Maritimt Vitensenter

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Abstract

The master thesis outlines a design proposal for a new maritime science centre at the West Coast of Norway near Stavanger. As a science centre the aim is to attract new talent to the maritime sector in Norway, which has for long been standing in the shadow of the oil-industry. To do so the centre seeks to further develop the concept of a science centre as a platform for knowledge by incorporating research and education on top of the exhibition. The aim is further strengthened by the placement of the building on the site, and working with the relation to the landscape in a New Nordic understanding of place and identity.

Maritimt Vitensenter

English title:	Maritime science centre
Theme:	Nordic Architecture
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Project module:	MA-Thesis 2015
Project period:	2nd of February 2015-27th of May 2015
Group:	Arc08
Semester:	MSc04 Arch
Supervisors:	Peter Mandal Hansen Lars Damkilde
Number of pages:	142
Number of prints:	4
Attachments:	Drawings, Cd

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Content

Introduction

This master thesis is developed at the Department of Architecture and Design at Aalborg University in accordance to the studyguide of MSc04. It represents my final architectural project, and aim to create an integrated design solution to a Maritime science centre at the Norwegian Westcoast, north of Stavanger.

Motivation

Since the oil prices almost halved in the second half of 2014, many Norwegian commentators have called for a need to start preparing for times where the oil-economy can no longer be a dominant sector. There is a need for change in the way that universities and sectors plan and innovate for the future, a need to focus on a wider field of opportunities. (Haugstad 2015) In the region of Stavanger, where the main part of the oil industry is focused, recent reductions in staff has been severe. In total reductions of more than 9500 people are planned in the oil sector (Skarsaune 2015). These are labour based jobs as well as highly qualified engineering jobs.

At the same time the maritime industries have experienced growth in the last 10 years. Ranging from coastal navigation to fish-farming this is one of the most diverse sectors in the Norwegian economy. This diversity is unique to Norway and it offers a potential which the government seeks to further develop as part of their strategy. (regjeringen.no)

Where young people, who chose to study in the field of exploiting natural resources, where earlier certain to get a well paid job afterwards, last year was the first year when graduates were not already employed as they left university. (Skarsaune 2014) In relation to this there lies a potential in making the maritime sector more visible as an important sector with jobs and exciting potentials in the years to come.

On the subject of choosing education, a survey among University students in Norway, revealed that science centres offering infotainment to children and young people, have a greater impact on choice of education than commercials and educational advisors. (Program 2014)

Therefore, a maritime centre of knowledge, offering an informing and entertaining insight into the maritime sectors and services, can be an important initiative in preparing Norway for the future. While maritime museums exists in Stavanger and on the coast of Norway, no institutions offer this combination of accessible knowledge and hands-on experiences.

Objective

The architectural objective is to create a place that connects land and sea, while providing a frame for interesting and engaging learning-environments.

The building should accommodate both primary and backstage functions relevant to the exhibition part. Furthermore, spaces which can be used in educational situations, but also for other purposes such as private functions and conferences, are an important part.

Methodology

The method of the project creates a base for an academic approach and ensures a comprehensive and thorough process. As a framework for the project the integrated design process by Mary Ann Knudstrup is used as a method (Knudstrup, 2004). This method is developed at Aalborg University in order to describe the iterative processes necessary to reach a design outcome which can fulfil the aim of being not only aesthetically, but also functionally and technically pleasing. By incorporating these themes and demands as parameters early on in the design process an integrated design solution can be reached. The process is split into five phases; a process of iterative loops between, and a variation of methods utilized through the phases, ensures a methodological triangulation where different scientific theoretical methods in the field of architecture and engineering are applied. It is the intention that the project will use a phenomenological approach in the areas where this is applicable.

"A great building must begin with the unmeasurable, must go through measurable means when it is being designed and in the end must be unmeasurable" (L.Kahn).

Problem phase

In this phase a hermeneutic document analysis creates a framework for the further understanding. A critical investigation into the notions of Tectonic and Nordic architecture is done, in order to form a point of departure for further development of the project. Likewise the brief from the original competition is analysed, to create an understanding for what the clients wish for the building and its functions, in a wider context.

Analysis phase

Along with the problem phase the Analysis phase sheds a light on the given constants forming the basis of the project. In this phase the site, the geographical context, the cultural context, and examples of build works, which address parts and bits of the scope of this particular project, is analysed. The analysis uses both hermeneutic document analysis, thorough phenomenological studies, as well as analysis of weather data, topography etc. Since the Experience of the site is of particular importance in the notion of Nordic architecture, a method for experiencing and mapping on site is developed in order to form a basis for further work in the sketch phase.

