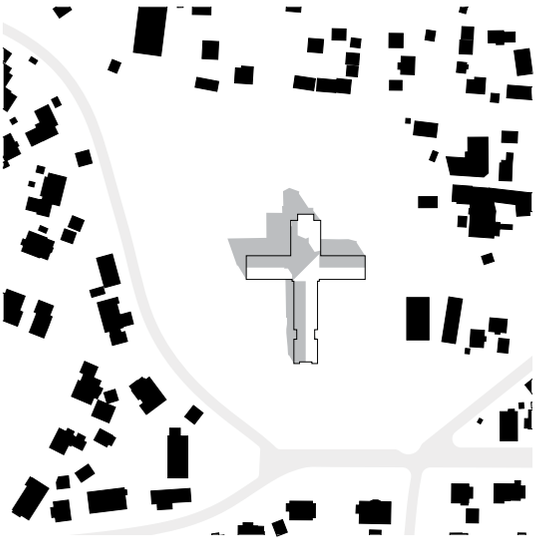
SITE

SHADOW STUDIES

As the Viking ship House is the only large structure on or in close proximity to the site, and the shadow study is therefor only investigating the existing structures influence on the site. Yet, as experienced on site but not shown in the study is the influence of the many large trees surrounding the area, and how they in winter is close to completely overshadowing the site.



09.00 March 21th



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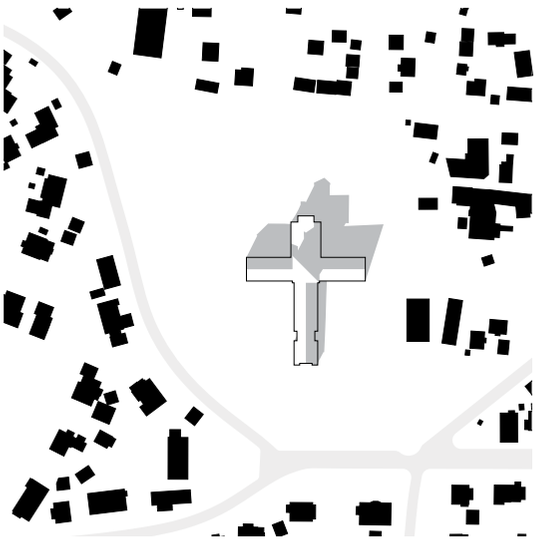

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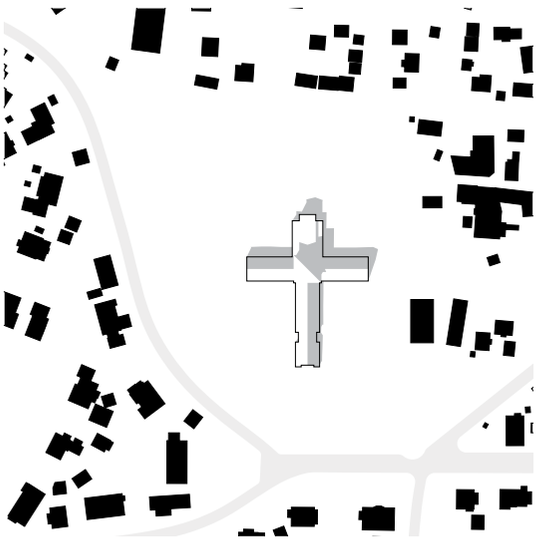

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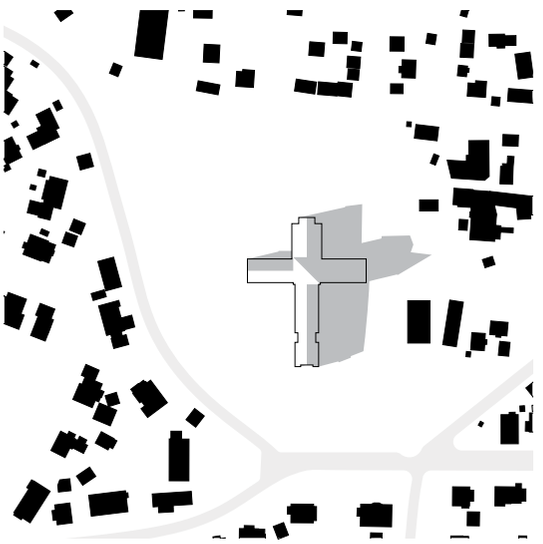

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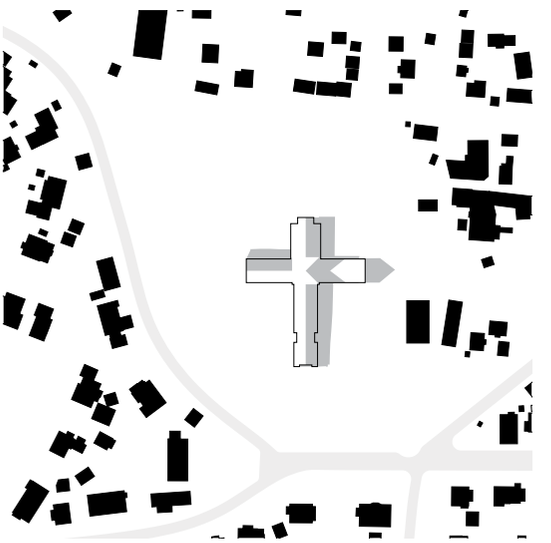

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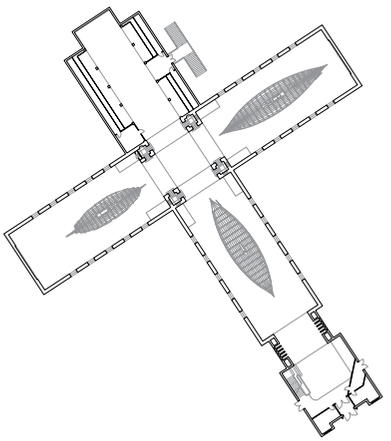


THE SHIPS & THE VIKING SHIP HOUSE

ARCHITECTURE & ARTEFACT

The main body of the Vikingship House is completed in a neoclassical style, with great gabled roofs in red tile that extends flawlessly above the modernistic entrance volume. With its dark wooden cornice and rough whitewashed finish the building almost has a slightly rural appearance. Despite its style the volume stands clean and without any extravagant ornamentation.

The interior of the building is equally simple as the exterior, but the spatial experience is rich. The entrance area appears tactile and intimate, brought down to human scale by the gallery above, with detailing in lacquered wood, brass and a rough brick floor, laid in a herringbone pattern. The brick floor is repeated in the centre of the building, underneath the tower, and on the narrow stairs leading up to the interior balconies. Narrow windows, like tall cuts in the masonry walls, let a diffuse light into the entrance space.

Spacious elliptic vaults act as the backdrop for the three grand ships, creating an introverted and almost sacral atmosphere. One can almost wonder if the building once was a church. The curves of the space gently cache the curvature of the ships, as they stand almost black against the whitewashed walls. Floating, out of context, but with their former greatness still apparent. Dimly lit, the details and woodcarvings are barely visible, but reveal them self for the patient eye. The vaulted spaces accentuate the direction of the ships, but are all to narrow for the whole length silhouette to be experienced. From the small balconies the visitors can observe the whole length of the ships, but being only 6 square meters each they allow little space for movement. Even outside of the tourist season they appear cramped and leave little time for studies and reflection.

The deeply set windows, their depth enhanced by the curvature of the wall, lets a limited amount of direct sunlight into the exhibition spaces, but from the round clearstory windows in the central tower the light flows down into the building. This effect gives an enchanting perception of depth where the vaulted structures intercept, and a spectre of blues and greys stand in sharp contrast.

In the northern wing of the building the smaller items are exhibited. A basilica like section provides spatial variation for the different items, where the sledges and other large artefacts can be studied in the tall centre of the wing, lit from above by the clerestory windows. On the sides the scale drops, and behind a row of pillars in the yet darkest area of the building, swords, coins, and other artefacts are exhibited behind protective glazing. Being one of the latest additions to the building, a transition is visible in the materiality for those searching for it. The floor is clad with linoleum and through the whitewashed finish of the walls a concrete structure can be seen. Despite the shifts in style an floor materials, the building stands in the highest degree as a uniform, complete volume – a cross in the landscape.

With it´s cross plan it is easy to get an overview of the exhibition, and the four exhibition wings creates a natural circulation towards and around the ships and other items. Yet the plan leaves little space for more than the ships, and potential in-depth information is lacking. The result is a half told history, leaving the artefacts as objects rather than tools and personal belongings from a bygone era.

“Everything is provided to accentuate these mighty finds, the ships lines, construction and decorative equipment. Here we have an architectural restraint that hardly could have achieve greater impact then in the halls erected over our early saga times most vivid heritage.” (Mørch 2006, p. 142)

THE ARCHITECTURE OF MUSEUMS

ARCHITECTURE & EXHIBITION APPROACH

Does architecture affect our experience of museums, and if so, in which way? How does the architecture relate to the art of exhibiting? Driven by these questions and guided by a strong belief that the architecture of museums, and their spatial quality, arguably is as important as the exhibited objects themselves, the following will explore the nature of the architecture of museums. Given the vast nature of museums though, their history, and the wide range of available information on the topic, to make a general observation on the institution of museums would be a redundant task, largely irrelevant to the project at hand. Thus, the following sections related to the 'The Architecture of Museums', will not seek to present a historical or chronological survey on the topic of museums. Rather, the intention is to present a collection of different themes, cases, theories and ideas, relevant to the project at hand, which will bring forth both questions and answers, intended to suggest an approach and direction for the ongoing design process.

When studying the architecture of museums, be that contemporary or historical, it becomes apparent that the spatial boundaries are directly influencing the experience of the spectators. As the physical frame provides the setting for which all of the museum activities takes place within, naturally, the choices regarding the physical environment is of great importance. The architecture can function as a neutral backdrop which remains relatively invisible to the users, it can complement the collection and display of the museum or ultimately, whether intentionally or not, distract from the activities of the museum. Regardless the choice, the museum architecture directly affects the experience of the user, influencing not only the perception of the architecture, but also the exhibited objects themselves.

Regarding the subject of perception, Pallasmaa (1996) emphasizes the importance of the corporal aspects over the visual, arguing that buildings are structured through distinct bodily activities. A building, according to Pallasmaa, is encountered, approached, confronted and moved through – all aspects, which are related to the human body, and not defined by visual elements. Pallasmaa goes on to state that; "A building is not an end in itself; it frames, articulates, structures, gives significance, relates, separates and unites" (Pallasmaa 1996, p. 68). Seen in the specific context of exhibition design, a somewhat similar statement is made by Professor David Dernie as he argues that "movement animates our imagination – through movement we understand our world" (Dernie 2008, p. 28). These statements suggest the significance of, not only the physical settings of the exhibition, in which the correlation between artifact and architecture are essential, but likewise the movement in and around these spaces.

A dominating approach to the architecture of museums in the 20th century is plainly manifest in modernist art museums in the form of the 'white cube'. This museum typology possesses a high degree of flexibility in which largely any spatial configuration can be achieved - with reconfiguration and maintenance being a relatively manageable task. The modernist approach sought to provide a neutral backdrop in which the spectators were free to form their individual interpretation, expressed by Brian O'Doherty (1986) as the work being isolated from anything that could potentially diminish the evaluation of the art. As the approach of the traditional modernist exhibitions have been somewhat critiqued for perhaps being too neutral (Birkett 2012), thus reducing the impact of the artworks, the typology of these exhibitions have continuously been explored and expanded upon, as in Lina Bo Bardi's Museum de Arte de São Paulo. In this case, Bo Bardi broke with the convention of the traditional exhibition and chose to display the paintings on vertical glass surfaces anchored only at the bottom by a block of concrete. The visitors were thereby able to move around the exhibited objects and perceive them as physical existences in space; much like the artists had seen them on their easels in his studio (Moore 2012). As a strategic element, the description of the artworks were mounted on the back of the glass sheets, to, as Bo Bardi put it; "leave the spectator to his own pure unhampered observations" (Moore 2012, p. 164). Thus, the exhibition required the viewer to move around and actively engage with the works, consequently making the viewer part of the exhibition as a ballet between the living spectators and painted dead.

Whether examining the innovative solution of Bo Bardi or other examples of similar museum typologies, a commonality is the notion of the 'free space' framing the gestures and narrative of the artist. A seemingly palpable metaphor of this correlation could be found in that of a 'black box' theater, in which; an inherent flexibility allows for the actors, directors and set designers to create an endless arrays of narratives for the spectators to immerse themselves in. This parallel might hold a lesson as Peter Zumthor remarks that: stage designers are seemingly better architects than architects themselves as they, even though being an illusion, are able to create atmospheres that are to the point (Kjeldsen, et al., 2012). Analogously, it is the role of the museum curator, in the case of the neutral space, to construct immersive narratives within the frames set forth by the architect.

Chichu Art Museum
Naoshima, Japan
Tadao Ando

At the Japanese island of Naoshima, a counterpoint to the above scenario is found at the Chichu Art Museum by Tadao Ando. Here, art and architecture are created in symbiotic collaboration making them, not only inseparable, but also equally indistinguishable from each other. With the unification of art and architecture as a permanent narrative, the two, if possible to mention as separate entities, elevates each other in a manner that would seem otherwise unattainable if treated separately. It is important to stress though, that there exists a distinct difference between the two museum typologies, as each one exhibits a radically different material from the other. The exhibited object in the two cases invites radically different architectural responses and highlights a series of important considerations to include in the design process. One highlights a scenario in which exhibited object and architecture is; created in accordance with each other, allowing each element to elevate the perception of the other. The other example highlights an option in which space is not highlighting the objects, but rather, the objects are used to create space.

The cases of Bo Bardi 's museum in São Paulo and Ando's museum at Naoshima are chosen, not for the specific objects which they display, as these are radically different from both each other, and the ones exhibited at the museum at Bygdøy. Rather, they are chosen as they display two diametrically different approaches, highlighting the scope and range of possibilities within both museum architecture and exhibition design. In the case of Museum de Arte de São Paulo, Bo Bardi exemplifies, through an interpretation of the 'free space', the potential qualities of a flexible exhibition layout. In this case, Bo Bardi made a conscious decision regarding the exhibited objects, presenting them in an, at that time, relatively innovative way. The quality of the space becomes the inherent flexibility of the space, allowing the curator to decide, at least to a certain degree, whether the physical context should interpret, relate to, or otherwise connect to the exhibited item, or rather, remain passive – leaving the act of interpretation purely in the hands of the spectator. In the case of Chichu Art Museum, the opposite is the case as art and architecture becomes a unity - permanent, inflexible and inseparable. In this case, the object are most certainly interpreted, and ends up, to a large degree, becoming experiential phenomena, and ultimately, more in connection to the human body than that of Bo Bardi.

Both of the above examples possess admirable qualities; the less interpretive and flexible space of Bo Bardi, and the spatial qualities and experiential phenomena of Ando, perhaps more closely resembling the qualities described by Pallasmaa. The question left is how these above elements figure into the museum context of Bygdøy, the artefacts, the ships and the existing building. Subsequent studies will explore these questions.

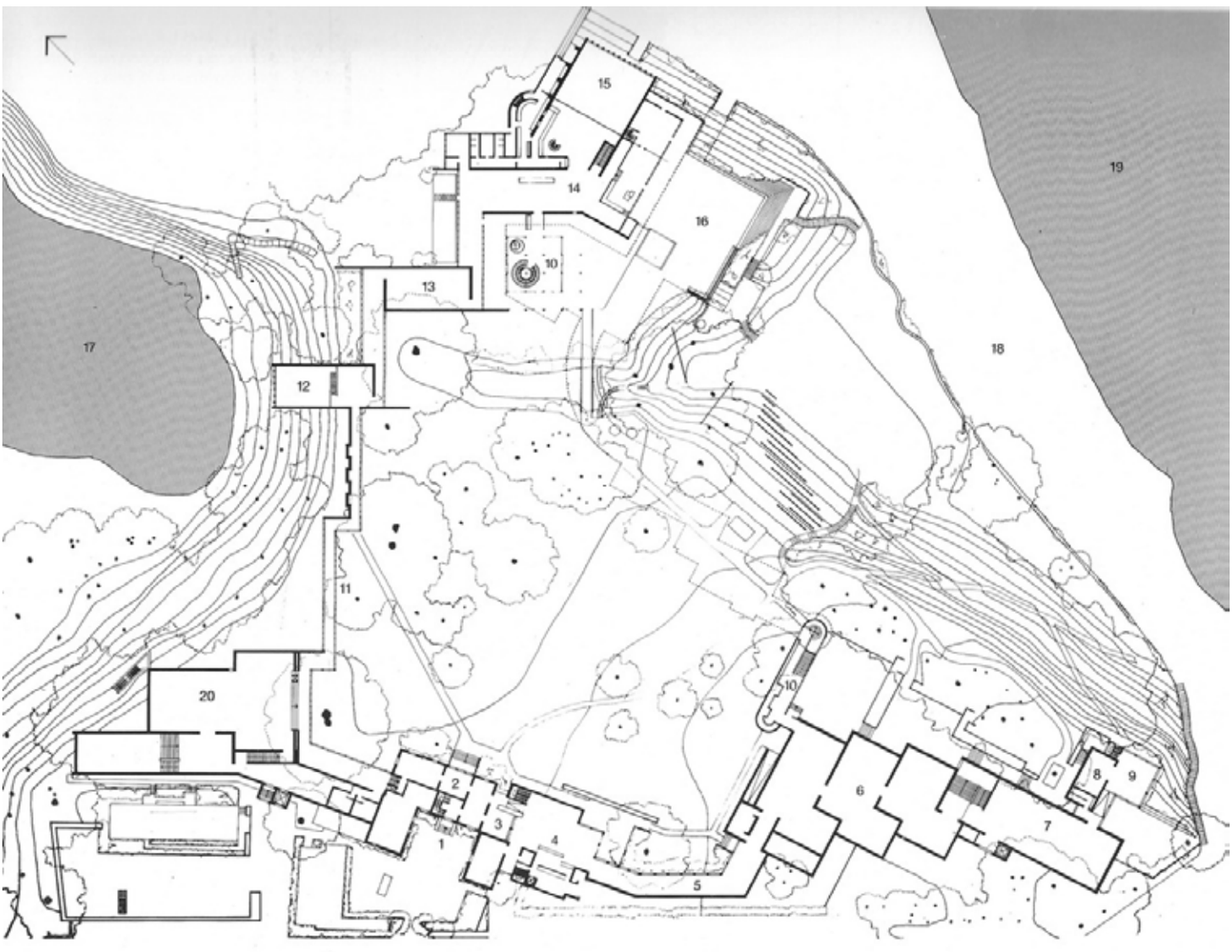
Louisiana Museum of Modern Art
The museum in the surrounding park
Humlebaek, Denmark

BUILDING DESIGN & EXHIBITION LAYOUT

ORGANISATION & CIRCULATION

Departing from the preceding examples of museum typologies, the following section will examine closer the considerations required, theoretical or practical, to achieve a rich spatial structure within museum design and exhibition layout. This section will thus, as the preceding chapter include a number of case studies, though in this section focusing in closer detail at the many layout possibilities and their individual potentials. The case studies chosen for the analysis are of different scales, different architectural styles and are all exhibiting distinctly different kinds of objects. Keeping the design assignment in mind though, the case studies included are all museums that house a permanent collection, either arranged permanently or periodically reconfigured, thus, their spatial design where conceived with a particular collection, or specific configuration in mind.

As touched upon in the preceding chapter and expanded upon by Kali Tzortzi in the paper 'Museum Building Design and Exhibition Layout: patters of interaction', the ordering of the museum spaces can be categorized into two theoretical extremes. At one end is the grid layout, which, through a randomization of the visitor exploration pattern, minimizes the control that the layout imposes on the visitor, thus, making it impossible to visit the museum in any orderly sequence. At the opposite end of the spectrum is the 'single sequence' museum, which offers little or no freedom of movement (Tzortzi, 2007). In the latter case, a strong spatial sequence dictates the movement of the visitor, minimizing ones exploration and options for changing path. For each of the two extremes there exists a number of sub-genres, which, in the case of the single sequence museum, could be expressed through the presence of a main axis with several sub-sequences added to that main path. An example of this is present at The Louisiana Museum of Modern Art in Humlebaek. Here, a main axis surrounding a central park, gives access to a series of sub-routes, which one can either chose to pass or explore in further depth. In the case of Louisiana though, even further flexibility lies in the central park as this allow the visitor to leave the main axis, and through crossing the park entering the main path again, at another destination. The presence of the park as a distributive element is thus offering a level of choice, which greatly affects the museum at a overall level. One can consequently argue that Louisiana, due to the many possibilities of the visitor, is actually somewhat closer to that of a grid plan than a single sequence layout, despite the very unidirectional appearance of the floor plan.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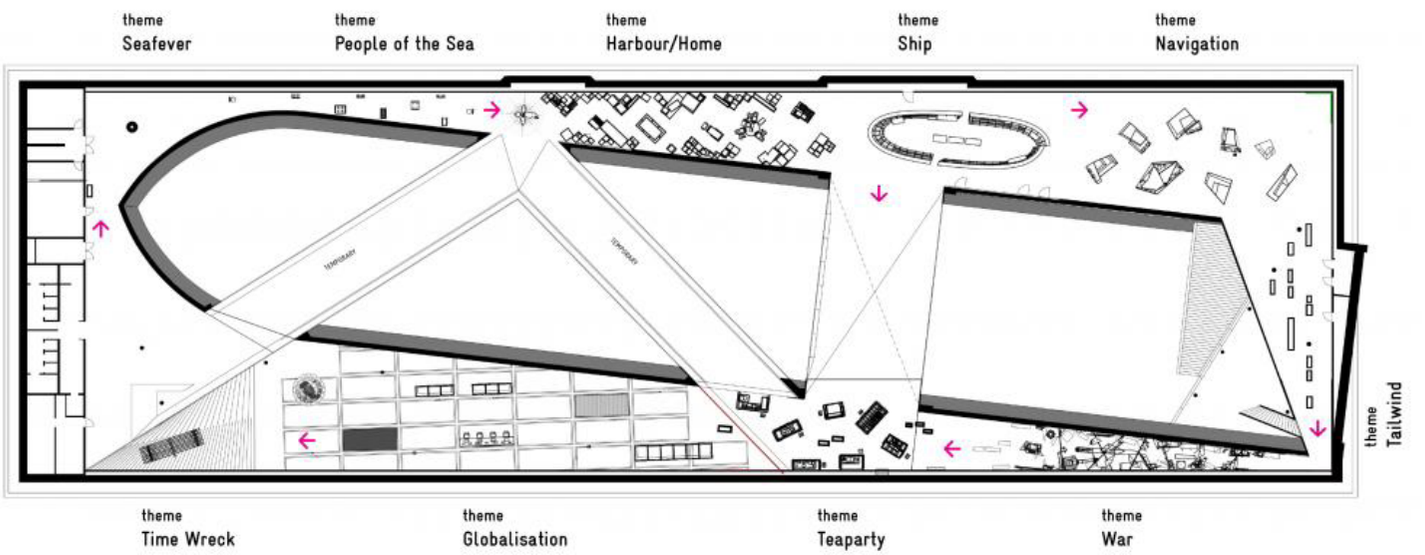
The Danish National Maritime Museum
The museum surrounding the old dry dock
Helsingør, Denmark

An example of a museum closer or equal to that of the 'single sequence' layout is The Danish Maritime Museum, located in Helsingør. Much like that of Louisiana, the museum revolves around a central space, in this case an old dry dock, which here is implemented exclusively as an aesthetical and conceptual element, as it doesn't have any functionality in terms of sequential flow through the museum. Circling around the old dry dock, the Maritime Museum does not provide many movement possibilities other than along the one main axis, which presents a very orderly, chronological sequence of exhibition elements. The continuous flow through the museum is only interrupted at a few points; one in form of a dead-end path leading to the museum café, giving access to the exterior area of the dry dock. At another place along the main axis a sub-route offers access to the special exhibition, which, apposed to the general exhibition along the main path, is a periodically changing exhibition. In case of logistics, movement and exhibition strategy, the design and layout at the Danish Maritime Museum are successfully executed. The single sequence layout around the old dry dock provides an extremely readable movement through the museum, accentuating the chronological story of the exhibited items, while the sub-route of the special exhibition can be reconfigured and altered periodically, without affecting any movement along the main axis.

Seen from an architectural point of view, there may be a significant difference between the building's actual structure and the final form experienced in the exhibitions designed by the museum curators. When studying the floor plans of the Moesgaard Museum near Aarhus, before furnishing, it becomes apparent that the building has been largely conceived, and designed through the means of a grid layout. This however does not mean that the structure of the building is reflected in the way the museum is experienced, as the grid layout in Moesgaard is anything but visible in the final exhibition design. This has resulted in an absence of the underlying structure, with the experience of the museum focusing exclusively on the exhibited items themselves. Presumably, intended like this, the architects has purposely provided a grand, entirely flexible space, for the museum curators to utilize in whatever manner they deemed appropriate - with the architecture never having meant to be exposed. Even though a chronological exploration is encouraged throughout the museum, the organization is arguably closer to that of the grid layout than the single sequence layout, due to the level of choices. In the case of this museum, the main axis appears in the form of a central entrance space to the exhibition areas. From this point, one can chose between several sub-routes, with no actual main route existing other than the before mentioned historical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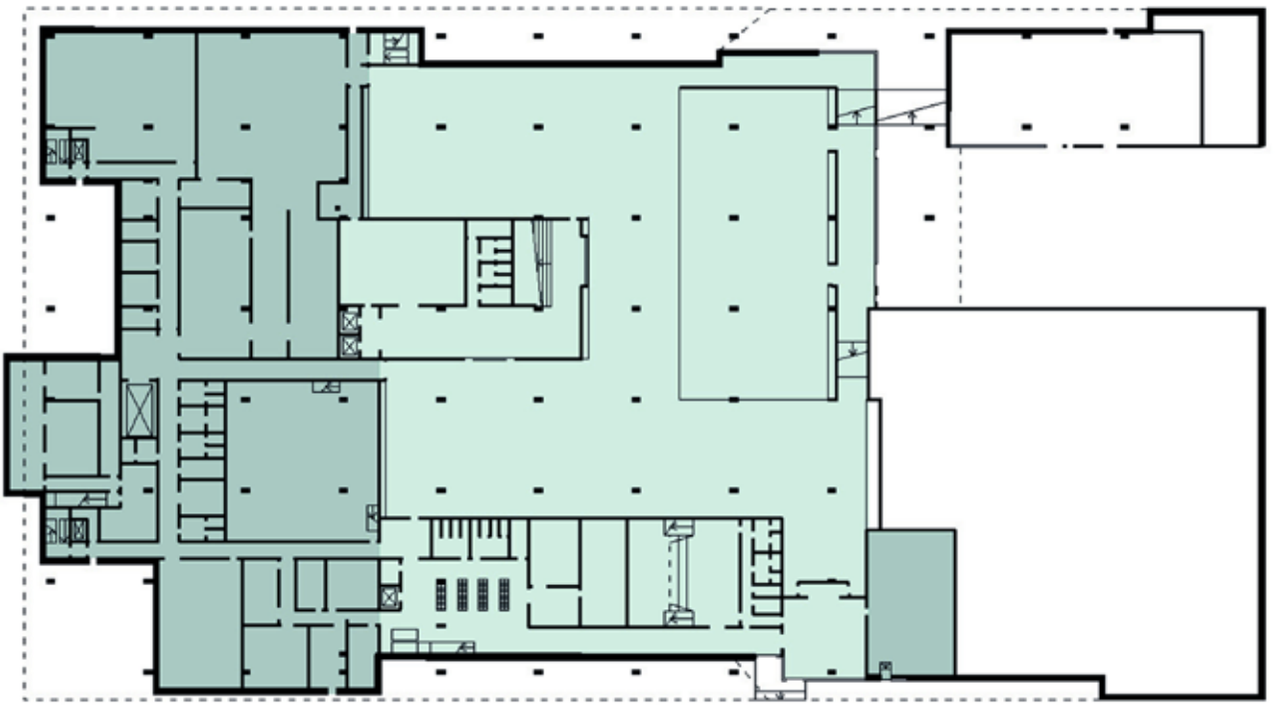
War

Moesgaard Museum
Exhibition space
Højbjerg, Denmark

chronology. Within each of the sub-routes, a further number of choices are provided, though many of these often leads to dead-end spaces. The many choices between primary routes and the individual sub-routes, makes it difficult to explore the museum in an orderly fashion, indicating that it is closer to the grid layout than anything else.

Within the vast spectrum of different layout possibilities, Tzortzi (2007) suggests, that the fundamental configurational properties of a museum, can be evaluated according to three main strategic relations between spatial context and exhibition layout. The three strategies possesses each of their qualities and challenges, with one; utilizing the space to enhance the exhibited objects, another using the objects to enhance the space, and lastly, an approach being both space and object retaining their individual autonomy. Again, subgenres exists as, for example, in some cases, the exhibited objects takes preeminence, and the architectural context simply becoming the stage setting - akin to that of a black box theater, seen for instance in the exhibition of Moesgaard Museum. From the preceding studies, we can begin to draw some conclusions to the way we perceive museums, and the experience of the spaces themselves. It is not exclusively the architectural strategies, which affects the choices of the curator, as conversely, the curator, can similarly affect the perception and spatial experience of the visitor. By using the exhibited objects to create spaces, the museum curator can potentially expand on the spatial experience of the museum, which opens a series of questions and considerations to take into account when designing a museum. Whichever of the above strategies is chosen, it becomes clear that the physical environments, and the choice of strategies behind these, greatly influences the final form, function and exhibition of the museum. The above studies can therefore inform the onward design process, with an implementation of the acquired awareness regarding strategic design principles.



TECTONIC APPROACH

THE BATTLE OF ARCHITECTURAL THEORY

It is undeniable that tectonics has assumed many forms and definitions throughout the past centuries. (Frampton, 1995, p. 375) Greek in origin the etymologic term refers to the work of the carpenter, involving the idea of poesies. This narrative is also present in Gottfried Semper's "Four Elements of Architecture" where he by studying a Caribbean hut, in an ethnographic manner, decomposes architecture to its basic elements. Consequently, he also differentiates the stereotomic, the earthbound, and the tectonic, as the framework or roof. (Frampton, 1995) This definition should later be accentuated in the essay "Structure, Construction, and Tectonics" by Eduard Sekler, where tectonics is described as the junction between construction and structure (Sekler, 1965). Throughout "Studies in Tectonic Culture" Kenneth Frampton (1995) stresses this definition as the backbone of good architecture, stating that "... the presentation and representation of the built as a constructed thing has invariably proved essential to the phenomenological presence of an architectural work and its literal embodiment in form" (Frampton, 1995, p. 375). Tectonics has here been narrowed down to encounter only, lightweight structures and forces in a materialized form, disconnected from the stereotomic earthbound character of the built. The poesies and the tactility in the work of the carpenter have been lost in the etymologic and ethnographic interpretation of the Greek tekton.

When stressing the essentiality of the presentation and representation of the built as a constructed thing, Frampton also indirectly presents the question of the how and of what. How is the built constructed and of what? This is the subject of Marco Frascari in "The Tell-the-Tale Detail" where he, through the work of Carlo Scarpa, emphasizes the importance of the detail to the architectural whole. In his description, the shaping of architectural elements is reunited with the crafting of materials and their tactile qualities, thereby reintroducing the poesies of architectural creation. He further introduces the issue of scale in architectural theory, pointing out that details can both be material joints as well as formal joints as a direct result of the multifold reality of functions in architecture. (Frascari, 1996: p. 2) Thereby an architectural detail can be both an entire staircase and the joining of two steps. The tectonic quality here depends on the crafting of the element according to the materiality and context. Louis Kahn poetically exemplified this in a monologue at a lecture at the University of Pennsylvania in 1971:

"You say to the Brick, "What do you want brick?" And the brick says to you, "I like an arch." And you say to brick, "Look, I want one too, but arches are expensive and I can use a concrete lintel over you, over an opening." And then you say, "What do you think of that, brick?" Brick says, "I like an arch."

It's important, you see, that you honour the material that you use."

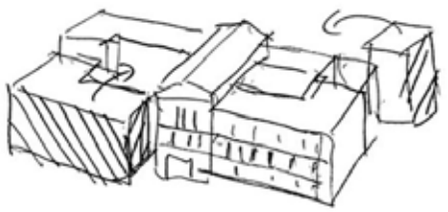
Kahn 1971 in (Musgrave and Price, 2010, p. 2)

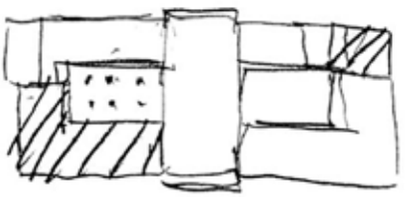
With Frascari and Kahn in mind, it might be appropriate to again go back to Semper's "Four Elements of Architecture" and the specification of the tectonic and stereotomic. Here the terms are used to describe specific architectural elements, in contrast to the phenomenological description by Frascari. Can there be only one definite truth? Can it be stated that tectonics is as much a method or architectural approach as it can be a description of particular architectural elements? Can architectural works, such as The National Assembly Building of Bangladesh by Louis Kahn or the The Therme Vals by Peter Zumthor still be described as being tectonic, in spite of their definite earthbound appearance? In both works, the architects have created a symbiosis between the architectural intention and material implementation, realising spaces of a high architectural quality that embrace our tactile senses. As Peter Zumthor describes in "Thinking Architecture", architecture in its final constructed form has its place in the concrete world (Zumthor, 2006, p. 12). Can our perception of tectonics, as an inherent part of architecture, rooted in the world of materials, enlighten our understanding of its true nature? As Scott Gartner states, "the body, if it figures into architectural theory at all, is often reduced to an aggregate of need and constraints, which are to be accommodated by methods of design grounded in behavioural and ergonomic analysis"(Frampton, 1995, p.11). With this framework of thoughts, the body and its experience do not participate in the constitution and realization of architectural meaning. But, as Juhani Pallasmaa also stresses, it is through our body that we perceive our surroundings, through the touch of our hand, smell, sound, and vision (Pallasmaa, 2012). Consequently, a discussion concerning tectonics in a purely etymologic or ethnographic manner is isolated of little use to the architecture of concrete world. Inasmuch as architecture is nourishment for our senses, tectonics should likewise be perceived and evaluated through our senses.

PROGRESSION THROUGH SPACE

When moving through a city, our understanding of it can only be fragmented and incomplete. As Steven Holl expresses it, this experience consists of partial views, unlike a static image, which offers a different kind of involvement or investigation than the birds view (Holl, Pallasmaa, Pérez-Gómez, 2006, p. 48). Is this also true for the interiors of our built world?

As August Schmarsow describes it, our concept of space is determined by the frontalized progression of the body through space in depth. (Frampton, 1995, p. 11) Junichiro Tanizaki's scenic description of the traditional Japanese toilet in "In Praise of Shadows" underlines exactly this connection between movement and perception. The room itself is described as a place of meditation, in dim light and absolute silence – a physical delight – but the way there is equally important for the story. Away from the main house, the walk along the narrow corridor, with the sound of the rain and the grove fragrant with leaves and moss. (Tanizaki, 2001, p. 9) As the camera team and director, assembling sequences, the architect can guide and stimulate, add pleasant surprises and relaxation. Movement and direction can be encouraged to support the use of a building – all in a very natural manner. (Zumthor, 2006, p. 45) As Peter Zumthor describes it in 'Atmospheres', architecture, like music, is a temporal art. (Zumthor, 2006, p. 41) Those who has been to a theatre or opera has felt this in presence. A series of open and compressed spaces, from brightly lit to dim, from marble to velour to dark smooth wood. The drama of the play started long before the spectator actually entered the hall.





REVITALIZATION & RENOVATION

NEW MEETS OLD

Given the nature of the competition, focusing on an extension to an existing museum, the utilization of the original building and how it will figure in the greater context of the future museum complex, was naturally one of the preliminary and most urgent questions posed in the design process.

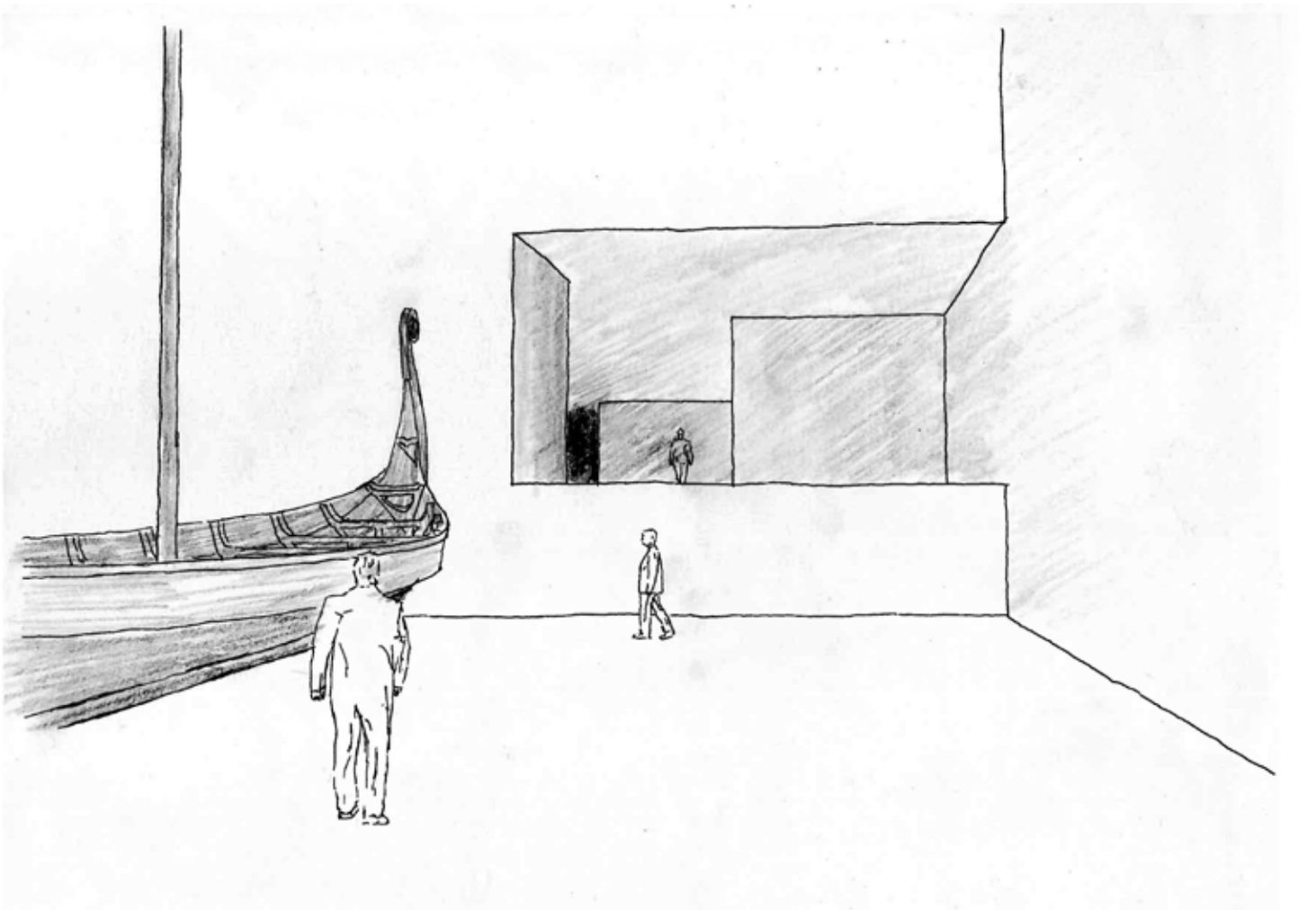
When considering buildings deemed worthy of preservation due to their historical, cultural or regional value, as is the case with the existing museum, two main strategies are traditionally used to approach the challenge; preservation and revitalization. Within these themes, depending on the degree of modification, a further division into restoration and renovation can further categorize the methods used. Restoration is primarily concerned with maintaining the historical and aesthetical value of the building, and is therefore primarily the approach applied in preservation projects. The modifications applied are often of a smaller scale, which is why it would be difficult to implement fully in the Viking Ship Museum, as it simply has become too small for its current purpose. Considering that the existing museum can no longer fully accommodate the current functions, it would indicate that larger changes, either programmatic of physical, are necessary to satisfy the intentions and visions of the competition documents. This speaks in favor of the method of renovation where a more active approach is undertaken. In this approach, the aim is not only to preserve the identity of the building, but likewise, to renew and revitalize the building, adding new values to what already exists. An important aspect in this approach though, is that all of the above should be done while still respecting the original character of the building, for which reason the building is preserved in the first place.

The approach of the renovation varies a lot depending on the project at hand. Approaches can include changing the entire envelope of the building, adding structure to the existing building, fundamentally altering the interior or reprogramming the building in terms of functions. Through the design process, several approaches have been utilized to renew and revitalize the existing building to suit the new demands, while maintaining the characteristic value and identity of the building.

An example of a particularly successful restoration and rebuilding project is that of the Neues Museum in Berlin by David Chipperfield. The structure, heavily damaged under the bombing of Berlin during the Second World War, was rebuild and redesigned by Chipperfield in the late 90s. Chipperfield chose to tackle the challenges head on, and accept all of the marks and scars of the building, and through this, letting the renewed architecture stand as a witness to its own history. All, which survived the bombing, was retained in the renewal. The architecture of the reconstruction contains a stripped-down, almost sculptural aesthetic, which refers more to the original building and its history than to itself. In a refined use of materials, the language of the architecture tries neither to mimic the original building, nor does it override or dominate it. Through avoiding an iconic architecture, Chipperfield created an architecture sensitive to the cultural and historical context, the restoration becomes a testimony to the memory of the original building and its imbedded history.

Architectural historian Joseph Rykwert describes in his essay 'The Museum Rejuvenated' that not all were enthusiastic about the restoration with some, calling for a total restoration and sterile solution. Though as Rykwert suggests; ". . . the enthusiasm with which Berliners have crowded into the Neues Museum seems to show that its fresh guise may turn out to offer a testimony that will continue to be a more important Mahnmal than any specific or 'dedicated' monument" (David Chipperfield, 2009). Rykwert goes on to suggest that the intricate overlays of Chipperfield's restoration can speak to the visitor our time and potentially, speak more clearly and sympathetically to the future, than did the grand, monumental narrative of the earlier age.

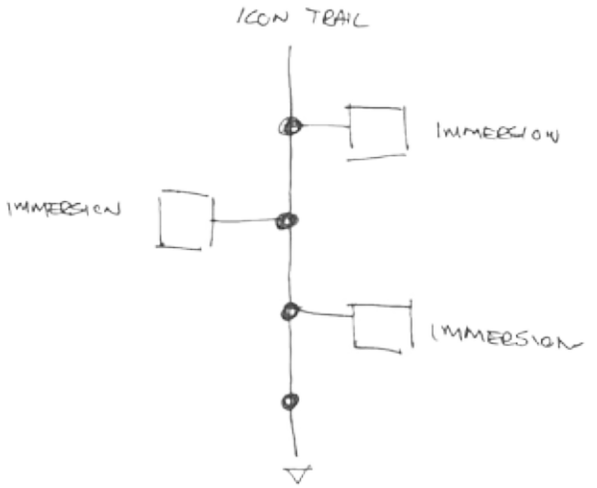
The question lingering, is how to approach the utilization of the existing museum at Bygdøy. Should one use the method of restoration of rather renovation? How much should be preserved in order to respect the history and identity of the building, while simultaneously striving for the success of the Neues Museum, in which a fresh guise stands as a testimony to past memories while avoiding the danger of becoming a sentimental monument stuck in the past.

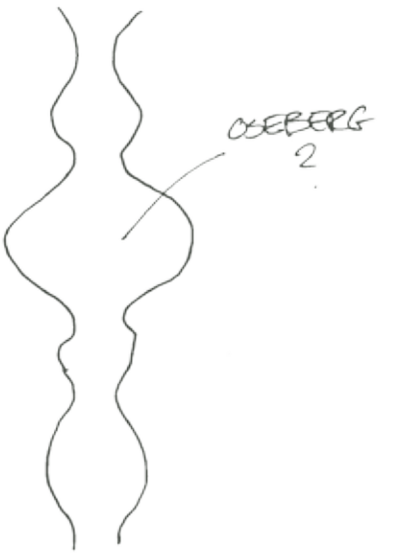


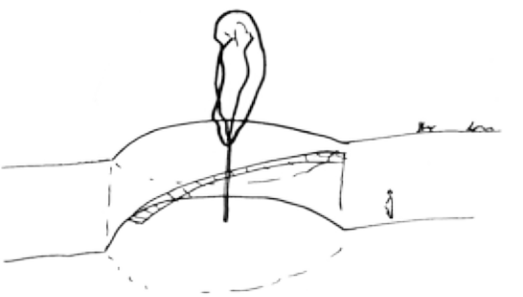
THE PROCESS IN RETROSPECT

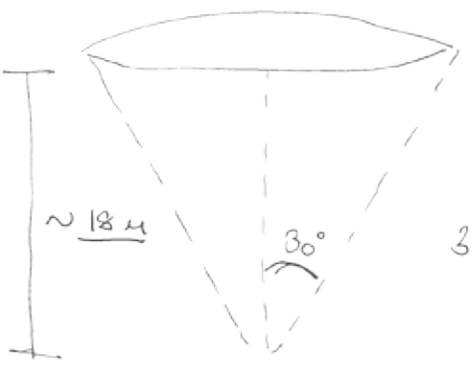
ORDER IN CHAOS

While being in the middle of it, a process is highly interesting yet somewhat chaotic. Sometimes it appears as a voyage across the North Sea in a far too small boat, while in periods it is more like a joyful ride down a skiing slope. Either way, a process is far from linear, and an early sketch might be closer to the final result than a late study model. A good process is often a result of the questions asked and the responding studies and arguments. The more precise the question appears, touching the mere foundation of a problem, the more precise the answer will be. Through a series of studies, both in physical and digital models, and a firm belief in a no discussion without a sketch policy, a museum has slowly been taking shape. Yet, the process you are a part of is far from the process you look back onto. Thereby the process presented is closer to being a retrospective analysis than an actual retelling, or as it often appears in the field of architecture, a recreation. Through the following description, we have tried to pinpoint some of the major questions asked and the responding reactions, as a chronological story drawing up the outlines of the museum and the major arguments behind its shaping. As a retrospective analysis it is both self-critical and concluding, all as a means to create order in chaos.

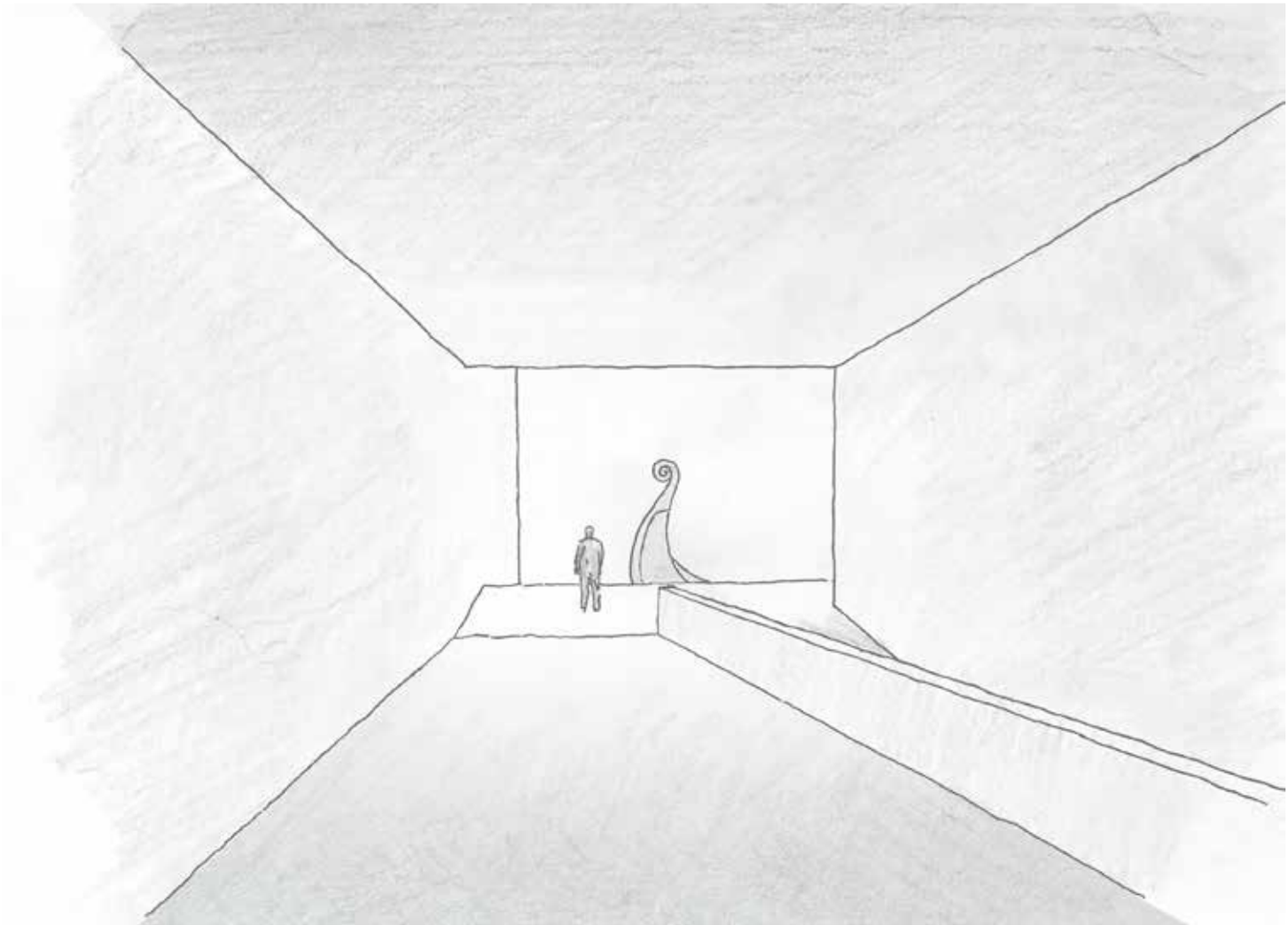








30° = NEAR PHERIPHERAL VISION



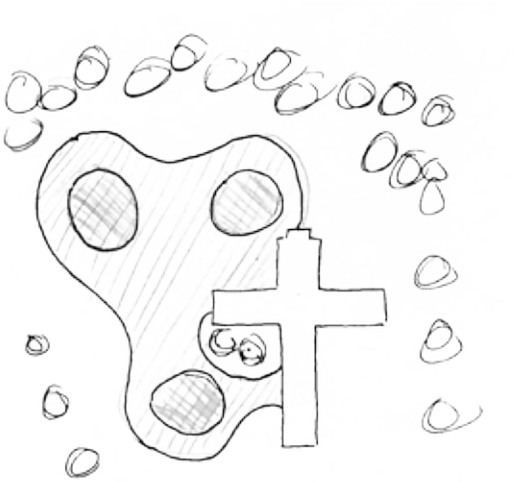
THE SKETCHING PHASE

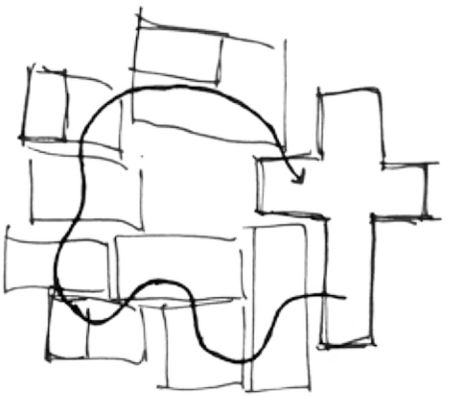
TOWARDS A CONCEPT

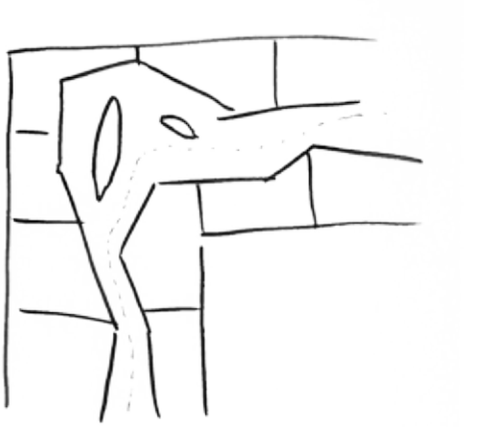
Three fragile Viking ships, a protected building on a large grass field, and a huge program that barely fitted on the site; that was the point of departure when the first line was drawn. Being both the largest and most significant items in the collection, and the main attraction of the museum, the question of what to with the ships became the starting point of the process. As the program stated, and we our self quickly became aware of, the existing Viking ship House by Arnstein Arneberg, though drawn specifically for the ships, had outlived its purpose, and did no longer fulfil the requirements of a modern museum. There was simply not enough space. Yet with its strong shape and vaulted interior spaces, an extension of the building as a continuation of the existing structure appeared invasive and unnatural. On the other hand the building was protected and stood as an iconic landmark as well as an important part of the architectural history of Oslo. The ships had to be moved. Even though the existing building was of the highest importance the ships were even more so, and the preservation and future presentation of them where at the centre of attention.

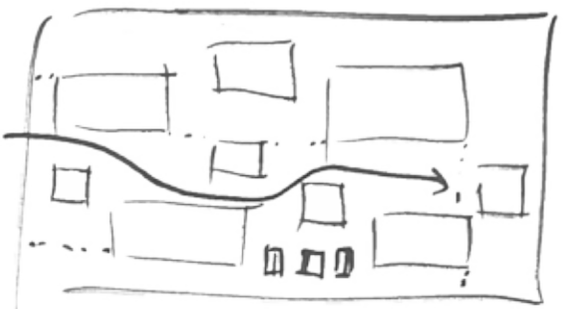
But where and how should the ships be relocated? Looking at the site and its context we worked with a series of different formal languages, trying to fit the program onto the site. Where would it physically be possible to place a new volume, and how would the outdoor areas appear after doing so? Could it be a soft shape that almost entirely enveloped the existing building, creating intimate courtyard spaces between new and old? Or a simple volume, cutting into the existing structure to break down its axiality?