Sketch phase

The sketch phase seeks to incorporate potentials and challenges seen through the previous phases and create bits of meaning which can start to inform a design. The tools used to ensure an integrated design process is a mixture of analogue and digital tools. Hand sketching and physical models are supplemented with digital representations and tools learned through the course "performance-aided design" at the 1st semester at the Master of Science program. Likewise, the different methods of architectural representation such as plan, section, perspective, detail etc. are used to investigate the qualities of the designs. Since this is a thesis project a particular emphasis is also put on the ability to use immediate impressions of an idea based on intuition, experience and accumulated knowledge, rather than reason and measurable qualities to select between different proposals. "I'm actually looking for the naïve moment in the first encounter .. the first impressions, the naïve impressions, they're really genuine." (Zumthor, in Lousiana 2012, p.66)

Synthesis phase

In this phase the solutions found through the sketch phase is sought put together to form a unique and expressive work which encompasses as many of the potentials and visions found through the initial phases as possible. Atmosphere and the bodily experience of the building is essential, and iterative loops between the sketch phase and synthesis phase in all scales should support an experience of the finished project as a 'whole'.

Presentation phase

In this final phase the finished project is presented through various architectural means of presentation seen as appropriate to convey the atmosphere and experience of the final proposal. The presentation material should emphasize the project for its aesthetic, functional as well as technical qualities.

Analysis

Framework

Programme

Place

Vision

Framework

To create a common ground of understanding and a point of departure for the project, the notions of Nordic and tectonic is introduced, discussed, and a position is taken. Case studies are done in relation to create an understanding of what these themes potentially can generate when it comes to built form.

Norwegian building

The project is situated in Norway and the Norwegian perspective on the Nordic tradition is therefore of the essence to the understanding of local building traditions and societal values.

Sverre Fehn
As a long practising Norwegian architect, Fehn has made extraordinary contributions to what is understood as Nordic architecture. The following is based on an interview with S. Fehn from 2010 and seeks to point out some of the potentials of building in Norway.

Relation to nature
In Norway wild nature is the norm, opposite many other places in Europe where most trees are probably planted by man. The Norwegians have come to take this for granted. When building a new house, often the site will first be cleared, cultivated, and then the project starts.
Fehn emphasises that there is a relation between nature and man, and between nature and architecture. The relationship between nature and man, in Norway, is an active one. It is based on escapism and the way the Norwegians use nature to go skiing, hiking, climbing etc. In this tradition the beautiful is not nature itself but, the act that happens between nature and man.
The relationship between the man-made, architecture, and nature has according to Fehn not been highly developed in the Norwegian tradition. In Japan there is a tradition for cultivating and creating an aesthetic relation between architecture and nature, Fehn says. In these cultures, nature has been raised to a philosophy. Architecturally it can be the way openings frame certain views of the nature or the way you step down onto the ground. In Fehn's opinion the Norwegian culture for buildings is not nearly as sophisticated. It is much more simple and less philosophical, partly because Norway has been a poor country for most of its existence.
Furthermore Fehn mentions a tendency created by urbanisation and modernisation in Norway. Where most people used to be farmers, fishermen or in other ways work with and live off of nature, the modern Norwegian relationship to nature has been degraded to an aesthetic rather than a practical one. People no longer have a feeling for the practical uses of nature, and therefore the aesthetic appreciation has taken over the practical. (Almaas 2010)

Ill. 11 Nordic pavilion in Venice by Sverre Fehn

Nordic identity

The Nordic architecture as a style has in several turns been subject to international attention, with masters such as Aalto and Utzon making their architectural mark on the world. In 2012 an exhibition at Louisiana showcased and discussed how a Nordic architecture and identity can be defined in the globalized world of today.

Genius Loci and critical regionalism

In 1979 The Norwegian architect Christian Norberg Schultz introduced the notion of 'Genius Loci' – a sense of place, as a reaction towards the international style represented in modernism. It represents an architectural focus on place and geography, and puts the architect in the role as the interpreter of place Place is seen as an objective constant which will reveal its secrets and richness to us if we open up and listen to its spirit. Later he especially emphasizes the role of light as crucial in the north, he speaks of a space of moods created by the light of the Nordic countries. (Norberg-Schultz 1996)(Louisiana 2012)

Around the same time the theory of Critical regionalism is formed and a concept of 'Placeform' is introduced by Kenneth Frampton, stating that the language of the architecture to a greater extent should make use of the local materials and construction techniques. This theory puts more emphasis on the role of the architect as someone who stages the quality of a place for human perception. (Louisiana 2012) An important figure in this context is Alvar Aalto, on whom Frampton wrote a full chapter in his book "Modern Architecture – a critical history". Aalto as a key figure in the development of the Nordic architectural style, has a very humane approach to creating architecture. "To make architecture more human means a better architecture, and it means a functionalism much larger than the merely technical one. This goal can be accomplished by architectural methods - by the creation and combination of different technical things in such a way that they will provide for the human being the most harmonious life" (by Aalto in Frampton 2007 p. 199).

Materialism

In 2007 Frampton writes an addition to the before mentioned book, in which he tries to lay out 6 categories in which the recent architectural trends can be discussed. Materialism as a category is strongly represented in the works of Peter Zumthor and to an extent Herzog & de Meuron. Zumthor, who is often mentioned to work in the framework of the place specific, with a focus on local materials and traditions, is often connected to the Nordic tradition despite being Swiss of nationality. On the use of materials as a conveyor of architectural meaning Frampton says: "Irrespective of whether they happen to be used as cladding or as structural form, traditional materials such as brick, stone and wood are cultural constructs whose implicit significance may readily be associated with a particular landscape, national character, or ethical value." (Frampton 2007, p. 370.) and; "Materials are appreciated for the qualities they represent … rather than their inherent physical qualities" (Morovansky in Frampton 2007, p. 370).