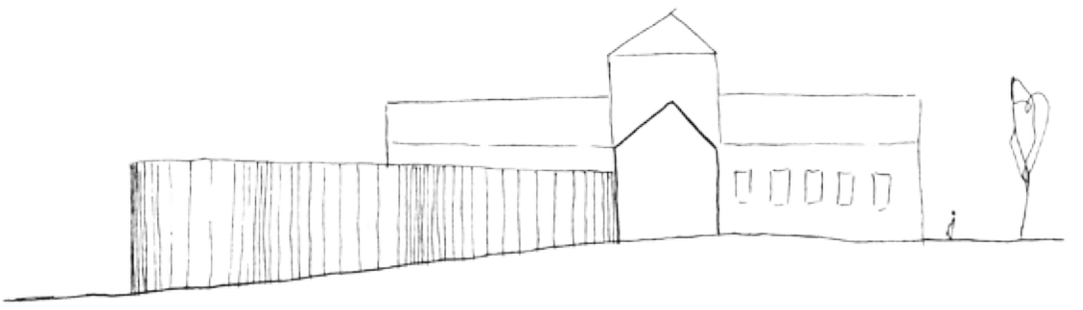
Looking at the exhibition space, comparing it to other museum spaces, both regarding content and function, it became apparent that the building by large would become an introverted volume. Since most of the artefacts are highly sensitive to direct light, they would be reduced to dust within few years if exposed to sunlight. Secondly, natural light is rarely an appreciated element among exhibition designers, with all their interactive graphics and visual effects. Regardless of shape, an extension would stand as a massive introverted volume among the villas, overshadowing both them and the existing building.

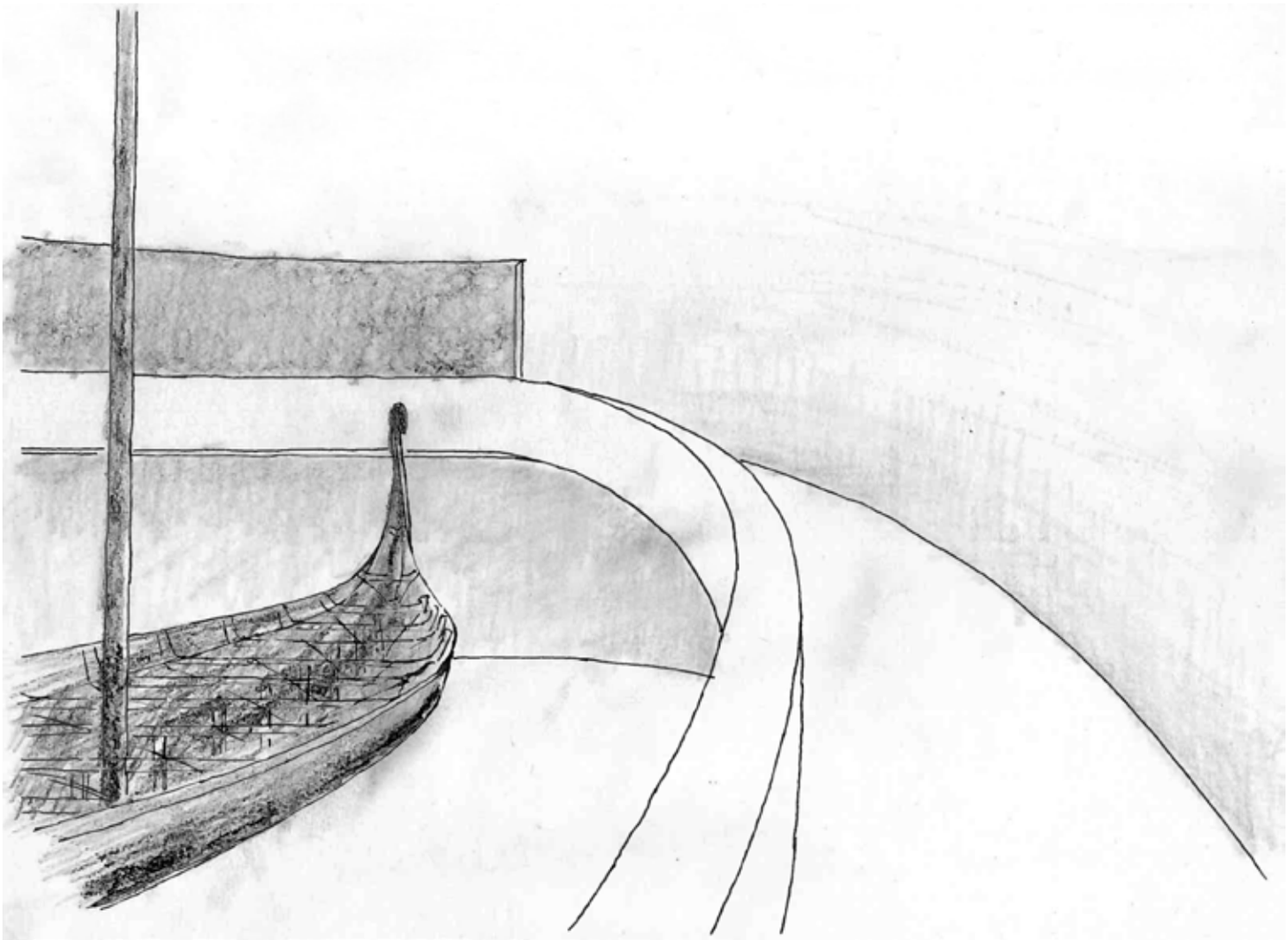








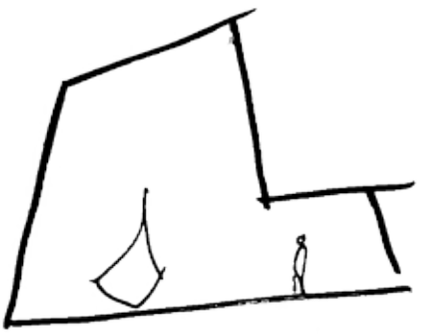


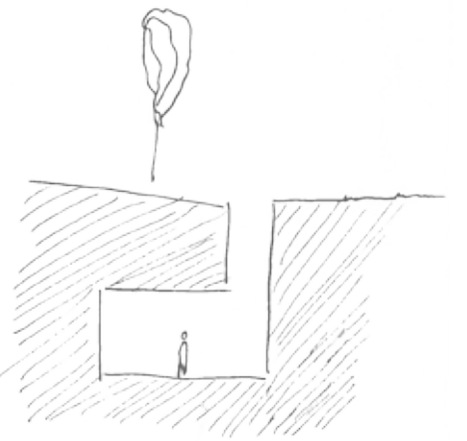


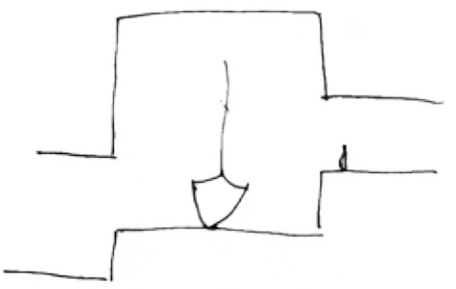
The extension moved slowly downwards, with a potential new connection between new and old through the basement of the existing building. As a partly or completely underground landscape the exhibition could provide a whole new level of experiences for the visitors. Being inspired by Tadao Ando´s Chi Chu Museum of Art and 21_21 Design Site an idea of a single flow exhibition space appeared, with a series of different spaces connected as a big loop. The different spaces would interact with the surface above according to their function, creating a landscape of extrusions and cuts.

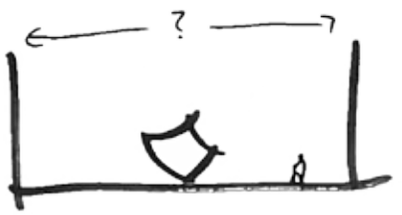
As a response to the program the exhibition space was organised into different areas, each with a different theme and collection of artefacts. The visitors would be led through a series of open and closed spaces while being presented to the varying aspects of the Viking age. Through a complete storyboard of the whole movement, different spatial experiences were added to the different sections of the exhibition. In the centre of the investigation were the ships. How would the visitors approach and move around them? How far away would you have to be standing to experience the whole length of the ships? Would there be framed views of them along the way, and how? An array of spatial expressions and sections were tested. Looking at their previous situation in the existing building, both curves and minimal surfaces where tested as a potential backdrop for the ships. Studying Jørn Utzon´s proposal for a museum in Silkeborg a more organic formal language could both relate to the curves of the ships and the museum as an underground space.

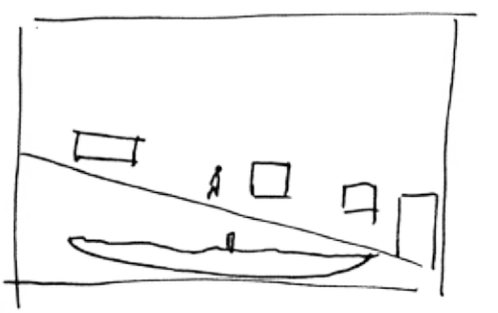
As the study unfolded the exhibition space grew. It became apparent that the ships needed more space than the 500 m2 first intended for each of them. New questions arose. Should they at all be situated in separated spaces? After visiting The Viking Ship Museum in Roskilde we slowly began to se the exhibition space more as an open landscape and less as a series of connected volumes. This had a direct consequence on the actual shape of the extension as a whole. Building underground there is close to no natural occurring boundaries, and thereby nothing that controls the outer perimeter. With the open

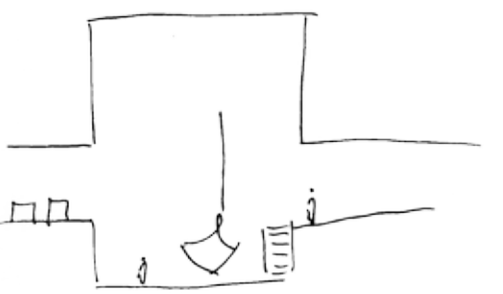


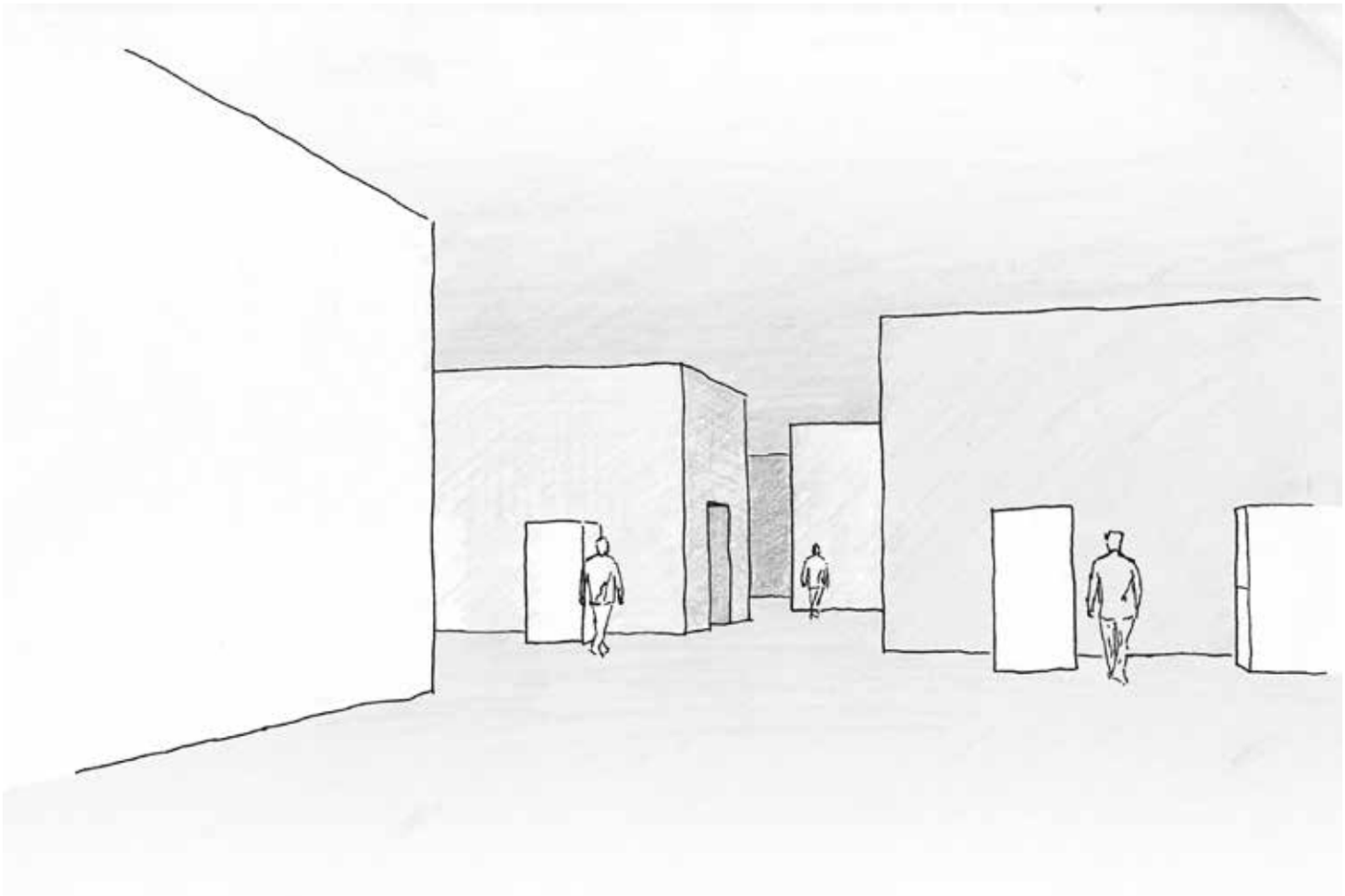








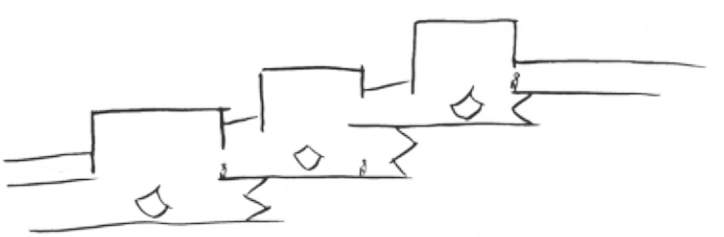


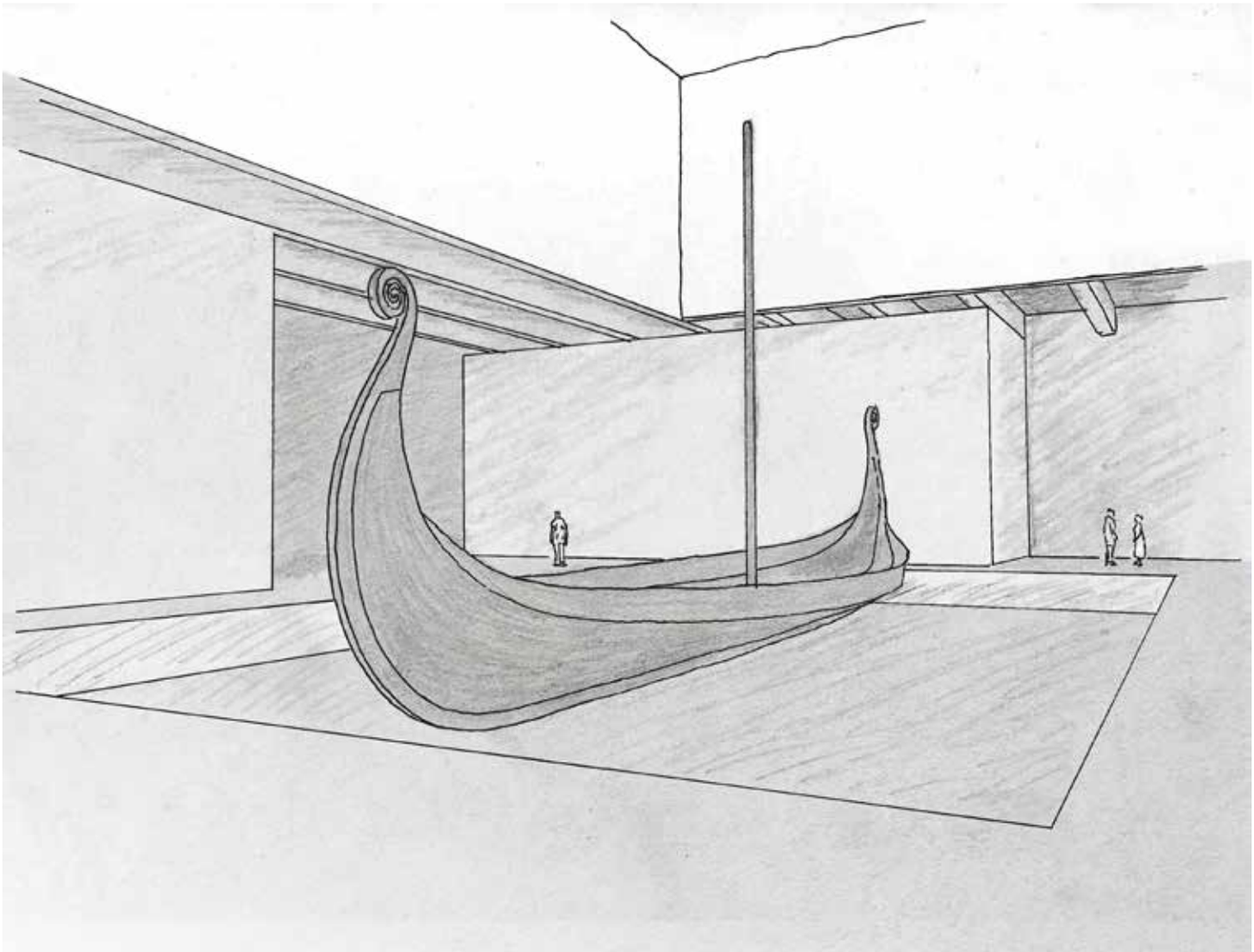


exhibition plan the building where taking shape, and by learning from the museum in Roskilde the formal language was toned down and straightened up. The ships and other artefacts where at the centre, while the building merely acted as a backdrop. Also in a literal sense the ships where moved from the perimeter as part of a loop, to the centre of the exhibition, acting as a backbone around which the main exhibition was situated, creating a continuous chronological circulation.

As for the existing building it was stripped clear of all content and original function. Even though the competition program stated that the building should maintain its function as an exhibition space, our initial sketches indicated another approach. It appeared as if any exhibited artefact would be a poor substitute to the ships, and rather an act of sympathy regarding the building. On a larger scale the building would either become a dead-end path or a detour from the main exhibition. Instead, by keeping its function as the main entrance and exit point, the building could become a public space, full of life and activity. From an exhibition point of view all historical references the building used to indicate would be separated from the actual exhibition, and the building would itself stand as a historical monument. This was the only time, throughout the whole process, that we deliberately disregarded the competition program.

Seen as a compact separate department in the larger organisation the staff areas had so far been little more than a dedicated area on the plan. Positioned in the northwestern corner of the site the idea had from the beginning been to utilise the existing infrastructure on the site, while creating a connection to the other functions through the basement of the existing building. Yet there was an issue with daylight. A large portion of the spaces had specific daylight requirements as well as purely logistic requirements. The response was a combination of a raised volume to allow facades towards the north and west while organising the different functions around a centred courtyard. Leaving all main functions on the same level ensured an efficient and clear organisation.

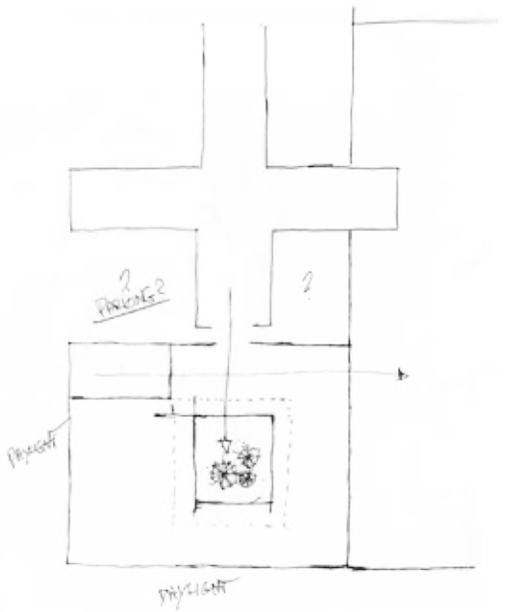


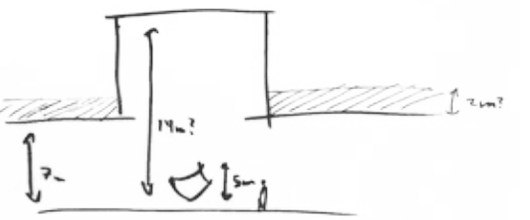


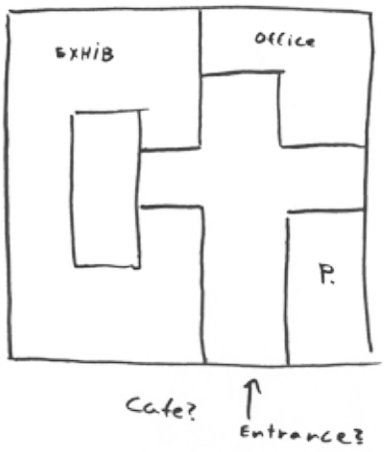
Though, as the new extension was taking shape, enveloping the existing building, the overall organisation appeared somewhat unorganised and the public functions situated in the basement of the old building where all but ideal.

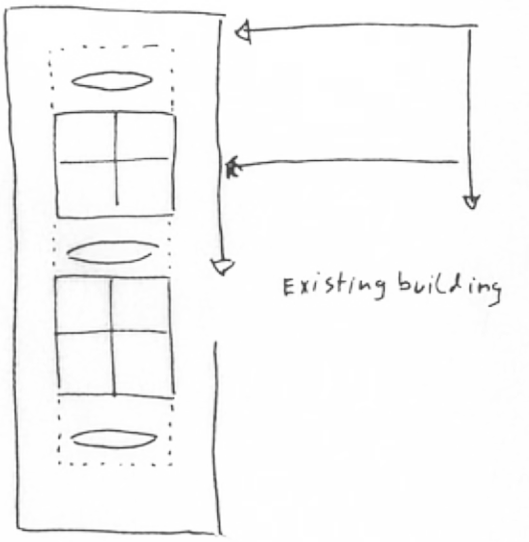
How where new and old to be connected? A long axial staircase cutting straight through both new and old provided a dramatic and strong connection, yet landed somewhat accidentally in the exhibition space. All though it started as a sympathetic idea, softly wrapping the new around the old, it didn't do much good for either. How do you preserve the spirit and character of an old building while revitalising it with a new program? It appeared as if a stronger move was needed.

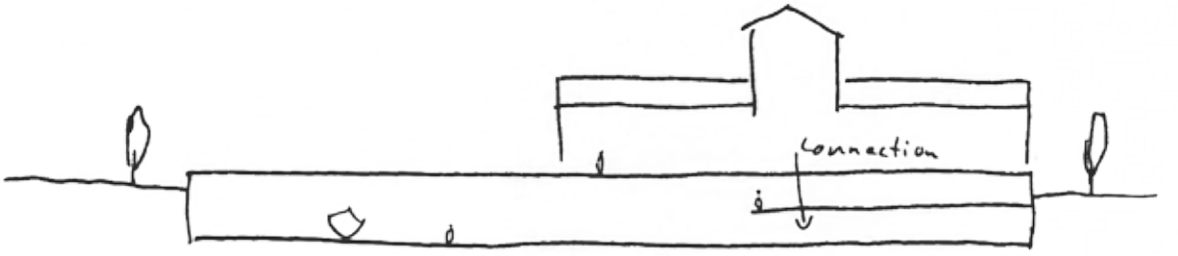
The response was a simple self-referring volume acting as a base, or maybe rather a podium, for the existing building. A strong shape to meet the equally strong shape of Arneberg´s building. While still appearing as if untouched from the outside, the basement of the building was removed, and the building now needed to be supported by a structure. A structural grid was developed, measuring 3,1 times 3,1 meters, or four times the width of the wings of the existing building. The complete plan was redrawn, but rather than being fitted into the grid it was as if the functions, from office to exhibition, landed in place. As a highly organised, logistically efficient, and spaciously intriguing volume, the building now stood as a simple independent shape, partly acting as a continuation of, and partly cutting into the softly sloping landscape of the site.


PARKING?
DAYLIGHT
DAYLIGHT


19m?
2m?
7m
5m


EXHIB
Office
P.
Cafe?
Entrance?


Existing building


connection

PRESENTATION

THE NEW VIKING AGE MUSEUM

Site plan
Scale - 1:2.000

CONTEXT & SCALE
THE OUTDOOR AREAS

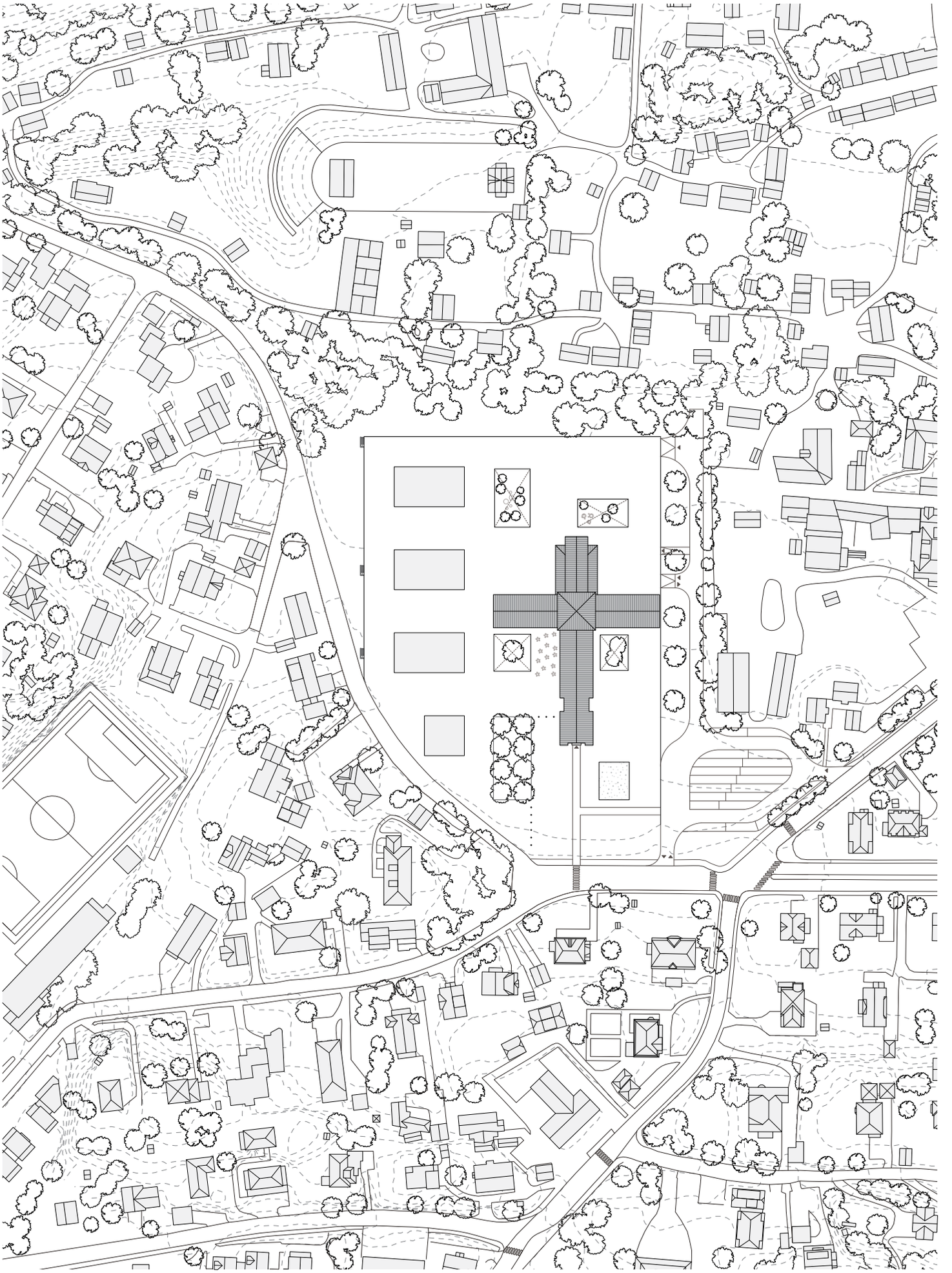
As a bastion in the landscape the new Viking age museum stands as an extruded volume, cutting into the bowl shaped landscape of the site. The unpolished light grey granite facade stands in sharp contrast to the green surface surrounding it, underlining the monolithic earthbound character of the building. Mounted in large panels the granite responds to the large scale of the volume as a whole and underlines its heavy appearance. Firmly resting on the bastion the existing building by Arnstein Arneberg stand as if untouched, as a white freestanding element on a green surface. The building as a landmark and part of the identity of Bygdøy is preserved. Yet, as an object on a podium, the building itself has become an artefact, telling the story of an ever-changing interpretation and presentation of archaeology and history.

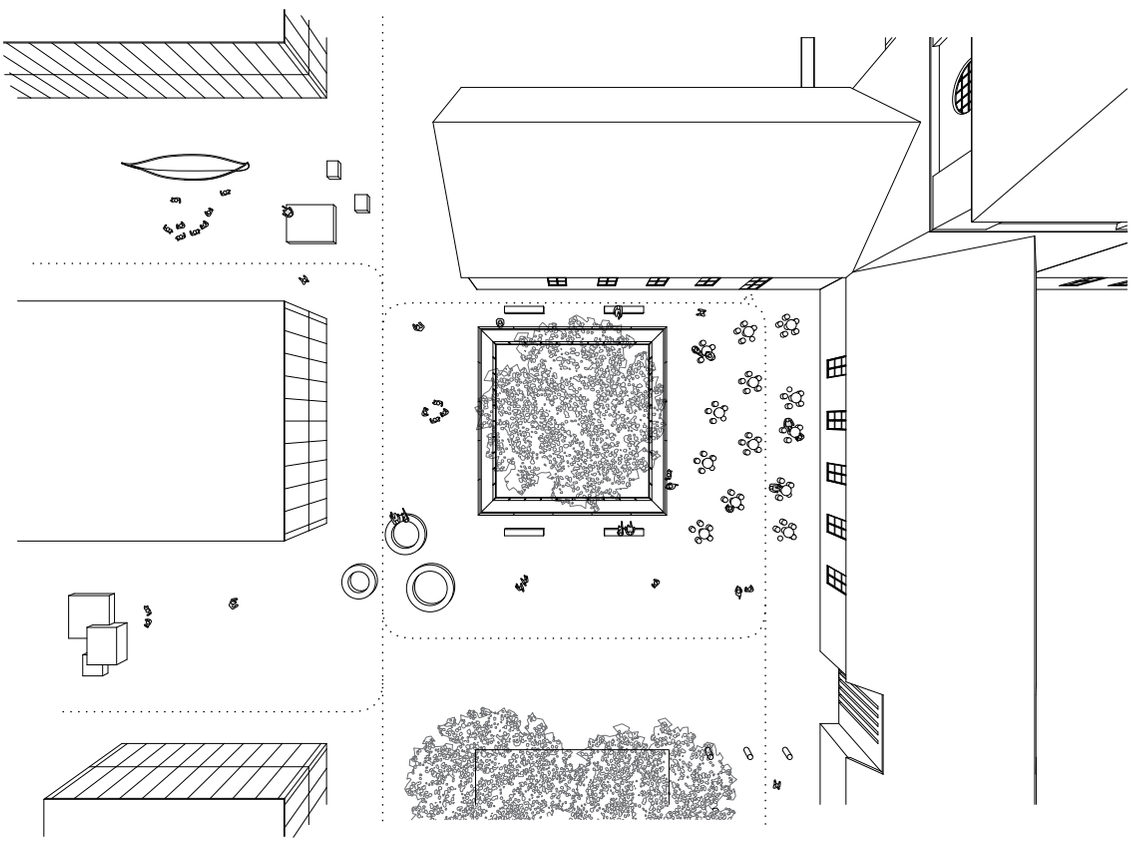
While the interior spaces appears introverted, as a world of its one, the new lifted outdoor area opens up towards the street and main entrance, inviting the visitors in. As the landscape slopes upwards towards south, the bastion becomes level with the terrain, securing direct access both along the axial main path and from the enlarged buss parking in the northeastern corner of the site.

On this surface the three skylights stands as sharply cut lanterns, indicating the activity below. Consisting of a double-layered envelope, the loadbearing steel structure is hidden behind a veil of aerogel glazing, giving the volumes a flush finish with a rice paper like appearance. The fourth translucent volume, an activity pavilion, is part of the strategy of activating the new outdoor area and to create an attractive environment for children and school classes, inspired by our impressions from Lindholm Høye Museum. The volumes have been dimensioned in accordance to the surrounding structures as well as the functions below as to naturally fit into their context. It is rather through their materiality and formal language that they stand out, marking the significance of the building as being a museum.

Like punched out holes in the surface four sunken courtyards allows natural light into the spaces below and allows discrete views into the interior spaces. This creates a visual connection to the staff areas and laboratories, adding a new layer to the communication of the museum, while securing a certain level of privacy for the researchers and staff.

Together with the existing building and translucent volumes the courtyards divide the outdoor area into smaller spaces. Likewise the large trees surrounding the raised plateau become a space-defining element. Much like the exhibition space below the different special units with varying textures and degrees of intimacy create a foundation for outdoor exhibitions, dining, and other activities to take place. This is further underlined with a combination of cobblestone pavement and grass, acting as a flexible surface that easily can be adjusted in accordance to different activities. With the raised plateau as an outer perimeter the space can also easily be divided into a potential publicly accessible and visitors area. With the new museum a stronger visual connection to the Folk-museum situated to the northwest appears, where the history is continued into modern times and the impact of the Viking age can be experienced in later woodcarvings and other crafting techniques.





With direct access to the entrance area and café, the elevated outdoor area consists of a series of defined spaces. From the outdoor dining, situated in an intimate corner of the existing building, there is a visual connection to the exhibition below through a sunken garden.

From the outdoor exhibition and activity space the existing building appears as if untouched, surrounded by sharply cut glass volumes and sunken gardens.

ENTRANCE

THE EXISTING BUILDING BROUGHT TO LIFE

As the ships are relocated and the building reprogrammed, the visitors is now met by a spacious open landscape when entering Arneberg's Viking ship House. Being restored to its former glory, Arneberg´s tactile detailing and ornamentation is preserved to give the visitors a complete impression, both of the building as a historical monument and as a piece of exquisite craftsmanship. As the floor is completely replaced the former partial areas of herringbone patterned red brick flooring is relayed as a continues surface, underlining both the historical and revitalized building.

After passing through the open foyer space, the former entrance area, the visitors is met by a 14 meter long counter, serving as information and ticket sales, and counter for the museum shop. This enables multiple costumers and visitors can be serviced at the same time, responding to the expected doubling of the number of visitors as well as the many tourist groups in the main season. Being both the entrance and exit point of the building the space secures a good overview both for the visitors and staff. The shaping and organisation of the entrance area has to large extends been inspired by the good experience of the entrance at Moesgård Museum. From the entrance area there is a clear line of sight to the spiral-staircase leading to exhibition spaces below.

The entrance level as a whole is thought as a publically accessible area, allowing the café in the southwestern wing to stay open outside of the regular opening hours of the museum. The café has dedicated kitchen facilities on the same level as well as direct access to the outdoor area. In the northwestern wing a flexible activity space, including two workshop rooms strengthen the museum as a platform for research and learning. These functions also provide potential space for a wide array of other activities, reaching out to a broader audience.

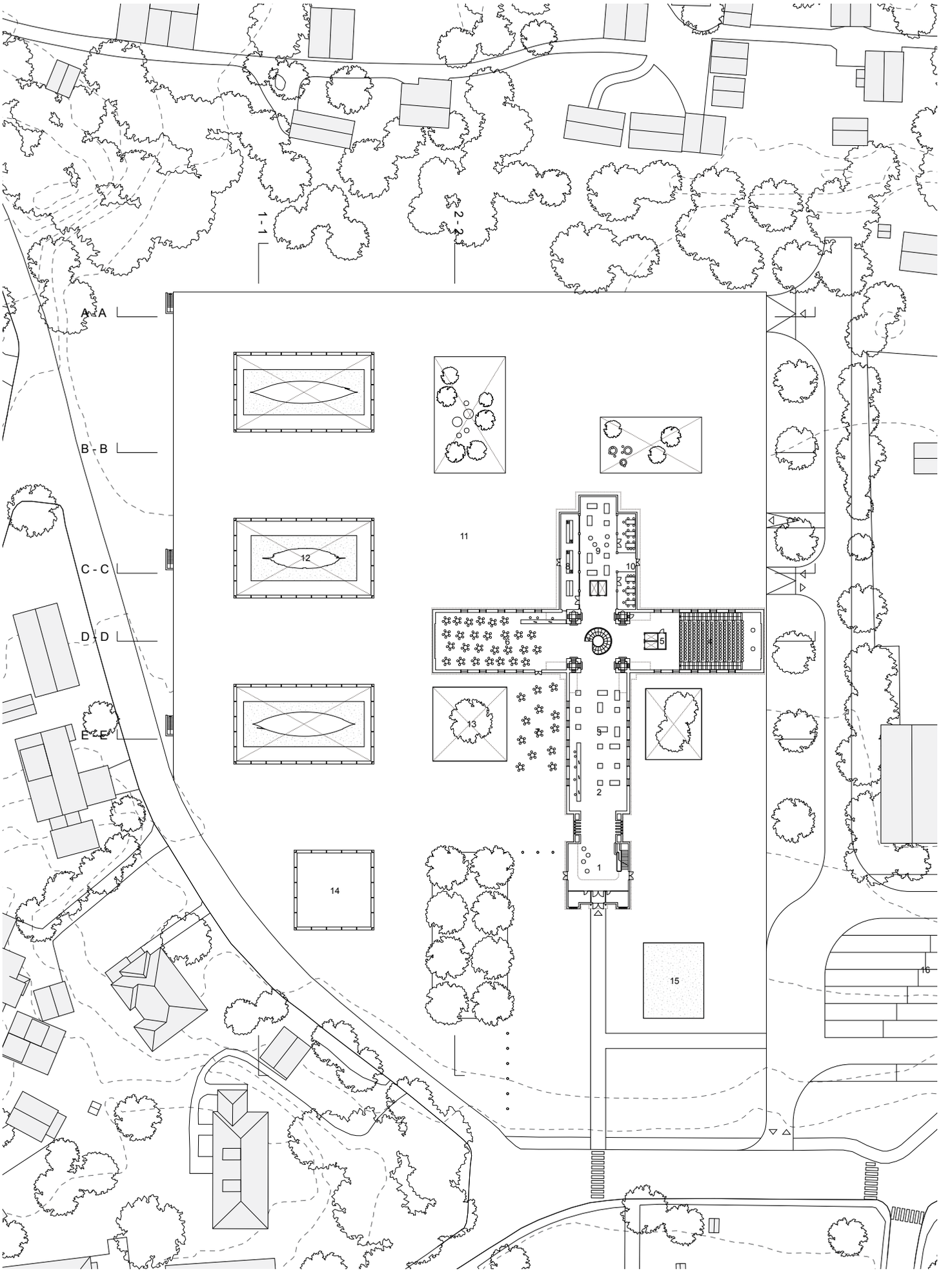
Two freestanding elevators connect the entrance level to respectively the parking and staff area, and the exhibition level, ensuring that all visitor flow passes by the entrance level. The elevator cores act as space defining elements, shielding the flexible activity space and workshop rooms, and the auditorium from the noise of the entrance area. Consequently they also help toning down the axiallity of the building. From the elevator connecting to the parking level there is a clear view to the ticket counter as well as the connections to the exhibition floor.

The auditorium, with seating for 200 people, is treated as a folded down surface connecting new and old. The folded cut in the floor surface provides good viewing conditions from all seats, shading the spectators from the activity behind, while revealing the joining of old masonry and new concrete. Functioning as a secondary connection between the entrance floor and the public functions below, both levels of the auditorium is also handicap accessible. As the concrete structure is folded down, resting on the columns, the wooden floor of the space below continues up as a soft blanket, marking the shift between new and old.

In contrast to the auditorium, the spiral staircase in the centre of the building cuts straight through as a corkscrew. As a strong independent object it acts as a pivot point for the whole organisation. Completed in glossy white panted steel it caches the light from the clerestory windows above and stands as a definite modern addition. Yet the soft curves is both a reference to the vaulted ceiling of Arneberg´s building and to the woodcarvings of the Vikings. On ground level the staircase faces the entrance, while rotating one and a half time it faces the wardrobe on the floor below, creating a fluid continues flow.

GROUND FLOOR, SCALE 1:1000

1	Foyer & Entrance area	- 202 m2
2	Info, ticket entrance	- 125 m2
3	Museum shop	- 230 m2
4	Auditorium	- 203 seats, 230 m2
5	Sound/light room	- 5 m2
6	Café	- 317 m2
7	Outdoor seating	- 350 m2
8	Kitchen	- 72 m2
9	Flexible activity area	- 190 m2
10	Workshop space	- 2x31 m2
11	Outdoor exibition area	
12	Skylight	
13	Sunken Garden	
14	Activity pavilion	- 231 m2
15	Water mirror	
16	Bus parking	- 20 parking spots


1 - 1
2 - 2
A - A
B - B
C - C
D - D
E - E
1
2
5
9
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11
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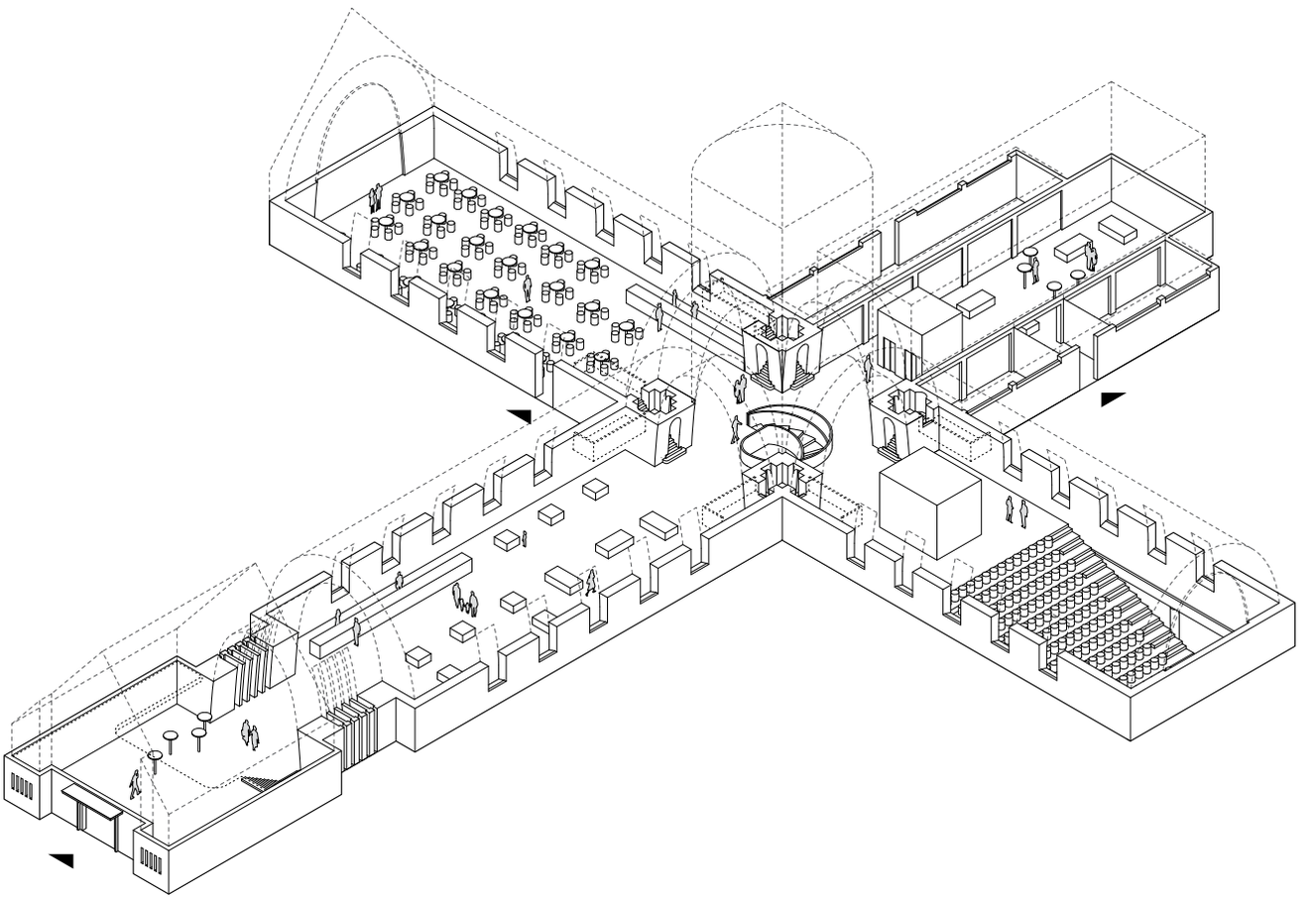
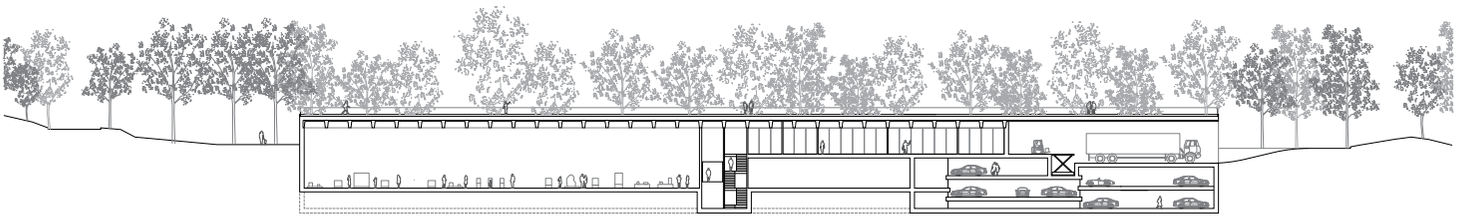
14
15
16

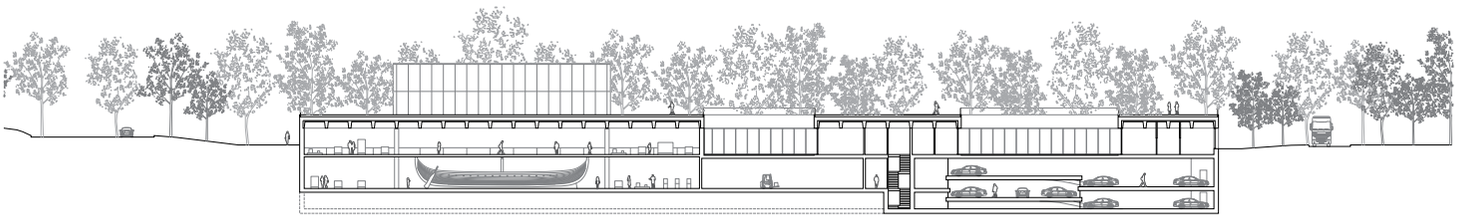


The existing building act as both the entrance and exit point for the new museum, with the centrally placed staircase connecting new and old. Each wing of the building has its dedicated function, naturally separated by the shape of the building.

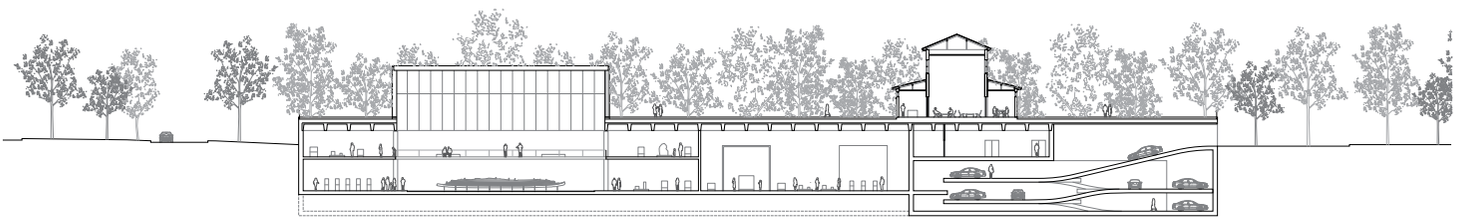
As the ships have been relocated, the entrance area now appears open and spacious. The new brick floor, as a continuation of the original expression of the building, creates a continuous surface for the new public space. With its central position, the staircase connecting the entrance with the exhibition below is a natural focal point from the entrance.



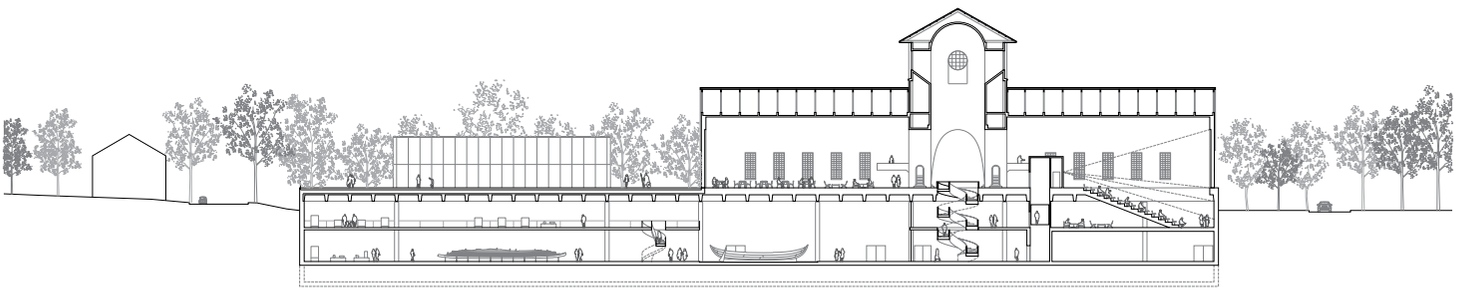
Section A-A



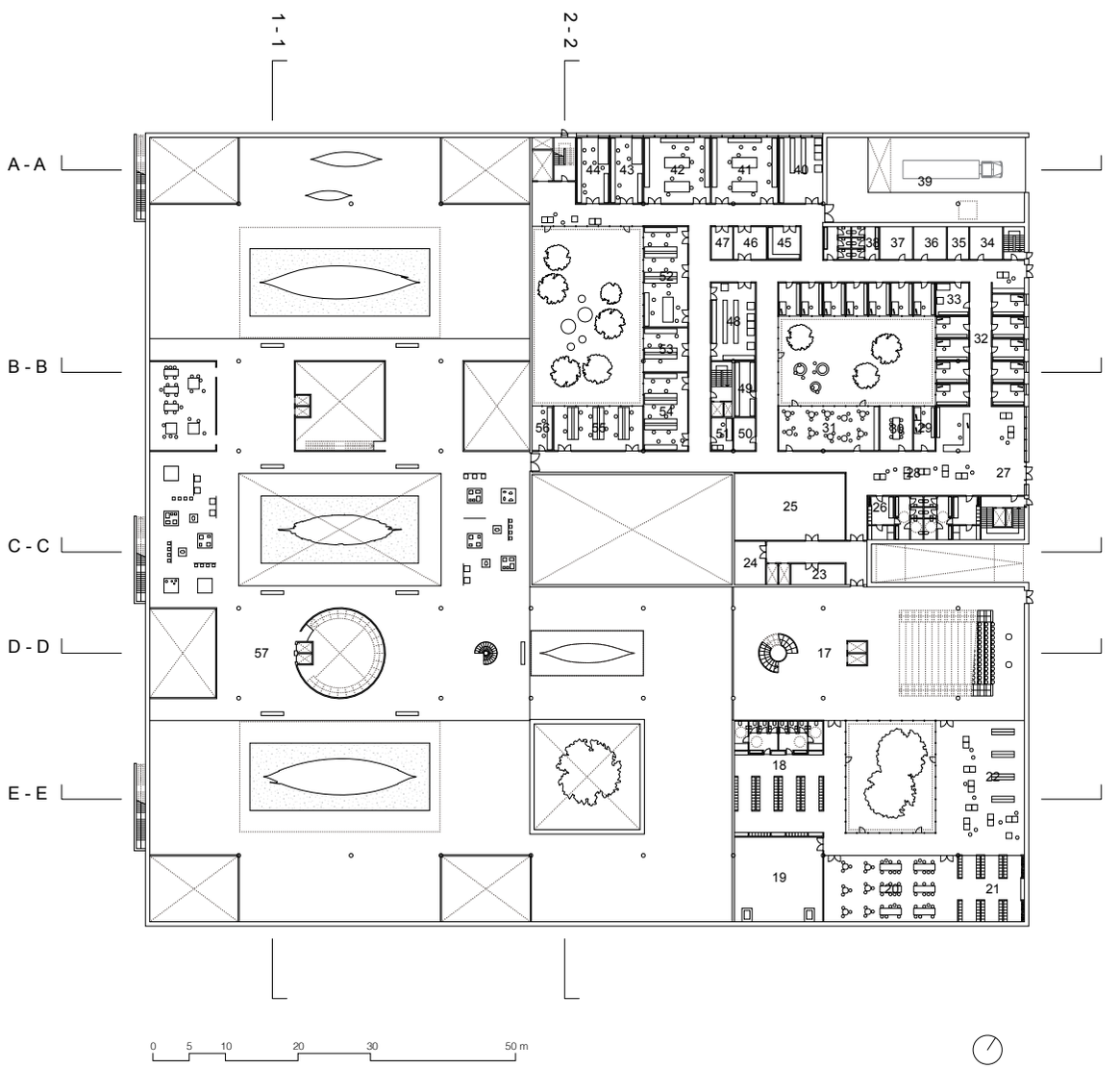
Section B-B



Section C-C

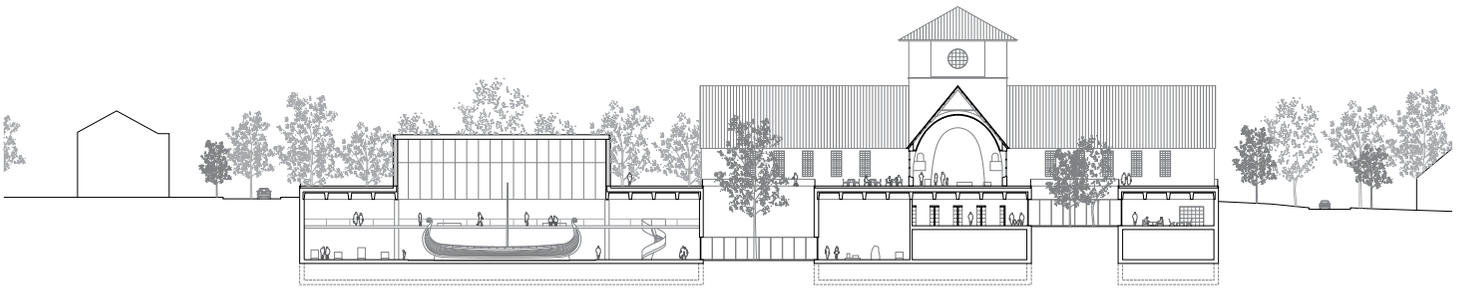


Section D-D

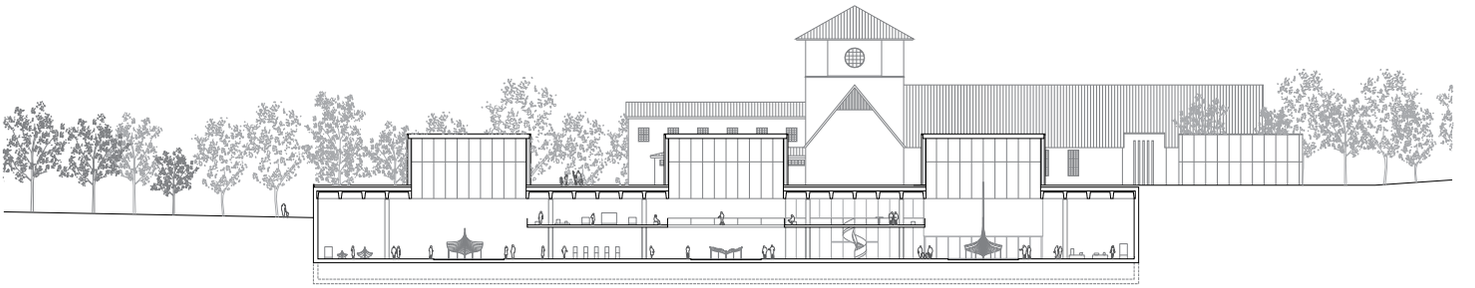


LEVEL -1

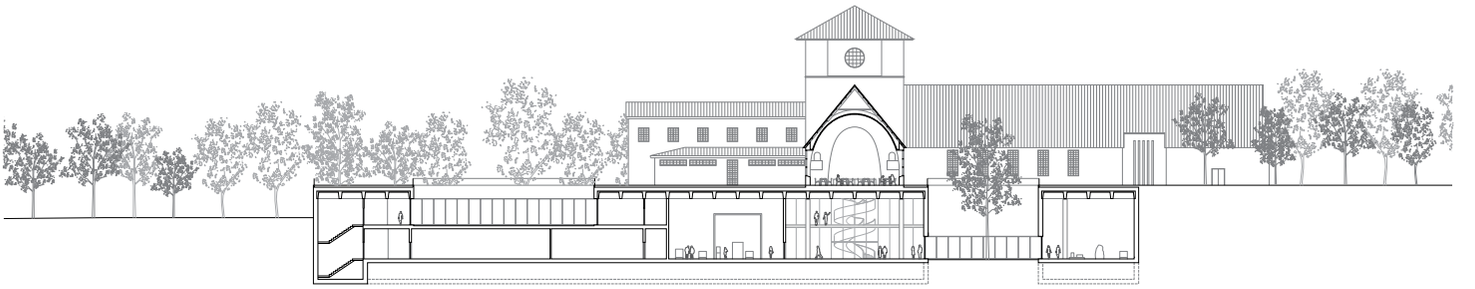
17	Lounge	- 350 m2
18	Wardrobe & toilets	- 180 m2
19	Storage	- 142 m2
20	Dining room for classes	- 168 m2
21	Wardrobe for classes	- 80 m2
22	Library	- 170 m2
23	Storage, kitchen	- 21 m2
24	Storage, kitchen	- 26 m2
25	Storage, museum shop	- 140 m2
26	Wardrobe, toilets, showers	- 86 m2
27	Staff entrance & reception	- 121 m2
28	Relaxation space	- 85 m2
29	Security office	- 18 m2
30	Meeting room	- 27 m2
31	Dining area	- 84
32	Offices	- 16x13 m2
33	Print, copy, archive	- 20 m2
34	Storage, equipment	- 20 m2
35	Storage, utilities	- 13 m2
36	Storage, operation equipment	- 20 m2
37	Office management & cleaning	- 20 m2
38	Toilets	- 32 m2
39	Goods reception & waste	- 320 m2
40	Storage, materials	- 55 m2
41	Common workshop	- 83 m2
42	Carpentry workshop	- 83 m2
43	Woodcarving workshop	- 41 m2
44	Painting workshop	- 41 m2
45	Storage, sound & light	- 20 m2
46	Print & foil cutter	- 20 m2
47	Metal workshop	- 13 m2
48	Secure temporary storage	- 65 m2
49	Dry storage	- 22 m2
50	Cleaning	- 13 m2
51	Microscopy	- 13 m2
52	Common wotkspace	- 84 m2
53	Laboratory, wet	- 36 m2
54	Object handeling space	- 64 m2
55	Laboratory, dry	- 74 m2
56	Workspace	- 17 m2
57	Exhibition deck	- 1812 m2



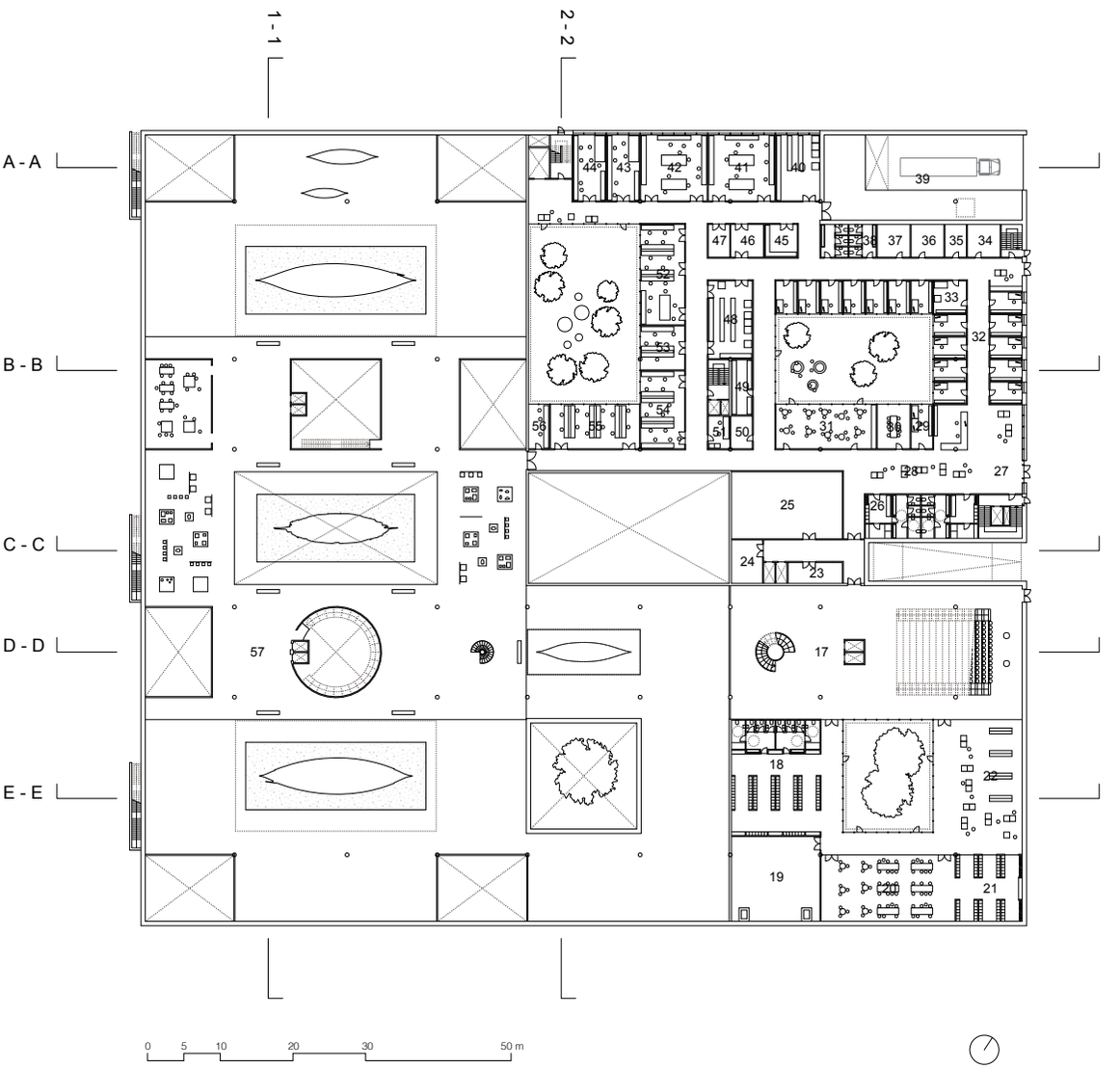
Section E-E



Section 1-1



Section 2-2



LEVEL -2

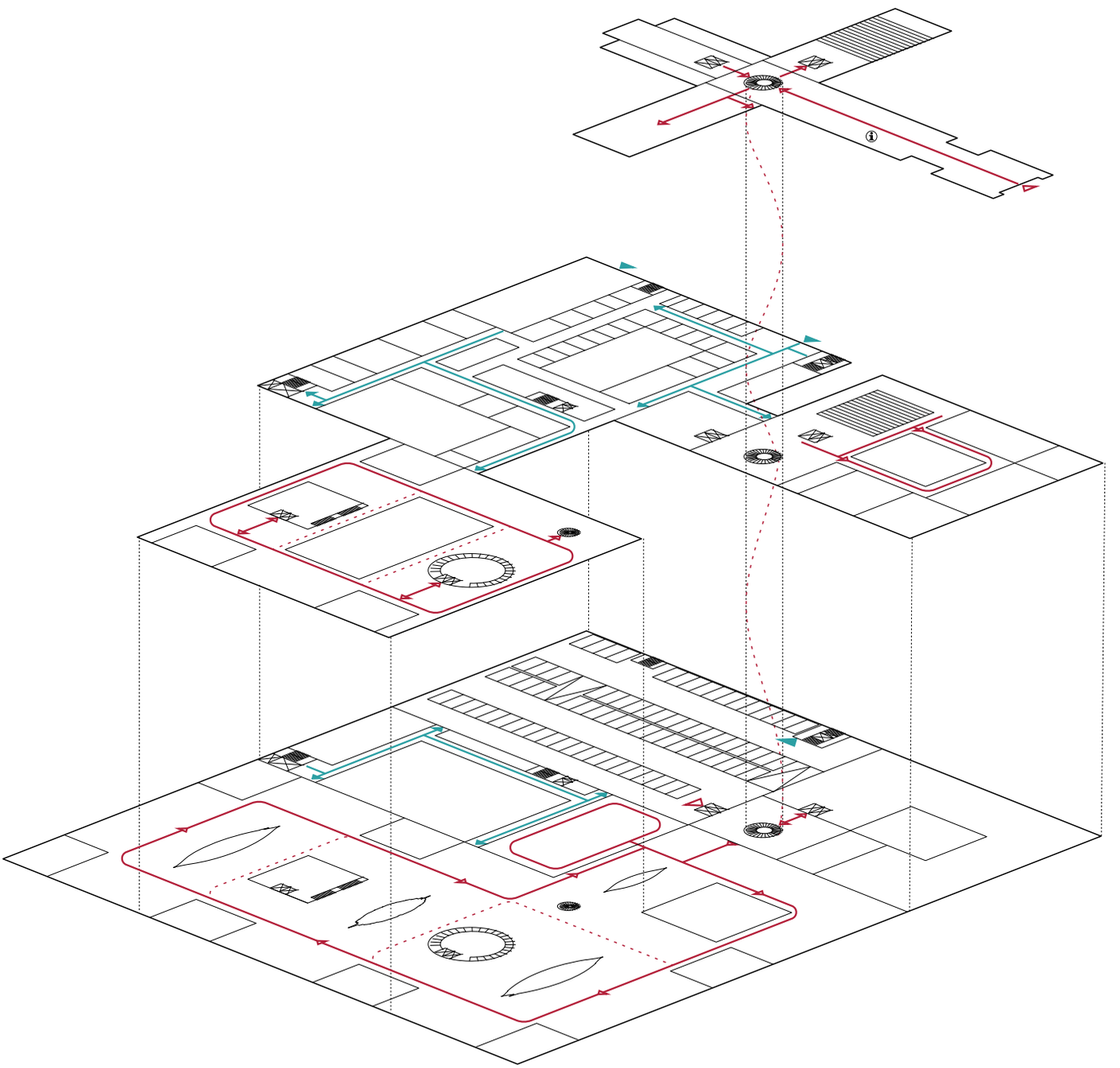
58	Temporary exhibition	- 950 m2
59	Main exhibition	- 5000 m2
60	Special exhibition	- 420 m2
61	Toilets	- 85 m2
62	Technical room	- 1230 m2
63	Long-term storage	- 850 m2
64	Dry storage	- 17 m2
65	Cleaning central	- 17 m2
66	Cleaning machines	- 17 m2
67	Cleaning room	- 13 m2
68	Parking	- 160 parking spots

ENTRANCE

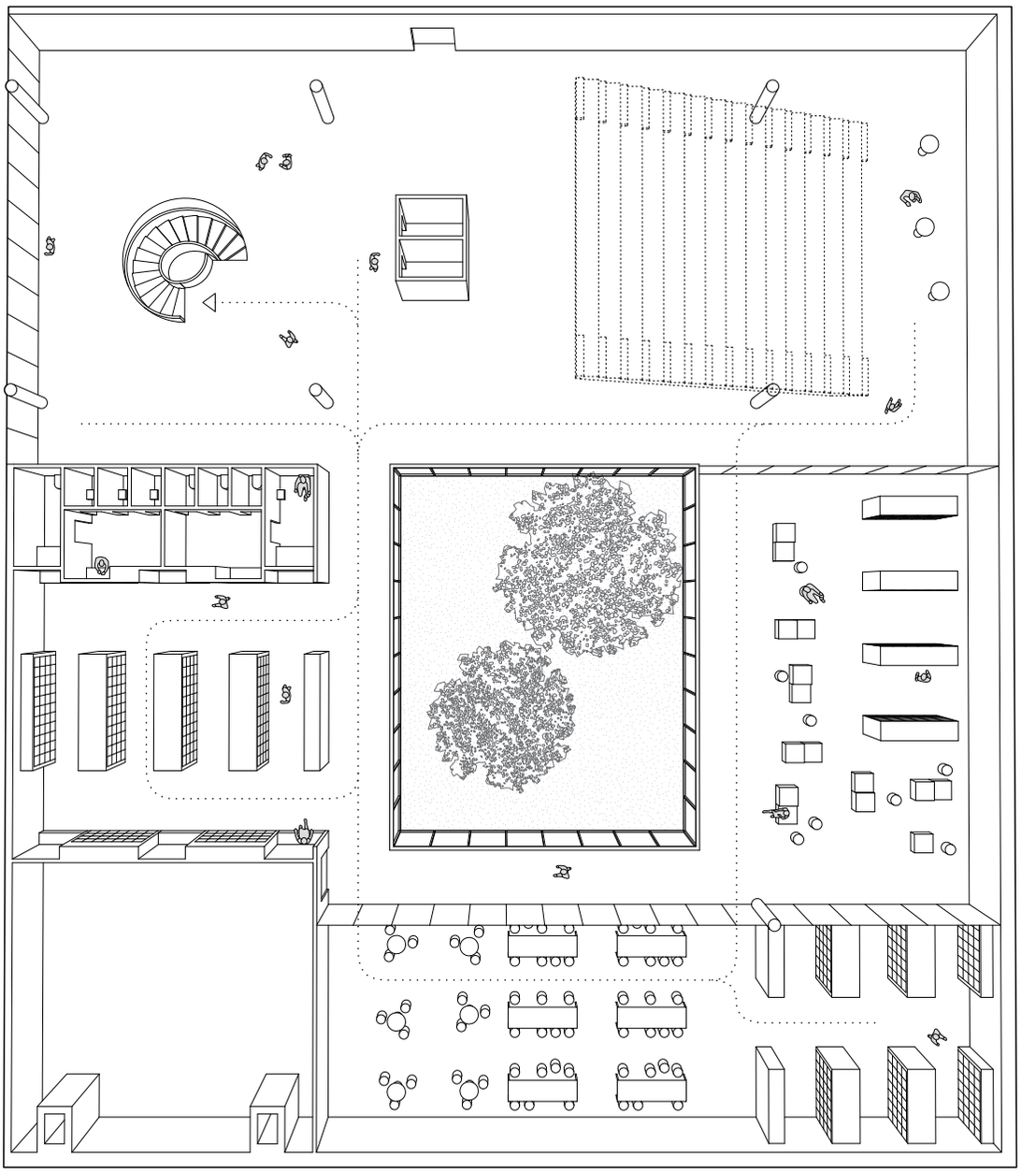
CONNECTING NEW AND OLD

Except for the columns, indicating the position of the building above, the new building stands as a completely separate volume. As the staircase spirals down through the building a courtyard opens up, leading light down to the surrounding spaces at the first exhibition floor. As a contrast to the entrance area this space appears intimate, with lower ceiling height and a soft wooden floor. As a continuous element the in-situ concrete grid ceiling can here be experienced close by as an enormous detail, extending into the exhibition space where it appears almost like a texture. The interaction between the solid concrete and the war fir floorboards enhances both through their scale and materiality the intimacy of this middle zone, half between entrance and exhibition.

Closest to the auditorium a library and lounge area provides space for learning and relaxation, while on the opposite side of the courtyard wardrobe and toilets are placed as a continuation of the movement of the staircase. In addition a dedicated wardrobe and lunchroom accommodate the many school classes visiting the museum. Situated around the courtyard, all the functions have both the benefit of daylight and direct access to the sunken garden, as a place to dine or just get some air. From the first exhibition floor the staircase continues spiralling down one round, both beginning and ending facing the main exhibition space.

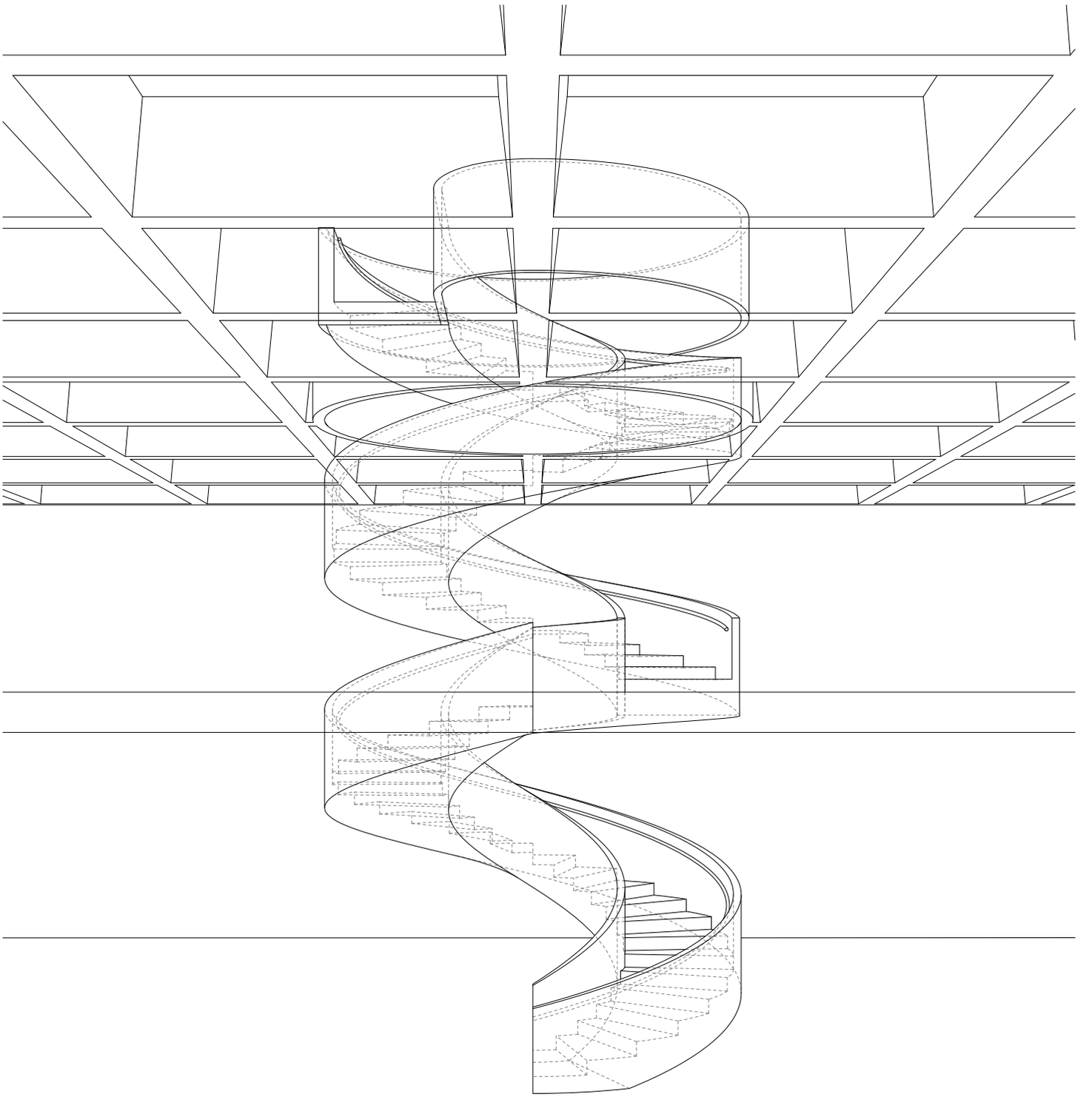


As the main connection point between new and old, the staircase is spiralling its way down through the building. At the lower level the centrally positioned ships act as a pivot point for the exhibition loop. From the loading bay and staff entrance there is direct access to both levels of the exhibition space.

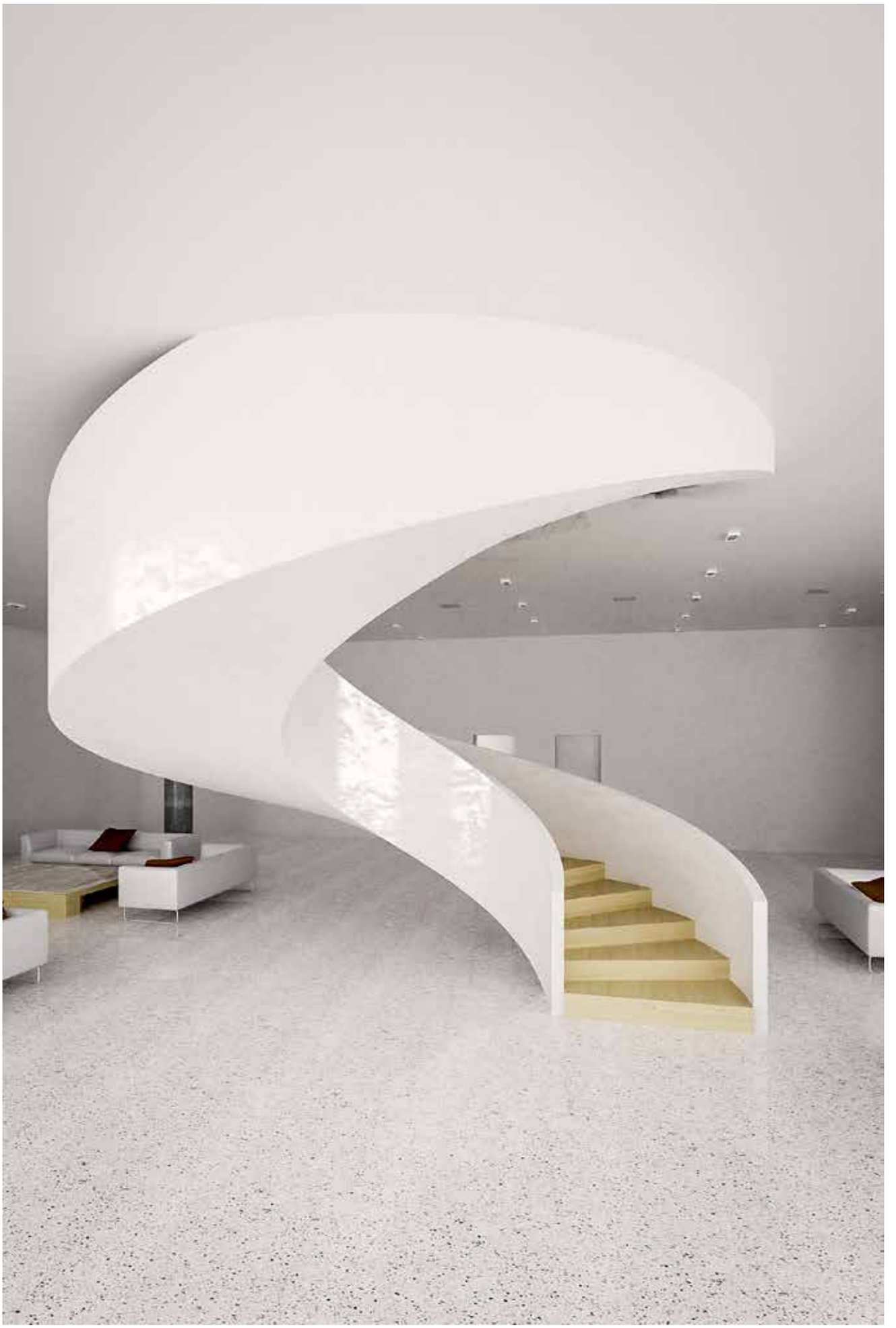


Through a sunken garden, light is brought down to the visitor functions. As the wardrobe, library and other functions is situated around it, the courtyard itself is also an enriching, almost graphical, element in the space, allowing views to the sky and the existing building above.

As the floor is folded down, resting on the columns on either side, the physical connection between new and old is exposed. As the whitewashed vaults come down, resting on the grid structure, a new space opens up below.



As a continuous element, the staircase cuts through both new and old as it spirals down. First one and a half round, facing the courtyard and the wardrobe, then one round facing the exhibition on the floor below.



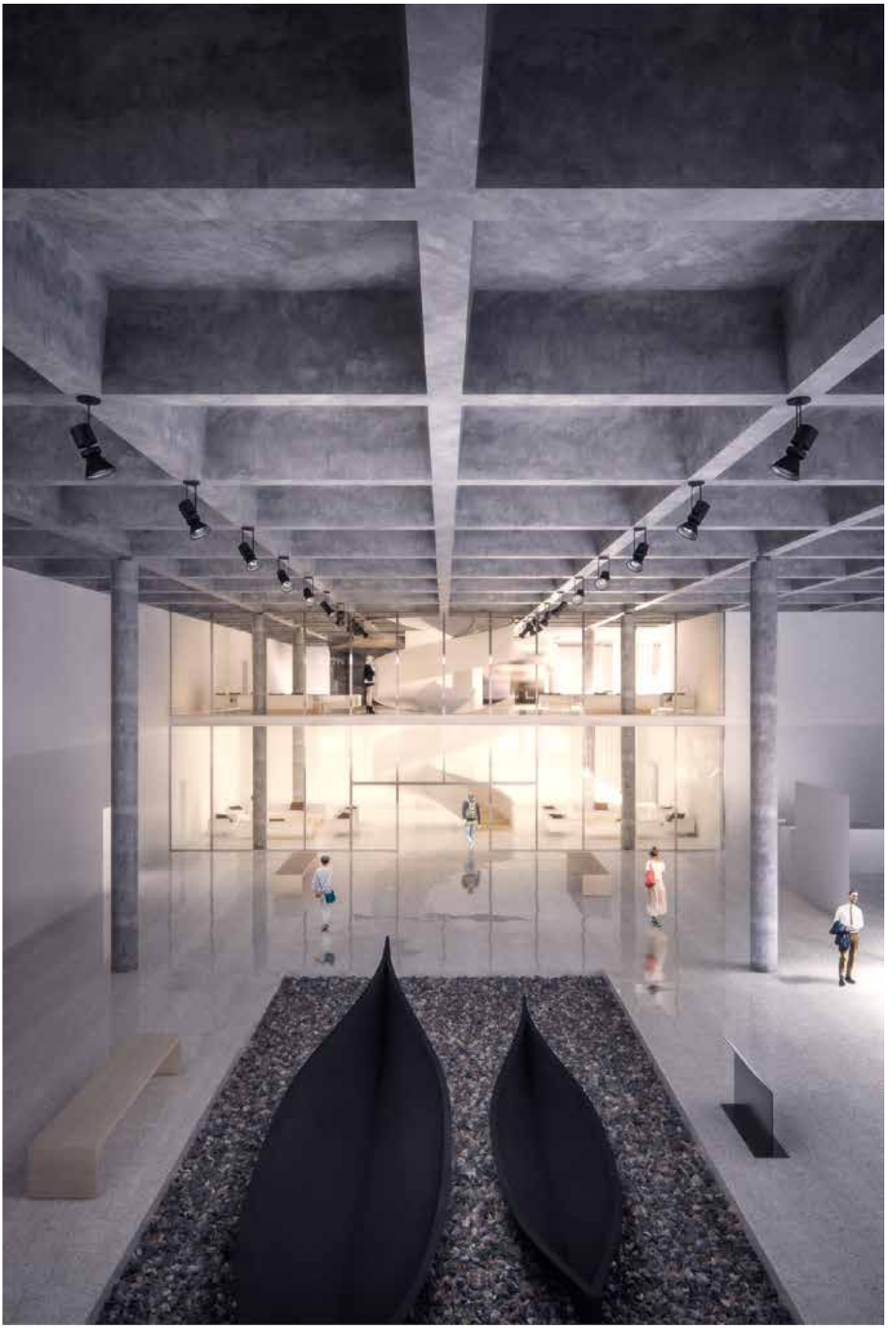
THE EXHIBITION SPACE

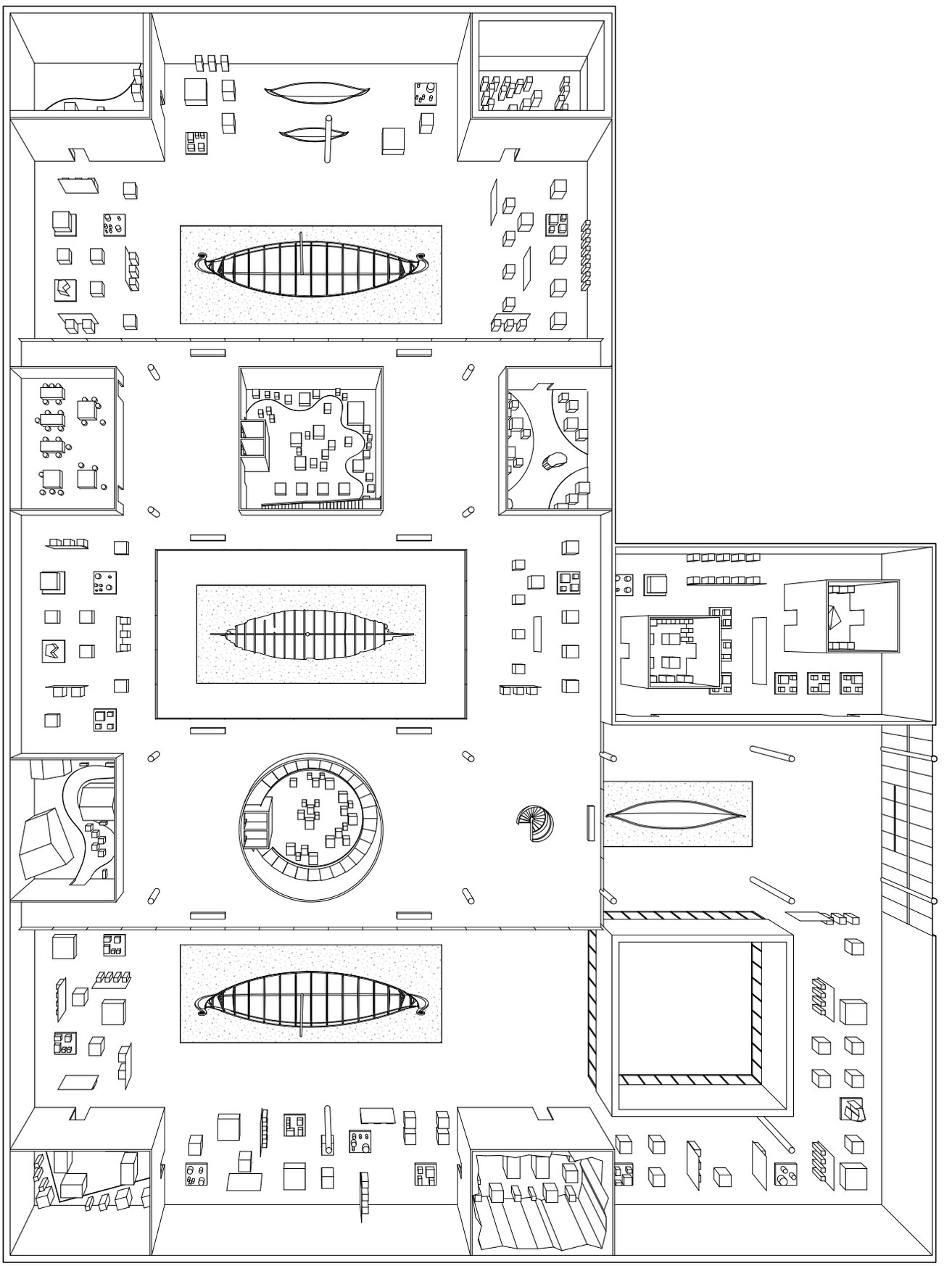
THE BUILDING UNFOLDS

The exhibition space is the arena where archaeology meets history, and stories of lived lives are told. Containing an extraordinarily large collection of artefacts as well as graphical and interactive elements the building itself stands merely as a self-referring framework and neutral backdrop.

In as much as the ships where at the centre of their age, they also stand as the backbone of both the collection and the exhibition. Centrally situated in the exhibition they act as reference points in the vast space and defines a pivot point for the chronologic exhibition, binding the different sections of the exhibition together. The three skylights, centred above each of the large ships, filter a soft light down to the ships marking their position in the exhibition and emphasize their curves and ornaments. A natural gradient between the light centre and the darker edges occurs, creating an atmospheric backdrop for the smaller artefacts.

Much like a black box theatre the exhibition area is treated as a flexible space where the story telling is handed over to the historians and exhibition designers. To underline this, densiphalt flooring in the lower exhibition level provides a seamless and highly robust surface and meets the requirements regarding long lasting point loads and moving of large objects. The light grey polished surface has a texture much like terrazzo, both tactile and neutral, and is in spite of its strength likewise soft and comfortable to walk on. Yet open and flexible the exhibition space is divided into three different areas with their own distinct character and spatial function.



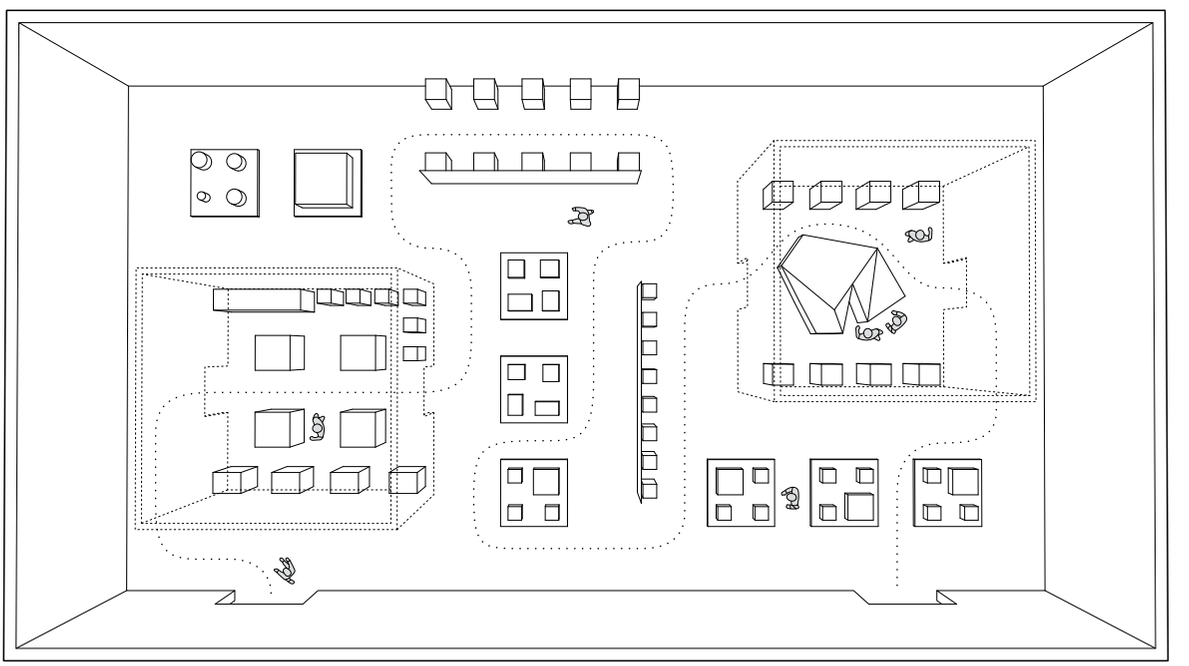


In the main exhibition space, the Viking ships can finally be experienced in their full length, giving the visitors a new understanding of their soft lines and scale. As the centre of the exhibition, they act as a backbone, while themselves being presented in a broader context.

THE SPECIAL EXHIBITION

TEMPORARY CHANGING EXPERIENCES

The first room the visitors meet when entering the exhibition space is the special exhibition. As a separated black box it act as a dedicated space for thematic exhibitions or exhibiting artefacts borrowed from other museums worldwide. The introverted volume acts as an extra security barrier, while with its full ceiling height of 8m and large floor area is fully flexible. With its central position in the exhibition the space addresses the regular visitors of the museum, providing direct access without having to go through the whole exhibition area.



With its 400 m2 floor area, the special exhibition is a flexible black box space that can both be treated as a large surface or divided up into smaller spaces.

THE TEMPORARY EXHIBITION

PRESENTING NEW KNOWLEDGE & RESEARH

Situated opposite to the special exhibition the temporary exhibition space is a likewise highly flexible area. As a arena for the museum to present the latest within science and research as well as artefacts not included in the main exhibition it addresses all the visitors, but with a certain focus on children and school classes. Situated around a sunken garden the space stands out as the only part of the exhibition with natural light and a view out. The courtyard itself can also be integrated as part of the exhibition, as a giant showcase in the middle of the space. As a hanging element the walls of the courtyard is extruded down to avoid any direct sunlight to reach the surrounding artefacts and potentially cause damage.

As a big showcase in the space, the courtyard itself can be included as a part of the exhibition as a space for large-scale replicas or merely a piece of untouched Scandinavian landscape.

THE MAIN EXHIBITION

STORIES FROM THE VIKING AGE

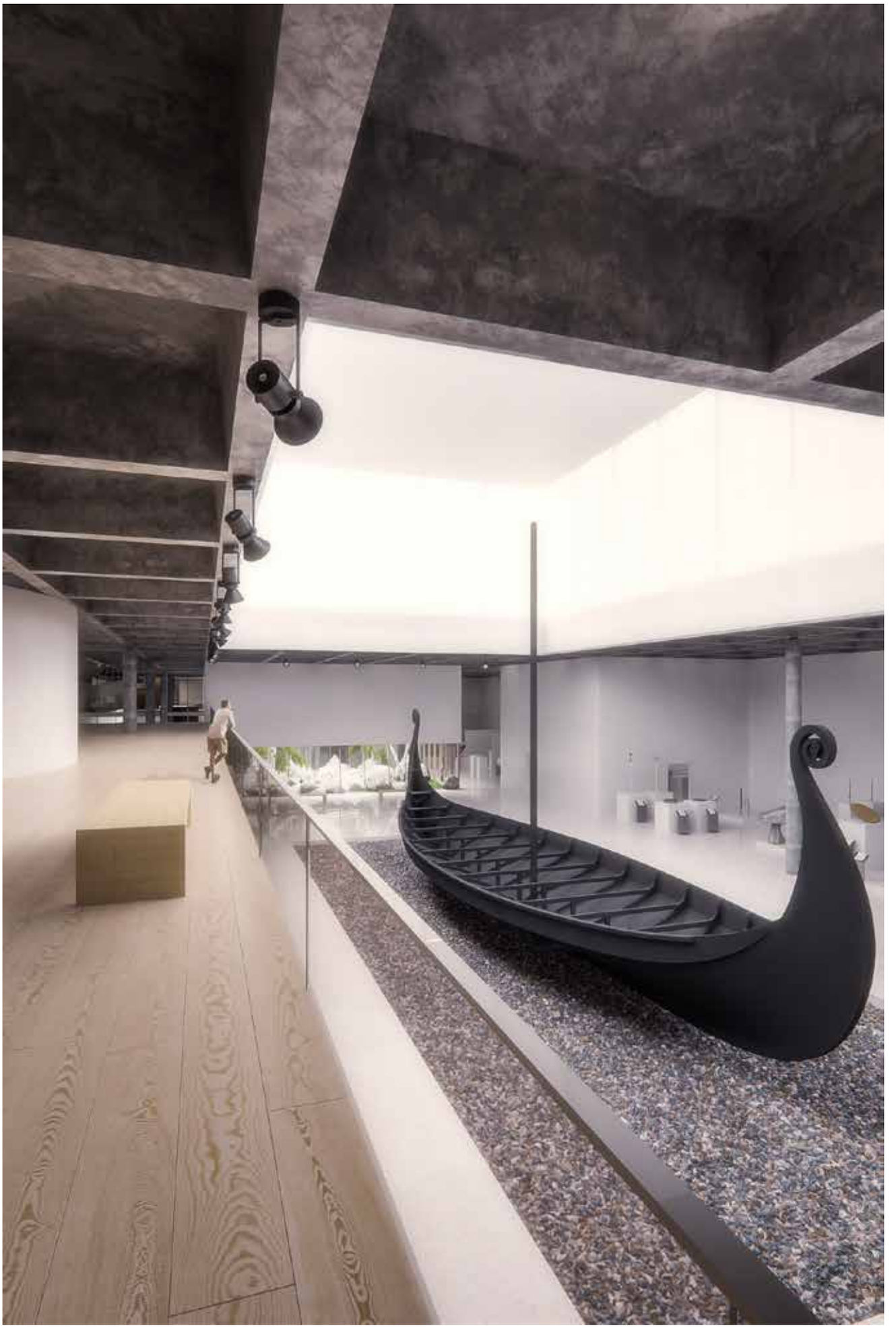
The main exhibition space offers the visitors a tour through 300 years of Viking history, beginning at 800 AD with the burial rituals of the Vikings, going to 1100 AD and the prevalence of Christianity. The exhibition is further divided into eight different thematic exhibitions, together providing a complete impression of the age. As the collection contains a series of world famous icons, including the three ships, these create the foundation for the different thematic exhibitions.

Each of the thematic sub exhibitions consists of an open space and a closed volume, separating storytelling and interactive graphics from the presentation of artefacts and their individual stories. This is a means to create order and clarity in the large space while also enhancing the significance of each individual element or object. The volumes create a series of niches along the outer perimeter of the space, breaking down the scale and giving a sense of intimacy in the exhibition. Even though the museum has a capacity for more than 800.000 visitors a year the experienced number might thereby appear smaller, providing the visitors with space both for personal reflection and social interaction. All volumes and wall surfaces in the space is treated with a white stucco lustro plaster, giving them a slightly shiny appearance with an intriguing depth, while still giving a neutral over all impression.

In the middle of it all the ships are situated, only separated from the visitors by a sunken field of pebble stones, as if dragged onto a beach. In the open landscape with a soft light flowing down from above they are presented as in their natural milieu, yet completely out of context. As the main attraction of the museum the space surrounding them is dimensioned in accordance to the large number of visitors and to enable the visitors to experience both the full profile as well as the smallest details.

The lightweight steel deck in the centre provides a complete overview of the three ships as well as the exhibition as a whole, adding to the spatial variation of the exhibition as it cuts through the space. Here the visitors can experience the ships while learning about their complete history and the people to whom they once belonged. This is also a place to just simply sit down and take a break from history. With a wooden floor of solid fir boards it stands out from the monochrome pallet of the exhibition below. As a large-scale detail the in-situ concrete grid ceiling can be experienced close by as it extends out into the exhibition space. In the interaction between the warm wood of the floor and the rough concrete of the coffered structure a contrasting, though

From the upper exhibition level, the visitors get a full overview of all the ships. Here the grid-structured ceiling can be experienced up close as it stands in sharp contrast to the soft fir wood floor.



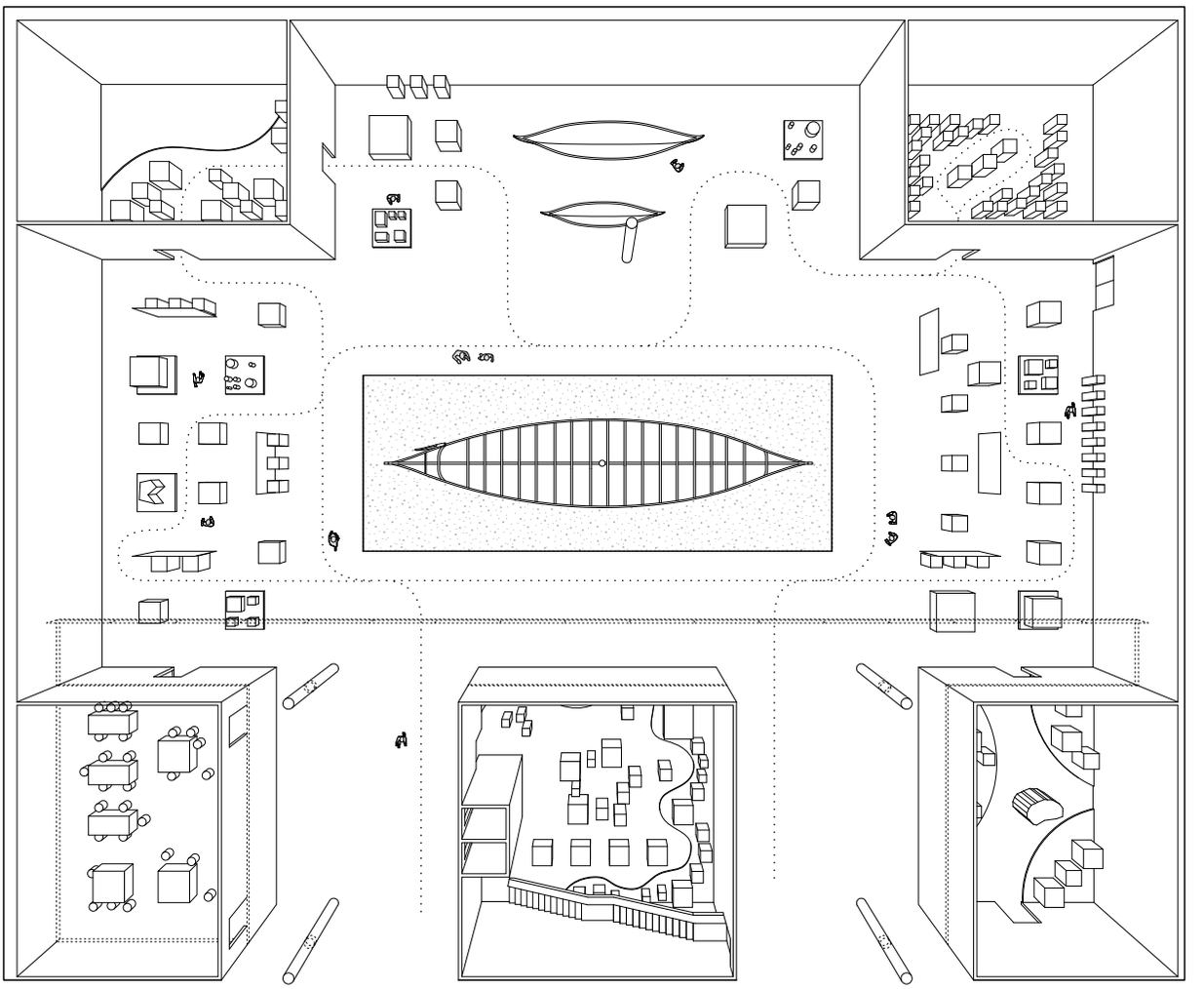
complimentary effect becomes visible, enhancing the atmosphere of the space.

Connected to the main exhibition space at three points the visitors can freely access the platform as they move around, either through two of the exhibition volumes or the freestanding staircase. From below the deck appears as an even seamless white surface, consisting of coated rock wool sound insulation. Due to its even texture the surface has a high light reflectivity, securing an evenly distributed light in the spaces below.

The exhibition volumes, as dedicated spaces for communicating histories through graphics and other scenographic elements, are kept free of all specific treatment to enable them to be filled with mystery and life-like stories. In these spaces the visitors can enter into a scene form a village, a grave chamber deep below grown, or a ship in the middle of the North Sea. They are also part of the larger exhibition strategy taking into account the different groups apparent in the visitor mass.

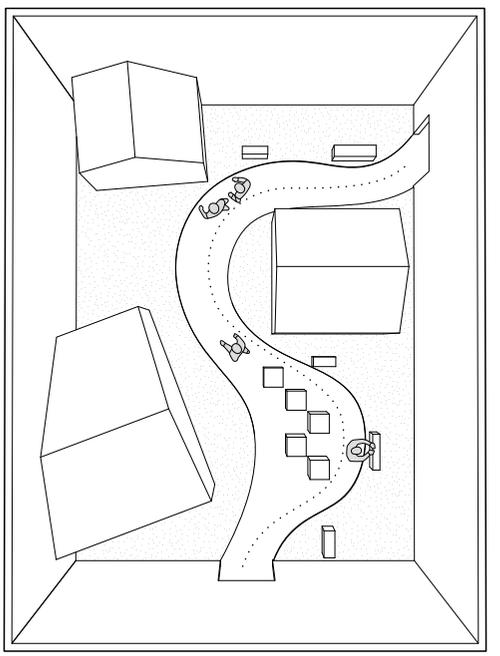
In the main season a large percentage of the visitor mass consists of tourist groups. Whit a tight schedule and limited time the exhibition loop leads the tourist groups chronologically past all the major icons situated in the open exhibition space, naturally presenting a series of different views of the grand ships on the way. For the regular visitors shortcuts can be made from the main loop. If visitors only want to se the ships and the collection of jewellery they are not forced to se a thousand swords and spearheads as well. For a whole day visitor the whole main exhibition is presented as a continuous chronologic path, as well as the outdoor activity and exhibition area.

As niches along the perimeter of the room, the exhibition spaces appear partly shielded from the main space. Here the visitors can explore the vast collection of artefacts in an intimate atmosphere with the ships as a historical backdrop.

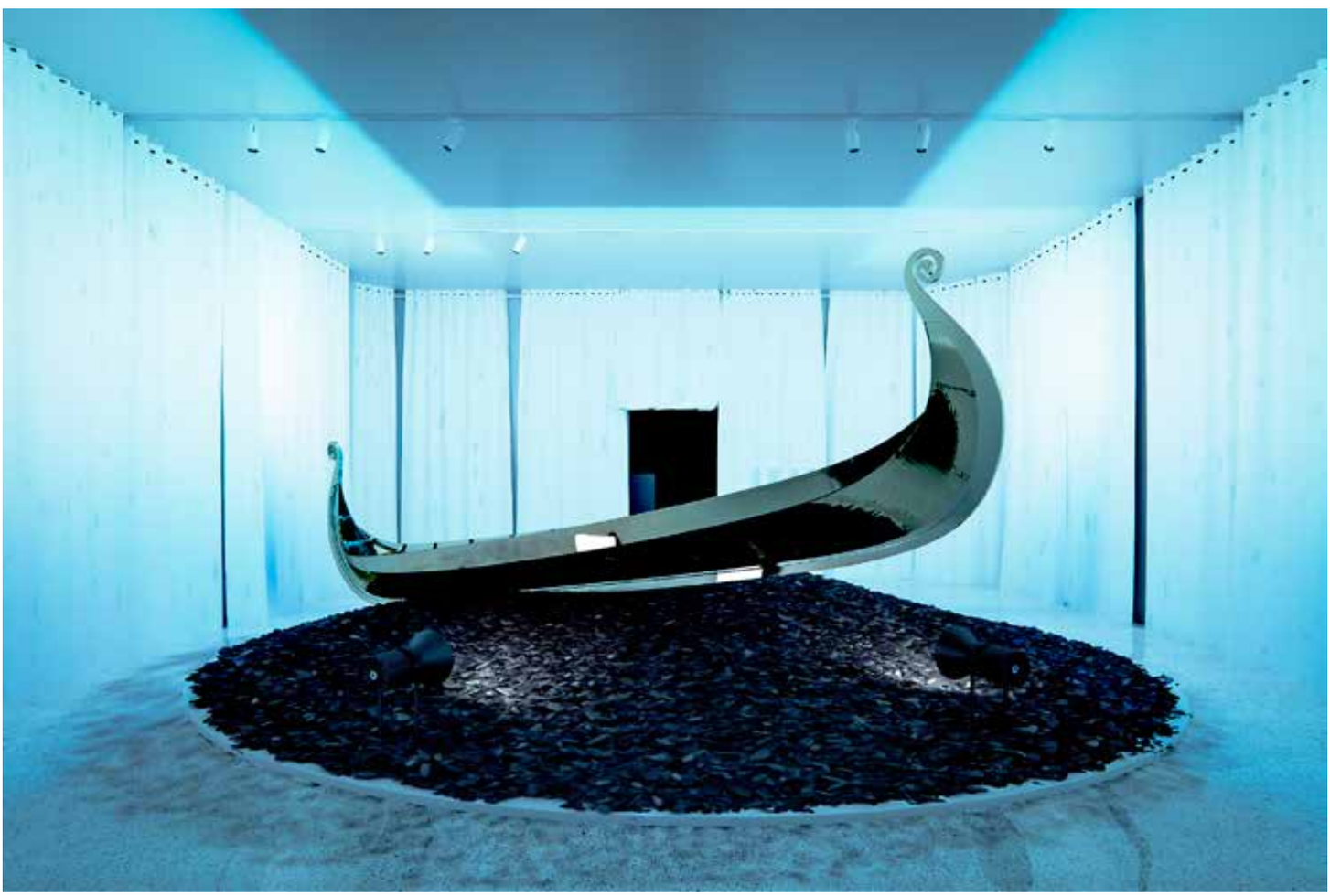


Organised as a loop with the ships in the centre the visitors is guided through three hundred years of Viking history. While the whole day visitors freely can study each and every thematic exhibition as they come along the way, there is also space for the tourist groups to rush past the icons of the collection on their thirty-minute tour.

Standing on the open floor surface, the ships are only separated from the visitors by a strip of pebble stones. While highlighting the ships the skylights is also defining a space within the space.



As separate black box spaces the exhibition volumes along the perimeter act as worlds on their own where the visitors is presented to specific scenarios or scenes.



In these spaces, the history of the artefacts is made alive in a staged setting through visual and audiotive effects.

STAFF FACILITIES

OFFICES, LABORATORIES & WORKSHOPS

In as much as it is a tourist attraction the museum is also a workplace for a large number of people. In addition to the service functions, maintenance and exhibition production, the building is also a centre for science and research. To accommodate this conglomerate of functions the staff area is treated as a compact unit within the building, separated form the visitor areas. Oriented around two courtyards to ensure daylight where needed, the staff area is organised into five different areas according to function and their relation. The division between staff entrance, offices and operation, object handling and preservation, exhibition and replica production, and loading bay secures an efficient organisation and security regarding transportation and handling of artefacts.

The courtyards and the staff entrance area act as social meting places binding the organisation together and encourages casual meetings between employees from different departments. As an open space with direct access to wardrobe facilities, meeting and dining rooms, and parking basement the staff entrance act as the connection point to both the exhibition and the public entrance. Thus all visitors and deliveries pass by the centrally placed information counter and security office, and make it a natural meeting place in the large organisation.

In the northwestern corner of the building the climate controlled loading bay is integrated within the envelope to encounter the safety precautions needed when transporting and delivering large and valuable objects. The loading bay is connected to the department for exhibition production and the department object handling and preservation as well as the main exhibition space with a gods lift. Situated on same level as the visitor areas, including the upper exhibition floor, the same flexibility is provided in all parts of the building. To ensure efficient logistics and a future proof organisation all hallways are dimensioned to allow transportation of large objects; or more specifically in this case a small boat in accordance to the competition documents. As in the exhibition areas polished desiphalt flooring provides an elegant and comfortable, yet durable surface in all rooms. Likewise the concrete grid ceiling, as a continuous element in the building provides an extra layer of tactility to the workplace, adding a sense of increased height to the spaces and an almost graphical perspective to the larger rooms and corridors.

In close proximity to exhibition production, object handling and preservation a secure storage space provides temporary storage for artefacts while being treated or part of a research program. In addition, long time storage facilities on the lower exhibition level enable the museum to store the unexhibited artefacts and exhibition elements within the complex, significantly improving the existing conditions. As an addition to the initial program, the long time storage facilities have been dimensioned with reference to the facilities at Moesgård Museum.

The same applies to the size of the technical room, which located in the northeastern corner of the building services both the new and existing building. To enable easy repairs and maintenance of the ventilation system, the ducts are led through installation corridors underneath the lower exhibition level, with air intake in the floor surface. This leaves the grid ceiling free of all major installations, making it appear coherent and calm.

Positioned around two courtyard spaces the laboratories, workshops, and other functions are organised according to their relation and need for light, as a means to secure well functioning logistics and a good work environment.

MATERIALS
THE MUSEUM PALETTE

"The body articulates the world. At the same time, the body is articulated by the world. When I perceive the concrete to be something cold and hard, I recognise the body as something warm and soft. In this way the body in its dynamic relationship with the world becomes the shintai. It is only the shintai in this sense that builds or understands architecture. The shintai is a sentient being that responds to the world."

Tadao Ando (Frampton, 1995, p. 11)

A museum is a place for histories to be told and experiences to be made through graphic and visual, auditive, and tactile impressions. It is also a conglomerate of logistical, technical, and administrative challenges. It all has an influence on the material palette. In the new Viking age museum half of the material palette was already inherent, in the existing building by Arneberg and in the vast collection of artefacts. All materials added create merely a backdrop - yet, white is not a material.

Within a subtle, almost monochrome, material palette the intention has been to implement a layer of elegant tactility, suitable for the buildings function and appearance, as well as strengthening the readability of the functions and elements within. Yet, as a whole the material palette appears neutral and timeless, creating a balance between exhibition and building.

To ensure a future proof design, a combination of easily reparable natural materials and extremely durable composite materials are being used throughout the building. This enables updates of exhibition technologies and graphics within a 10-year perspective, as well as a partial or complete remodelling of the exhibition in a 50-year perspective.

DENSIPHALT:
Densiphalt is a composite material, which combines the strength of mortar and the flexibility of asphalt in a seamless wear resistant floor surface. Applied in a 15-25 mm top layer the material is widely used in industrial buildings due to its durability and simple application on large surfaces. As with concrete, densiphalt can be given any colour and texture.

When polished the light grey densiphalt flooring on the lower exhibition floor and the staff areas has a similar appearance and texture of terrazzo or polished concrete. This provides a seamless and neutral, yet playful surface. Its softness and flexibility makes it a comfortable surface to walk on – essential for a large museum – while its smooth surface and durability makes it ideal for transporting large objects and easy to clean and maintain (Densit, n.d.).

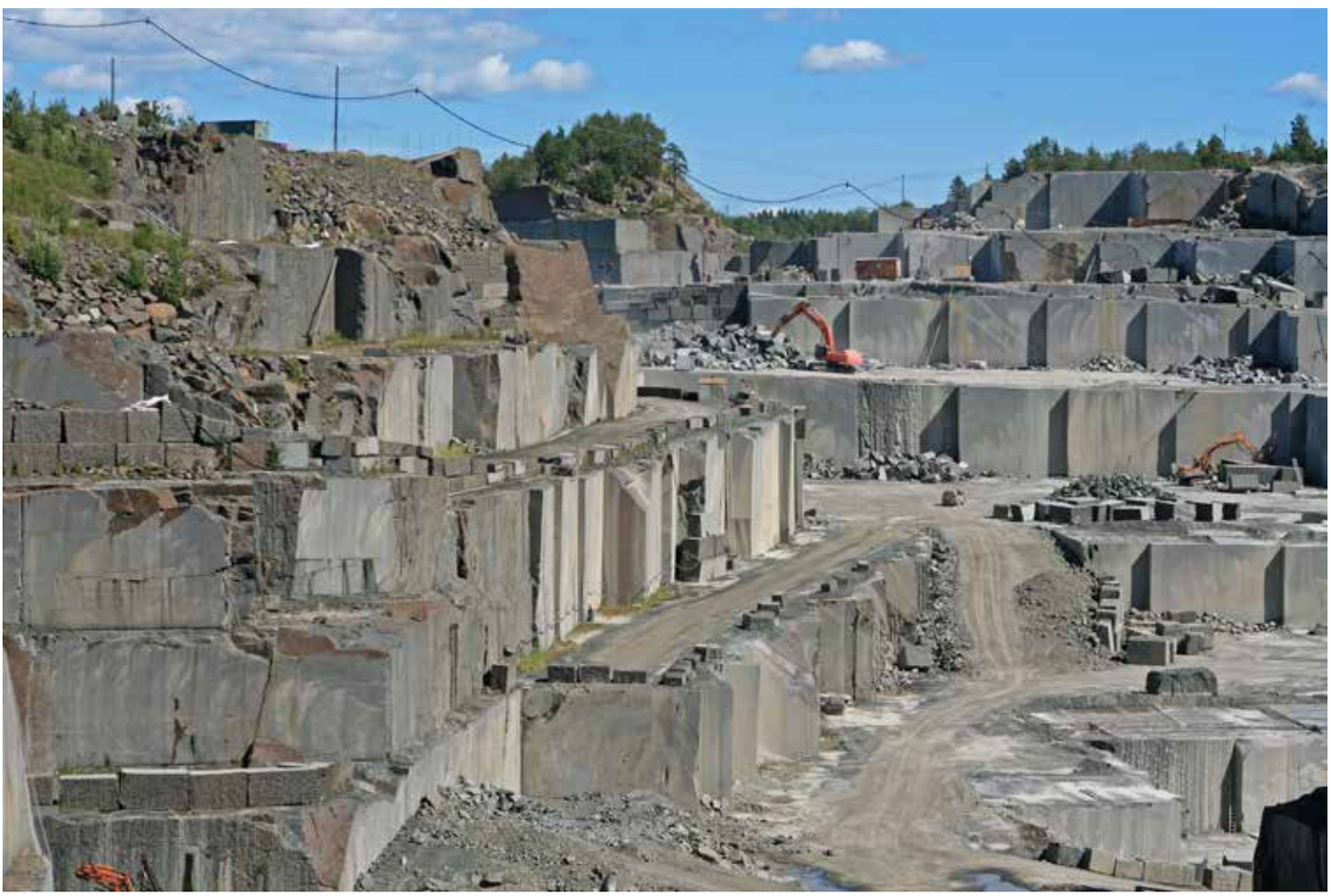
ROCKFON:
A Rockfon mono acoustic ceiling provides a seamless elegant surface for the lowered ceilings in the exhibition space. The seamless white finish has a light reflectivity of 78%, giving an even distribution of light in the lower exhibition area. Mounted as panels both electrical installations and sprinklers can easily be fitted with a flush finish, giving the ceiling a calm neutral appearance. The panels consist of compressed rock wool that provides good sound insulation, as well as being entirely recyclable at a future replacement (Rockfon, 2015).

CONCRETE:
The C35 concrete is an extremely strong composite material, combining the compression strength of mortar and stone with the tension strength of steel reinforcement. Being in-situ cast on top of a formwork, consisting of more than a thousand coffers, the concrete gets a slightly varying and uneven texture, adding depth to the perception of the grid structure ceiling. This creates a naturally appearing contrast to the concrete columns as when cast in a cylindrical formwork appears smooth and continuous.

DOUGLAS FIR WOOD:
With its natural warm yet light appearance massive Douglas fir wood boards is implemented as flooring in a few selected spaces, adding a bit of colour to an over all monochrome interior material palette. With board lengths of up to 15 meters, the floor appears continuous and soft, both for the eye and the foot, and is comfortable to walk on. In the museum, the wood flooring is also implemented as a means to distinguish between heavy and light constructions, permanent and re-shapeable structures, as it is purely implemented on the lightweight steel decks (Dinesen 2015).

STEEL STAIRCASES:
As freestanding elements the staircases stand with a white glossy finish. The powder coated steel elements can be partly prefabricated, ensuring the swirling curves to appear continuous and flawless. The finish makes them durable as well as slightly marking them out in the space as the individual elements they are.

GRANIT:
Larvikitt is a type of granite found only in Norwegian but widely used worldwide due to its texture, play of colour and its durability. (http://www.geoportalen.no/nasjonalbergart/larvikitt) At the new Viking age museum a light grey larvikit is used on the facade to accentuate the weight of the bastion as it cuts into the landscape. With its rough unpolished finish the volume of the building stands as if pushed up from the ground, creating a natural transition to the surrounding landscape. The stone is mounted as large panels to respond to the scale of the building as a whole and underline its monumental character.



AEROGEL GLAZING:
The volumes above the ships act as a light diffusor, letting an evenly distributed soft light into the exhibition space below. The outer layer of the volumes consists of two layers of heat-strengthened glass with a core of aerogel. The material is one of the lightest insulating materials in the world consisting of more than 90% air contained in a pore structure smaller than the free path of air molecules. This gives the material an extraordinary insulating ability, and with a thickness of 5 cm the glass panels has a U-value of 0,61 W/m2K.

Rather than the texture of sand blown glazing the aerogel glazing appears quite similar to rice paper. Compared to regular translucent glazing it is also a better light diffuser, distributing light in a larger angle and eliminates the need for lamellas. Mounted to an interior steel structure as a curtain wall the glass volumes stands with a flush sharp cut finish, like lanterns in the grass (Solera, 2012).

STUCCO LUSTRO:
Stucco lustro is a traditional Venetian plaster technique using a limestone and marble based plaster. The plaster is applied at a small area at the time, resulting in a slightly uneven but elegant texture with overlapping patches of varying glossiness.

As the finish of the interior walls in the new building the white marble plaster creates a tactile, yet neutral, backdrop for the exhibition. By the touch of the hand the stucco feels like silk, but as a surface treatment it is robust due to its limestone base and is easy to repair (Stucco Italiano, 2015).

BRICK FLOOR:
As a symbol of good craftsmanship the herringbone patterned brick floor in the entrance area becomes a natural part of the existing building. As a continuation of the existing elements of brick flooring in the building the pattern changes at the centre of the building marking out the transition from one vault to another, while still appearing as a continuous red brown surface from a distance. Through its materiality and texture the floor becomes a part of the atmosphere of the space, emphasizing its function as a place to stay. All though durable, the brick will, over time, slowly be polished by the many people walking on the surface; itself becoming a part of the buildings history.

OUTDOOR AREA:

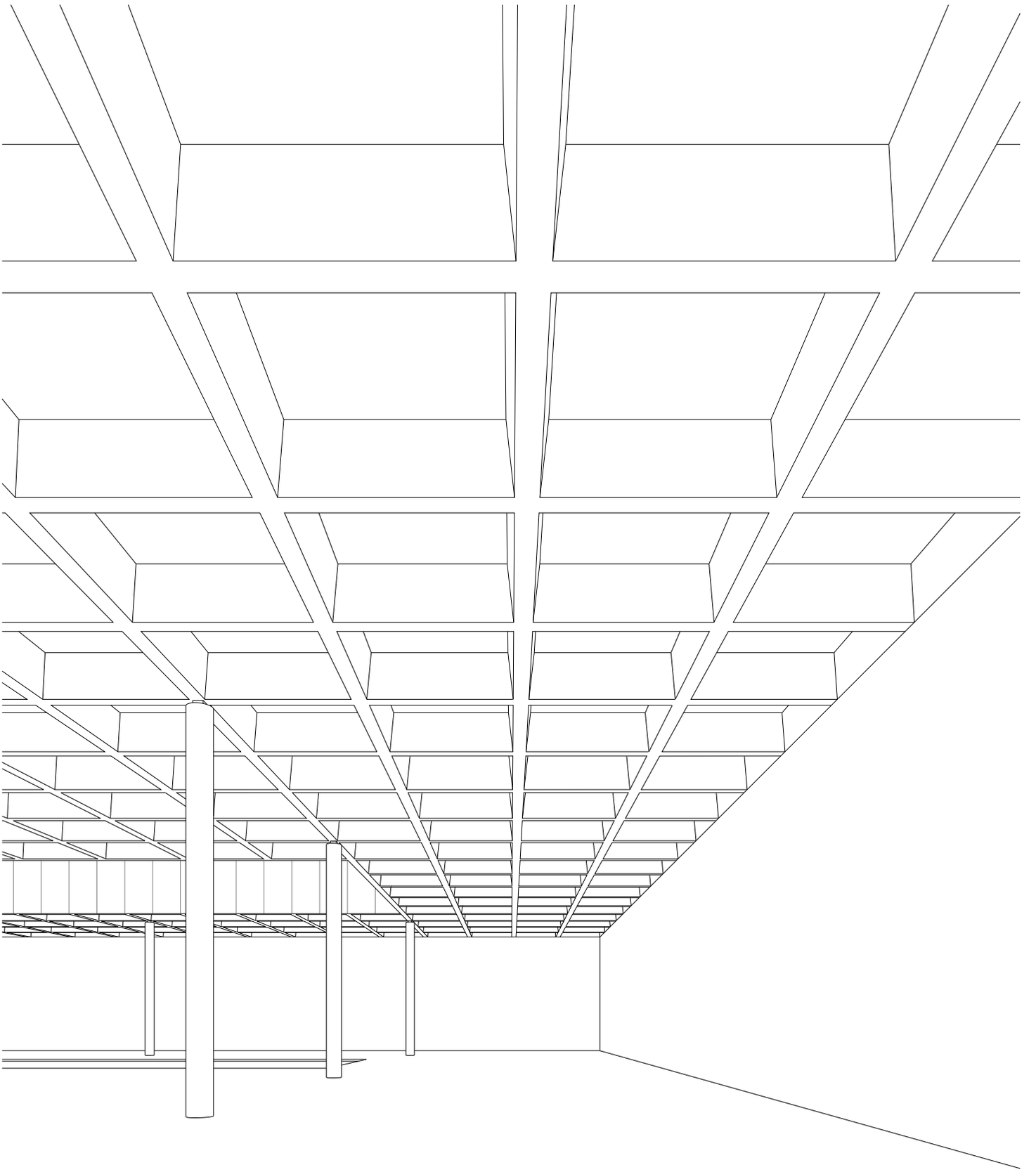
The large outdoor area consists of a combination of grass and cobblestones. As grass only needs a soil depth of about 20 cm it is well suited for the outdoor area, being to a large extent a green roof. Acting as reinforcement, protecting the grass from wear and tear, cobblestones is implemented at the outdoor seating area specifically and on areas with a high activity level generally, according to function. Through their shape and materiality the cobblestones is referring both to the structure below and the existing building. As an open green landscape the outdoor area as a whole is seen as a continuation of the existing expression of the site. Likewise some of the smaller existing features are continued in the new proposal, as the gravel path leading to the main entrance, and most of the larger trees and other vegetation.

STRUCTURE & CONSTRUCTION

SYSTEM & ORGANISATION

As the grid structure ceiling acts as one continuous slab, spanning in two directions, it was well suited for the open character intended for the new exhibition space. As a continuous element in the new building it structures all functions according to a strict 3,1 X 3,1m grid, resulting in a well organised and well dimensioned organisation. Compared to earlier sketches of a louver like beam structure the symmetric grid create a surface without direction, ensuring a full future flexibility in the spaces below, but within a consistent framework. In the main exhibition specifically the system of the grid structure is continued through out the organisation, securing a good distribution between exhibition space, circulation area, and the ships in the middle. Likewise all other functions in the building are organised according to ceiling, measuring either whole or half coffers and creating straight connection axis between exhibition and support functions.

An irregular grid of columns both lessens the maximum span of the ceiling and supports the existing building above. Thereby they stand as the only testimony of a connection. The columns was included in the plan as a space defining element as well as a means to control the dimensions of the ceiling structure and ensure a maximum thickness of the roof. Placed according to the building above and the ships in the centre the dimensions of the columns is a result of the maximum span, where the grid has been adjusted accordingly to achieve a balance between length and radius. While firmly resting on the floor surface only a pin joint connects the columns to the ceiling structure, making them appear as freestanding obelisks in the space.



DISCUSSION

THE FINAL SKETCH PROPOSAL

DISCUSSION
THE OUTDOOR AREAS

What is a museum? Or more specifically, what is a Viking age museum? Throughout the process we have been faced with a series of questions, and responded to them as we saw fit at the point. As we built up layer upon layer of argumentation through our sketches, new questions arose. Sometimes we asked good questions, other times we simply asked the wrong question, taking the project into an equally abstract direction for weeks before bringing it back on track again. Yet these detours can often be said to be a necessary evil, as it is through testing and failing that a strong idea or argument is born.

In the end we have established a sketch proposal for a museum extension that we through our arguments and professional experience firmly believe in. But as with all architectural projects, this doesn't mean that it stands without its compromises or that there are no further questions to be asked. Architecture, as the art of the built, belongs in the physical world, and as still on paper, our proposal is far from complete and should be seen as a framework. Likewise, within this framework there is room for future development and detailing, but based on our project management experience, both academic and professional, the process was stopped in the state presented due to time considerations.

Reflecting on an active project is often problematic due to the lack of perspective. Yet some of the, for us, crucial aspects regarding the project and the questions asked, both during the process and at the later stages, could act as a point of departure for further discussion and as a clarification for some of the choices made.

BUILDING UNDERGROUND:
Why build underground? This started out as a reference to the grave mound and the idea that all artefacts from the Viking age have been excavated, though it was also a response to the site and the function and content of the museum. Does a museum have to appear as a monument, greatly exposed to the public? In a context of open landscapes and villas, how tall should it be? As in most creative processes, some initial restrictions can help guide the project in a clear direction. As for us, it was never an alternative to build taller than the surrounding context, due to the character of the area and Bygdøy´s position in a larger context. Yet this does not mean that a multi-storey design could not be successful, but rather that we chose not to investigate the direction. Architecture tends to be at its best where the restrictions are at their greatest. In this case, our analysis suggested a restriction.

As for the idea of building underground, it opened up a completely new level of questions. Should an underground structure reflect the fact that it is underground? How should the architecture influence the presentation of the artefact, or should it at all? As architecture historian Ulf Grønvold stated in a comment, the ships belong at sea, and not in a grave mound, even though that was how they were found. They represent much more than merely the burial rituals of the time. In his comment he was referring to the Viking ship House by Arstein Arneberg and the way it completely envelope the ships as a response to a sketch proposal for an underground extension. This was while moving the ships from Bygdøy was still an option. (http://omarkitektur.blogspot.dk/2010_03_01_archive.html) Even though we came across this comment as writing this dicussion, we had come to the same conclusion in our process. But can something exhibited underground appear as if on the ocean? At the Viking ship museum at Roskilde the ocean act as a backdrop for the ships, as if they where floating on it. As the site was fixed and without a view to the sea, our response was to bring the light down as if being filtered through the clouds. In this context it was irrelevant if the exhibition was above or below ground. At the same time it also marked a major change in our understanding of the exhibition space.

SIZE AND DIMENSIONING:
If our statement concerning the ships where true they needed a lot more space than initially intended. As the main exhibition space grew, so did some of the other functions. The result is an exhibition space at least one third larger than suggestion in the competition documents, and a building about the same size as Moesgård Museum near Aarhus. The question of square meters where for a long time slowing our process as we tried to place three large ships into a far to small space, and in the end a compromise was made. Yet, as the competition documents is merely an initial draft, it might be questioned if this choice was a compromise. Has our sketch become too big, or is the program simply to small? Without knowing the full extent of the museums collection it is hard to do more than to speculate.

SCALE AND DETAILING:
In the beginning of the process, we naively thought that we would be able to detail the whole project at the same level, discussing everything from pavement of the buss parking to the smallest handrail details. The fact however is that it simply takes more time to draw fifty doors than ten, and as the scale of the project became clear the level of detail dropped. This has among other

tings resulted in a particularly low level of detail regarding the outdoor areas, an aspect that would have been interesting to study, and could have strengthened the story of the bastion and the meeting between new and old. The more detailed studies we have made, has thereby mostly been driven by interest.

PRESERVING THE OLD:
Another issue throughout the early stages of the project was the treatment of the existing building. One might say that there is a value in old buildings just by being old, yet the idea of the existing building being protected, together with the value we added to it, slowed down the process. Even though eventually cutting of the whole basement level seemed as a dramatic gesture, the building could potentially have survived an even harder treatment without loosing its character and history. In regards to the idea of the artefact on the podium, the building as a historical monument resting on the new volume, our gesture appears valid. Yet, an interesting discussion that could have been raised if testing an even bolder move was not.

THE EXISTING BUILDING AS ENTRANCE:
When we decided to utilise the existing building as the main entrance and exit point, it was as a means to activate the spaces in a meaningful way. Breaking with the competition documents this is also the first sketch proposal for the new museum, as far as we are aware, that does so. Both regarding logistics and the visitors experience as they move through the museum, it stands as one of the strongest proposals in the design. As for the treatment of the interior spaces of the building, we have been striving for a modest and respectful approach with the only major alterations being the auditorium and the elevator cores. As a means to strengthen the contrast between new and old, this is an approach that appears credible. Yet, satisfied with the result, we haven't investigated the treatment of the interiors further. What if? Again, this is a discussion we have avoided but that could have been interesting to explore.

THE BASTION IN THE LANDSCAPE:
As for the bastion itself, with a maximum height of four and a half meters, it is resting rather subtly in the bowl shaped landscape. With its new clearly defined perimeter the new lifted outdoor area, connected to the entrance level, provides a new level of potential activities to take place. As for the area surrounding the new volume, it still appears somewhat as an untreated backside. That the area is a backside is not in itself an issue, as it appears with an active façade with views to the workshop spaces. Likewise the untreated character

of the landscape is a natural continuation of the character of the peninsula as a whole and underlines the meeting between nature and building. As for the connection to the Folk Museum this is a study that could have been interesting, creating new connections and making the space more accessible.

THE TRANSLUCENT VOLUMES:
As they stand on the raised plateau the translucent glass volumes act as a space-defining element both in regards to the exterior and the interior space. As the visitors step towards the ships they also enters a space within the space. In the landscape the volumes strengthen the visibility of the museum as they stand as clearly recognisable landmarks. They are on purpose left clean and sharply cut, both to create an uninterrupted backdrop for the ships and to ad a layer of mystique to the building. It is apparent that something is taking place below, but you have to enter the space to get to know what it is. One could definitively argue that the three best-preserved Viking ships in the world are worth both the ticket and the waiting. Yet again this is one of the elements of the building that we could have studied further. Through the process a series of sketches of the volumes as a double-layered structure where produced, where the visitors could move all the way up from the exhibition space and get a view down, or merely access the volumes from the outside. In both cases it could have activated them in a whole different manner. The question we asked was in what way this would be an improvement. Do all architectural elements have to be double or triple programmed, or is it sometimes valid to simply leave them as they are, simply being themselves? Regarding the translucent volumes we argue that they through their materiality, formal language, and context are better left alone, without a new layer of pragmatic architectural storytelling being added. Yet, to see that physical model would have been interesting.

THE BALANCE BETWEEN ARCHITECTURE AND ARTEFACT:
As we have experienced, a museum is not simply a museum. The relation between the building and its content in existing museums is fare from being a constant, and rightfully so. When looking at two of our most admired museum projects, Teshima Art Museum by Ryue Nishizawa and Chichu Art Museum by Tadao Ando, they are both custom-made in collaboration with artists, and has them selves become a piece of art as much as they are great examples of contemporary architecture. It is not often that you are able to state what you have learned while still being in the middle of a process, but in this case we can. Historical museums are simply different. While art is given meaning by the artist, and later the spectator, historical artifacts and history itself is constantly added meaning as our understanding is widened. The danger of adding new meaning to history, either intentionally or unintentionally is simply to great. Our response was to draw a simple shape, close to being a perfect square, so simple that it almost appears boring and with an equally simple interior. By being so the building is only referring to itself and is cut free from the historical content of the existing building. Yet there is a thin boarder between something appearing boring and a refined simplicity. We believe that this proposal is on the appropriate side of this boarder, but it is hard to document. Simplicity is best observed in its built state.

HOW HISTORY IS COMMUNICATED:
Through our experiences at the museums we have visited we have come to acknowledge that exhibition architecture is a profession of its own, equally challenging as the branch of architecture that we belong to. Yet to prove that the design is well functioning we have been obligated to investigate the subject of exhibition design, and a proposal for an exhibition layout have been integrated as part of the sketch proposal. In this process there is especially one experience that has been of great influence, Moesgård Museum outside Aarhus. In contrast to the Cultural History Museum in Copenhagen Moesgård Museum has an apparent focus on the communication of history, rather than the artefact. The history is broken down into countless stories that expressed through a strong graphical language is striving for a personal experiences where the visitors feel connected to fictive characters. Even though this approach might be highly appealing to some groups, especially the younger generation, we experienced the exhibition as chaotic, where an elsewise astonishing collection was disappearing. Yet as a newly completed museum and one of the most modern in Denmark regarding exhibition technology, it can no simply be disregarded as a study. In our sketch proposal we have therefor tried to create a balance where elements of both museum traditions are implemented. As being a sketch it should be understood as being one of many potential layout options, and as a starting point for a discussio of what a modern exhibition space is or should be.

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APPENDIX

STRUCTURAL CALCULATIONS

STRUCTURAL DETAILING

In the process and presentation chapter, the structural principles of the roof construction was explained in terms of capabilities and the influence on the overall aesthetics of the exhibition spaces. This section will focus on the detailing and dimensioning of chosen elements within this structural system.

Throughout the design process, rudimentary estimations and calculations were implemented in the evaluation of initial conceptual suggestions regarding structural principles. With a point of departure in the theme of tectonics, the goal for the structural system was to achieve an appropriate solution, which was optimal in terms of both the loadbearing capacities as well as the spatial qualities the construction brought with it.

As the structural principle became increasingly detailed, and a specific direction was decided upon, the initial calculations were incorporated into a major excel spreadsheet. By interconnecting all of the many parameters, such as loads, material properties and structural dimensions, the spreadsheet allowed us to turn the design of the structural system into an iterative process. This approach allowed us to quickly assess the consequences of alterations to the design, and thus make informed decisions regarding the design of the structure.

The following calculations will present the final dimensions of the chosen elements, together with demonstrations showing that the chosen dimension are satisfactory according to the applied loads.

DIMENSIONING LOADS

SNOW LOAD:
The following calculation will present the various load cases, which are affecting the structural system and the calculation of each of these, consisting of the snow load, the live load, and the dead load for the roof construction.

The equation for the calculation of the characteristic snow load can be found in Eurocode 1 (EN 1991-1-3), and is given as:

$$s = \mu_1 \times C_e \times C_t \times s_k$$

Where,
s snow load on roof [kN/m²]
μ_1 snow load shape coefficient
C_e exposure coefficient
C_t thermal coefficient
s_k characteristic value of snow load on the ground [kN/m²]

The Norwegian Design Guides (SINTEF), specifies a characteristic snow load on the ground of 3,5 kN/m² in the Oslo area (SINTEF, 2003). The shape coefficient is derived from the shape of the roof, and can be determined in table 5.2 in Eurocode 1. The shape coefficient is consequently determined to be 0,8, as the angle of the roof is between 0 and 30 degrees. The exposure coefficient is in a similar way determined as set as the value 1,0 due to the nature of the site. In cases like ours, where the roof does not have a high thermal transmittance, due to the green roof, the thermal coefficient is considered to be 1,0.

Thus, $s = 0{,}8 \times 1{,}0 \times 1{,}0 \times 3{,}5 kN/m^2 = 2{,}80\ kN/m^2$

LIVELOAD:
Considering the nature of the roof of the building, being an publically accessible area, the live load becomes an essential element in the dimensioning of the structural system. The live loads can be determined according to DS 410, where the category C5 is chosen from table 3.1.1.7. The live load is determined as:

$$q = 5{,}0\ kN/m^2$$
$$\Psi = 1{,}0$$

Where,
q variable surface load
Ψ load combination factor

DEADLOAD:
The dead load consists of a set of permanent loads, which are affecting the beam, and consists of; the construction above the grid of beams, the green roof as well as the self-weight of the beam. The chosen type of green roof is categorized as an 'simple intensive' type, which can accommodate moderate types and sizes of vegetation. The typical saturated weight at a depth of 200mm of such a roof is estimated at an characteristic load of approximately $G_{k,1}$ = 2,4 kN/m² (GRO, 2014).

The characteristic load of the remaining elements, respectively for the concrete frames (beams) and the insulating layers together are determined as:

$$G_{k,concrete} = 9{,}26\ kN/m^2$$
$$G_{k,insulation} = 0{,}22\ kN/m^2$$

The total imposed dead load is found by adding the above together which gives an total dead load of 11,88 kN/m².

LOAD COMBINATIONS

The characteristic load is only applicable for structural analysis after one has calculated the relevant load combinations. A load combination is utilized when more than a single load type influences the structural system. To ensure the safety of a structure under various, extreme, load conditions, most building codes specify a number of scenarios (load combinations), together with different load factors for each of the load types. The factored loads are combined in order to determine the required strength of the construction, in which the largest of the load cases is chosen for the dimensioning of the structure. The following equation is derived from Eurocode 0 (DS/EN 1990).

$$E_d = \gamma_G \times G_k + \gamma_{Q1} \times Q_{k1} + \gamma_{Q2} \times \Psi_0 \times Q_{k2}$$

Where,

E_d	Design value of effect of actions
γ_G	Partial factor for permanent actions
G_k	Characteristic value of permanent action
γ_{01}	Partial factor for variable action
Q_{k1}	Characteristic value of the leading variable action
γ_{02}	Partial factor for variable action
Ψ_0	Factor for combination value of a variable action
Q_{k2}	Characteristic value of the accompanying variable action

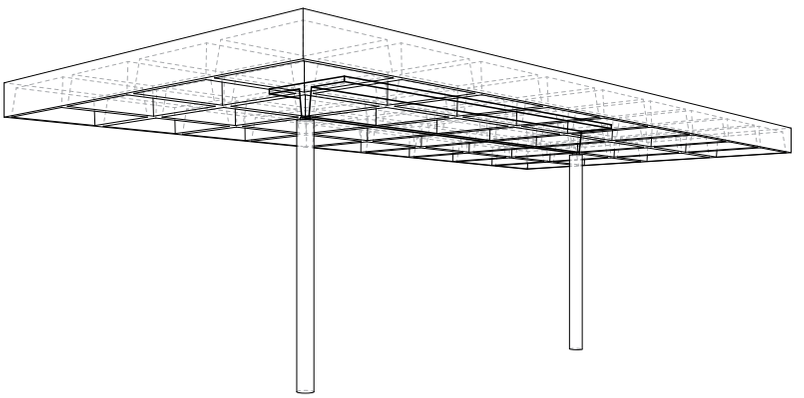
Calculation were made for the different scenarios, in order to determine whether the snow load or live load has the biggest impact on the structure as a dominating variable. In this case, as the roof surface is used as an outdoor exhibition space, the live load contributed with the most extreme load scenario, and is thus used as the dominating variable in determining the design value E_d.

Thus, $E_d = 24{,}09\ kN/m^2$

$E_d = 74{,}67\ kN/m$

$E_d = 5728{,}86\ kN$

The specific calculation for the various load scenarios can be found in the attached spreadsheet.



NOMINAL MOMENT STRENGTH - RC T-BEAM

These calculations will focus on the roof construction, consisting of a grid of continues in-situ cast concrete frames, supported where necessary by concrete columns. According to DS411, the reinforced concrete frames can be calculated as T-beams, considering that the structural system essentially can be seen as a grid of perpendicular beams, which are to be embedded into an above concrete slab. The area where the beam interacts with the above concrete slab is the described as the *flange* of the T-beam, while the bottom part of the beam is described as the *stem* or the *web*.

PREMISIS FOR THE CALCULATIONS

Chosen for the calculations is concrete C35 with a characteristic compressive strength of 35 MPa and a maximum aggregate size of 32 mm. For the reinforcement, it has been chosen to use Ø25 steel bars with a characteristic yield strength of 550 MPa, where the allowance of tolerance for the cover is set at 5 mm. For the calculations of the beam, the maximum span is set at 15,5 meters, with a beam c/c at 3,1 meters. The total imposed lineload on the beams is calculated as 75 kN/m as seen in the attached spreadsheet.

Thus,

f_{ck}	$35\ MPa$
f_{yk}	$550\ MPa$
d_g	$32\ mm$
q	$75\ kN/m$
l	$15{,}5\ m$

CALCULATION OF THEDESIGN VALUE FOR THE APPLIED INTERNAL MOMENT

According to Teknisk Ståbi, 3.2.2 (Jensen, 2011) the formula for determining the design value of the applied internal bending moment for simple supported beams can be determined by the following formula:

$$M_{ed} = \frac{1}{8} \times q \times l^2$$

Where,

M_{ed}	the design value of the applied internal moment
q	the total imposed load
l	the span of the beam

Thus,

$$M_{ed} = \frac{1}{8} \times \left(0{,}5 * \frac{75kN}{m}\right) \times 15{,}5m^2$$

$$M_{ed} = 1126\ kNm$$

The total imposed load *q* is divided by two as the forced distribute in two directions due to the grid construction of the roof – thus dividing the distributed loads in half.

DETERMINING THE CROSS-SECTIONAL CONFIGURATION OF THE T-BEAM

Based on grid structures and general measures of other elements in the building, the stem width of the beam is determined to be 300 mm. The thickness of the concrete slab, and thus the height of the flange, is set as 150 mm. According to DS411 the effective flange width of the beam can be found by:

$$b_{eff} \leq\ b_w + 2 \times 8 \times h_f$$

Where,

b_{eff}	the effective flange width
b_w	the width of the stem
h_f	the height of the flange

Thus,

$$b_{eff} \leq 300mm + 2\ \times 8 \times 150mm$$

$$b_{eff} \leq 2700mm$$

Due to the c/c of the beams, the maximum width of the flange is 3100 mm, and the effective flange width of 2700mm is thus considered a plausible dimension.

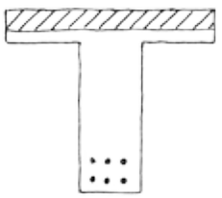
ANALYSIS OF NOMINAL MOMENT STRENGTH FOR FLANGED SECTIONS

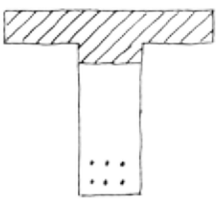
For the analysis of the flanged section, Whitney's stress block have been used to model the distribution of concrete compression stresses (Wight and MacGregor, 2012). This approach does only apply for compression zones with constant widths, and is therefore inappropriate to use if the depth to the neutral axis, c, exceeds the height of the flange, h_f. As it for the most part is the case that the effective depth of Whitney's stress compressive stress block, *a*, is less than or equal to the thickness of the flange, h_f, it is the recommended approach to assume this for the calculations. Should the stress block prove to exceed that of the flange height, one has to proceed to a form of calculation that the one presented in the following. Firstly it is assumed that the stress block is less or equal to the flange height, and that the tension steel is yielding.

Assume,

$$a \leq h_f$$

$$\varepsilon_s \geq \varepsilon_y$$





Where, a Whitney's compressive stress block
ε_s strain in reinforcement
ε_y tensile yield strain for reinforcement

Whitney's compressive stress block is calculated through the following:

$$a = \frac{A_s \times f_y}{0{,}85 \times f_{cd} \times b_{eff}}$$

Where, A_s the area of reinforcement
f_y the specified yield strength of reinforcement
f_{cd} the specified compressive strength of concrete
b_{eff} the effective flange width

Thus, $a = \frac{3927mm^2 \times 458{,}33\ MPa}{0{,}85 \times 25\ MPa \times 2700mm}$

$$a = 31{,}4mm$$

Thus, $a = 31{,}4 \leq h_f = 150mm$

The calculation above proves that Whitney's compressive stress block is less than the height of the flange, making the width of the compression zone constant, and thus the following approach can be used be find the nominal moment strength. Before continuing though, we have to confirm that $\varepsilon_s \geq \varepsilon_y$, this is done by:

$$\varepsilon_s = \left(\frac{d-c}{c}\right) \times \varepsilon_{cu} \qquad \text{and} \qquad c = \frac{a}{\beta_1}$$

Where, d effective depth, distance from the extreme compression fiber to the centroid of the tension reinforcement.
c distance from the extreme compression fiber to the neutral axis.
ε_{cu} maximum useable compressive strain for concrete
a Whitney's compressive stress block
β_1 0,85 for $f_{cd} \geq 28$ MPa

$$\varepsilon_y = \frac{f_{cd}}{E_s}$$

Where, f_{cd} the specified compressive strength of concrete
E_s module of elasticity of reinforcement

The above equations is now used to calculate the difference values and finally determining the nominal moment strength for the flanged section in positive bending:

$$c = \frac{31{,}4mm}{0{,}85}$$

$$c = 36{,}9$$

The calculation of the effective depth, *d*, the maximum useable compressive strain for concrete, ε_{cu}, and the module of elasticity for steel, E_s, see the attached appendix.

$$\varepsilon_s = \left(\frac{926-36{,}9}{36{,}9}\right) \times 0{,}08 = 1{,}9268$$

$$\varepsilon_y = \frac{458{,}33}{200000} = 0{,}00229$$

Thus, it is hereby proven, that the two values meet the expectations of what we firstly assumed to be true.

$$\varepsilon_s = 1{,}9268 \geq \varepsilon_y = 0{,}00229$$

We can therefore continue to the calculation of M_{rd}

$$M_{rd} = A_s \times f_{yd} \times \left(d - \frac{a}{2}\right)$$

$$M_{rd} = 3927mm \times 458{,}33 \times \left(926 - \frac{31{,}4}{2}\right)$$

$$M_{rd} = 1638{,}15\ kNm$$

Thus, it is hereby proven that the nominal moment strength for the flanged section is satisfactory in relation to the applied moment, as:

$$M_{rd} = 1638{,}15\ kNm > M_{ed} = 1126\ kNm$$

MAXIMUM DEFLECTION - RC T-BEAM

In the following section, it will be demonstrated whether the requirement for the maximum deflection of the flanged beam is met. According to DS411 the maximum deflection of the beam is determined relative to the span of the beam.

$$u_{max} = \frac{l}{400}$$

Thus, $u_{max} = \frac{15500}{400} = 38{,}75\ mm$

In order to calculate the deflection of the beam it is necessary to know the modulus of elasticity of steel, which is given by the following formula.

$$E_c = 35700\ MPa\ \times \frac{f_{ck}}{f_{ck}+13}$$

Where, E_c is the module of elasticity of concrete
f_{ck} is the characteristic compressive strength of concrete

Thus, $E_c = 35700\ MPa \times \frac{35\ MPa}{35\ MPa+13} = 26031{,}3\ MPa$

To determine the maximum deflection u_{max}, it is necessary to know the value k, the bending moment M and the transformed moment of inertia I_t. The formula for the transformed moment of inertia for the T-beam is given by:

$$I_t = \frac{1}{12} \times b \times {h_f}^3 + (b \times h_f) \times \left(h_1 + \frac{h_f}{2}\right)^2 + \frac{1}{12} \times b_w \times {h_1}^3 + (b_w \times h_1) \times \left(\frac{h_1}{2}\right)^2 + A_{s_t} \times c^2 - \sum A \times \bar{y}$$

Where, $\bar{y} = \frac{\sum \bar{y} A}{\sum A}$

Where, $\sum \bar{y} A = (b \times h_f) \times \left(h_1 + \frac{h_f}{2}\right) + (b_w \times h_1) \times \left(\frac{h_1}{2}\right) + (A_{s_t} \times c)$

Where, $\sum A = b \times h_f + b_w \times h_1 + A_{s_t}$

Where, $A_{s_t} = (\propto -1) \times A_s$

Where. $\propto = \frac{E_s}{E_c}$

Where,
A_s the area of the reinforcement
A_{s_t} the transformed area of reinforcement
E_s the module of elasticity of steel
E_c the module of elasticity of concrete

Thus, $\propto = \frac{200000}{27115{,}9} = 7{,}38$

$A_{s_t} = (7{,}38 - 1) \times 3927 = 25037{,}5$

$\sum A = 2700 \times 150 + 300 \times 850 + 25037{,}5 = 685037{,}5\ mm^2$

$\sum \bar{y} A = (2700 \times 150) \times \left(850 + \frac{150}{2}\right) + (300 \times 850) \times \left(\frac{850}{2}\right) + (25037{,}5 \times 35) = 483876313\ mm^3$

$\bar{y} = \frac{483876313}{685037{,}5} = 706{,}35$

$I_t = \frac{1}{12} \times 2700 \times 150^3 + (2700 \times 150) \times \left(850 + \frac{150}{2}\right)^2 + \frac{1}{12} \times 300 \times 850^3 + (300 \times 850) \times \left(\frac{850}{2}\right)^2 + 25037{,}5 \times 35^2 - 685037{,}5 \times 706{,}35$

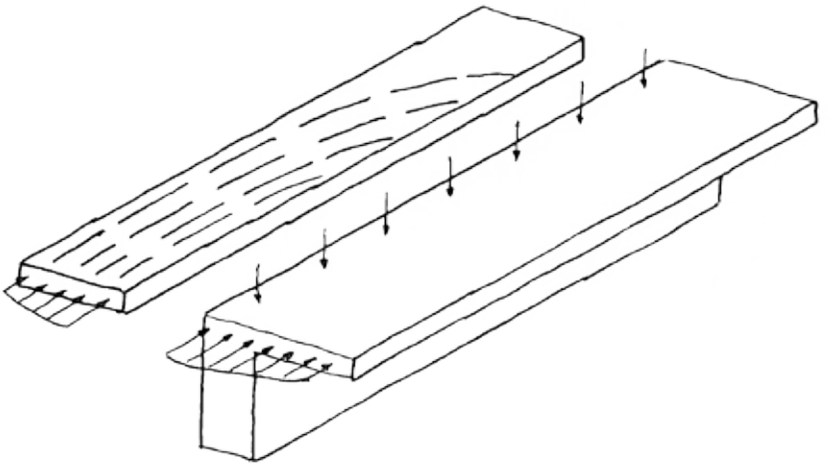
$I_t = 6{,}434 \times 10^{10}$

After determining the transformed moment of inertia, the value k can now be calculated by the following formula:

$$k = \frac{M_{ed}}{E_s \times I_t}$$

$$k = \frac{1126}{200000 \times 6{,}434 \times 10^{10}}$$

$$k = 8{,}752 \cdot 10^{-8}$$



It is now possible to calculate the maximum deflection of the beam.

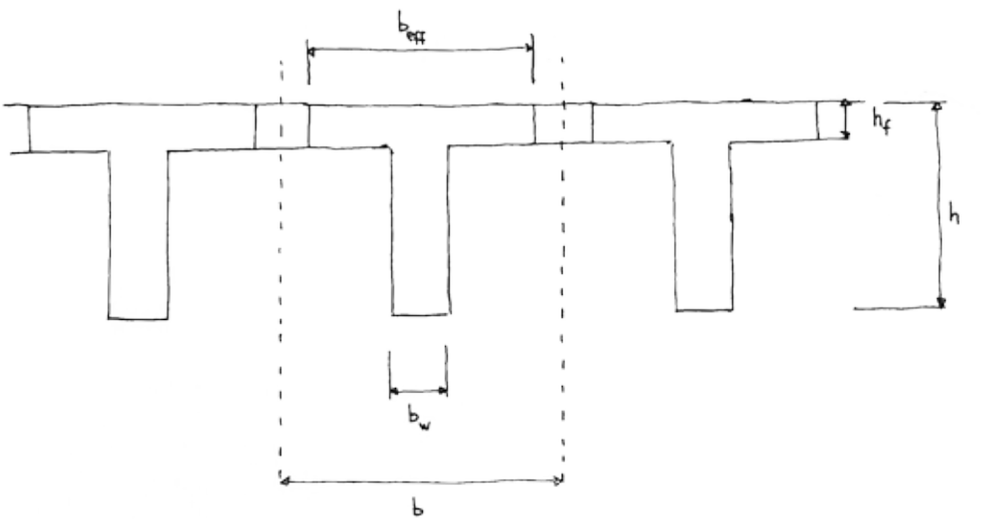
$$u_{max} = \frac{1}{10} \times k \times l^2$$

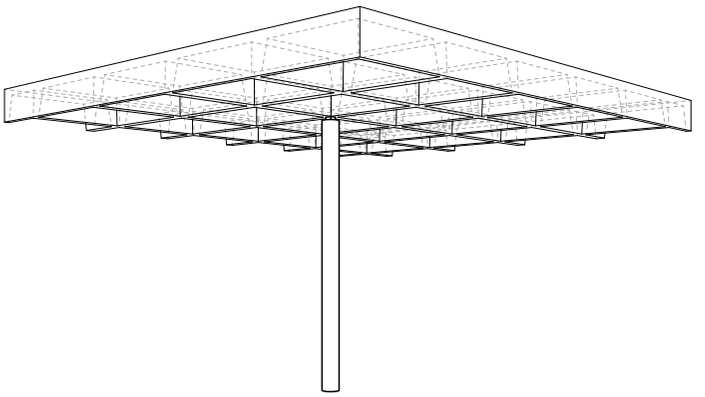
Thus, $$u_{max} = \frac{1}{10} \times 8{,}752 \cdot 10^{-8} \times 15500 mm^2$$

$$u_{max} = 2{,}1\ mm$$

Thus, $$u_{max} = 2{,}1\ mm\ < 38{,}75\ mm$$

As the maximum theoretical deflection allowed was determined to be 38,75 mm according to DS411, it is hereby demonstrated that the actual deflection is satisfactory according to the claim made in DS411.





NOMINAL MOMENT STRENGTH - COLUMN

The following analyzed column have a calculated related length $l_0 = l$ of 8 m with a cylindrical section with a radius of 275 mm. Chosen for the calculation is a concrete C35 with a characteristic compressive strength of 35 MPa. For the reinforcement steel, it has been chosen to use steel with a characteristic yield strength of 550 MPa, counting a total of 12 steel rods, each with a diameter of Ø25 mm. The combined point load on the specific column, amounts to a total of 5728 kN. The calculations of this specific load can be found in the attached spreadsheet.

The calculation of the value for the specified compressive strength of concrete is found through:

$$f_{cd} = \frac{f_{ck}}{\gamma_c}$$

Where,
f_{cd} the specified compressive strength of concrete
f_{ck} the characteristic compressive strength of concrete
γ_c partial coefficient - in-situ cast concrete , normal control class

Thus, $f_{cd} = \frac{35\ MPa}{1{,}45} = 24{,}14\ MPa$

The specified yield strength of the reinforcement is found through:

$$f_{yd} = \frac{f_{yk}}{\gamma_s}$$

Where,
f_{yd} specified yield strength of reinforcement
f_{yk} characteristic yield strength of reinforcement
γ_s partial coefficient for steel

Thus, $f_{yd} = \frac{550\ MPa}{1{,}20} = 458{,}33\ MPa$

The reinforcement ratio ρ must satisfy, $0{,}2\% < \rho < 4\%$ with the value ρ found through:

$$\rho = \frac{A_{sc}}{A_c}$$

Where,
ρ the reinforcement ratio
A_{sc} the cross section of reinforcement
A_c the cross section of the concrete

Thus, $\rho = \frac{5890{,}49mm^2}{231692{,}46mm^2} = 2{,}54\%$

Additionally, another condition has to be satisfied relating to the slenderness ratio, λ, of the column, which is must satisfy that $\lambda < 90$, the slenderness ratio can be found through the following:

$$\lambda = \frac{l}{i}$$

Where,
λ the slenderness ratio
l column length
i radius of inertia

The radius of inertia for the column in unknown, though can be calculated through the following formula:

$$i = \frac{h}{\sqrt{12}}$$

Where,
h the height (diameter) of the column

Thus, $i = \frac{550mm}{\sqrt{12}} = 158{,}77mm$

The radius of inertia is now used to calculate the slenderness ratio of the column.

$$\lambda = \frac{8000mm}{158{,}77mm} = 50{,}39mm$$

Thus, as $\lambda = 50{,}39 < 90$, the column is proven to be satisfactory in term of the slenderness ratio.

The critical tension for the concrete is found using Ritter's formula, a rewriting of Engesser's 1st column theory, where the column is seen as influenced be a central load. The formula is given by:

$$\sigma_{cr} = \frac{f_{cd}}{1 + \frac{f_{cd}}{\pi^2 \times E_{c0k}} \times \left(\frac{l_0}{i}\right)^2}$$

However, instead of using E_{c0k} the value is often replaced with that of E_{0crd} in order to apply a careful value for the module of elasticity. Thus, a special value is applied in relation to calculations of stability. In case of a practical dimensioning, table values are implemented, which can be found in table 5.14 in Teknisk Ståbi (Jensen, 2011). The following value have been derived from table according to the use of concrete C35.

Where, $\frac{f_{cd}}{\pi^2 \times E_{0,crd}} = 1{,}3 \times 10^{-4}$

The above value is now used to calculate the critical tension:

$$\sigma_{cr} = \frac{24{,}14\ MPa}{1{,}3 \times 10^{-4}} = 18{,}15\ MPa$$

Likewise, the tension in the reinforcement is calculated, with the value of α, found in table 5.14 in Teknisk Ståbi, is dependent on the choice of concrete.

$$\sigma_s = \alpha \times \sigma_{cr} = 19 \times 18{,}15 = 344{,}81\ MPa$$

The loadbearing capacity of the concrete can then be calculated as follows:

$$N_c = \sigma_{cr} \times A_c = 18{,}15\ MPa \times 231692{,}46 mm^2 = 4311{,}69\ kN$$

Likewise, the loadbearing capacity of the reinforcement is found:

$$N_s = \sigma_s \times A_{sc} = 344{,}81\ MPa \times 5890{,}49 mm^2 = 2031{,}13\ kN$$

The above values should now meet the following demands of:

$$N_s < 0{,}5 \times N_c = 2031{,}13\ kN < 0{,}5 \times 4311{,}69\ kN$$

Thus, $2031{,}13\ kN < 2155{,}85\ kN$

The final loadbearing capacity of the concrete column is thus,

$$N_{cr} = N_c + N_s$$

Thus, $N_{cr} = 4311{,}69\ kN + 2031{,}13\ kN = 5728{,}86\ kN$