Architecture reflecting society

A quality often associated with Nordic architecture is its reflection of a society with a fairly flat hierarchy between citizens and its institutions. One of the most successful Norwegian architects lately, Kjetil Trædal Thorsen of Snøhetta, says about that: "The best and most popular architecture always has an element of sound social democratic ideology; buildings should be as public as possible. In my view, the ideal is a building with many different entrances an unlimited accessibility, like a park. I'm talking here about the horizontality of architecture, about generosity, openness towards the users. Public buildings take up a lot of space, and so they should" (Carlsen 2010 p. 97).

New Nordic identity

In opposition to the critical regionalism and place thinking of Norberg-Schultz a new notion of Performative regionalism by Barbera Allen appears, this theory states that place is a result of its culture as well as geography. Allen defines culture as the interaction between humans and between humans and landscape in an ongoing process of experience. This means that humans are at the centre stage, and place appears as a social construct (Lousiana 2012 p. 42).

In the modern world of globalization, a constant sampling and borrowing from other cultures is taking place. As an antithesis to globalization an intensified focus on identity, the local, and a connection to nature has been part of making the Nordic popular again. In relation to this architecture can be an important carrier of identity (Louisiana 2012). "..maybe the question of identity comes down to destinctiveness; that something is recognizable, has character and is a bit different from something else. … I think there is character in good architecture. It creates place, place that you can relate to, and this produces identity." (Zumthor in Lousianna 2012 p. 72)

I opposition to the traditional understanding of Nordic architecture as something that was subordinate to its place, the table has suddenly been turned, and the architecture can now be an important player in defining the place as well as its identity. Architecture has the potential to frame and exhibit time and culture, and be a constant in a dynamic globalized world. As Zumthor describes it Architecture must be "a tribute to the landscape", rather than merely subordinate to it. (Zumthor in Lousianna 2012 p. 69)

Ill. 13a Tverrfjellhytta by Snøhetta, a small lookout pavilion for experiencing wildlife

Ill. 13b Oslo Operahouse by Snøhetta, the roof is a public plaza making this cultural building 'belong' to the people

The notion of tectonics originates from the greek word 'tektōn' meaning carpenter or builder (oxforddictionaries.com). It is a term which has been widely discussed in architectural theory for more than a hundred years now, and with a variety of definitions to follow. The following offers a take on an essential approach to tectonics and how it can be incorporated in the project in order to ensure an architectural unity between the three pillars of architecture defined by Vitruvius; firmitas, utilitas, venustas – that is, it must be solid, useful, and beautiful.

Semper and Frampton

In 1851 Gottfried Semper published the essay "Die vier Elemente der Baukunst". It took a newly discovered Caribbean hut as an ethnographic basis from which to deduce the four primordial elements of all building culture. These were: (1) the elevated podium or earthwork on which the hut rested; (2) the framework and the roof, which provided the basic shelter; (3) the woven infill wall, which protected the hut from the elements; and finally, (4) the heart, which was not only the source of heat and food and the focus of social intercourse, but also the symbolic societal core, presaging the eventual emergence of spiritual and civic form (Frampton 2007). Frampton further emphasizes the related opposition of roofwork and earthwork as a conceptual frame in which to analyse architectural works.

Frampton himself has written about tectonics as well, and have defined the need for an authenticity in the built environment. He emphasizes how a building is first and foremost a construction, and only later an abstract discourse based on surface, volume and plan. To Frampton a building must, in order to be truly tectonic, utilize the expressive potential of the constructional technique rather than simply reveal it (Frampton 2001).

Frascari and the art of joining

In the sense of constructional technique the interesting and challenging place of design often happens where things meet. Where column meats beam, and beam meets post. Where solid construction meets filigree construction, and where materials overlap. In relation to this, Marco Frascari wrote in 1984 an essay on the art of joining in which he says: "Details are much more than subordinate elements; they can be regarded as the minimal units of signification in the architectural production of meanings" (Frascari 1984 p. 23). As such the detail can tell a story, or a 'tale', of the building as a whole by being the recognizable pattern in a building volume, which usually incorporates many different functions in its typology, being it a home, a school or a museum etc. He further argues that the details are more than merely physical construction: "In architecture, feeling a handrail, walking up steps or between walls, turning a corner, and noting the sitting of a beam in a wall, are coordinated elements of visual and tactile sensation. …" (Frascari, p7, 1984)

This way of defining the detail as the minimal units in the architectural production of meaning, but also an important part of how one experiences the atmosphere of the spaces, is intriguing. If one defines the atmosphere as the bodily feeling which is the result of all the senses, including visual, tactile, auditive, and other sensory recordings (Pallasmaa 2012). Then the details, materials and these transitions become essential in the way architecture affects human beings.

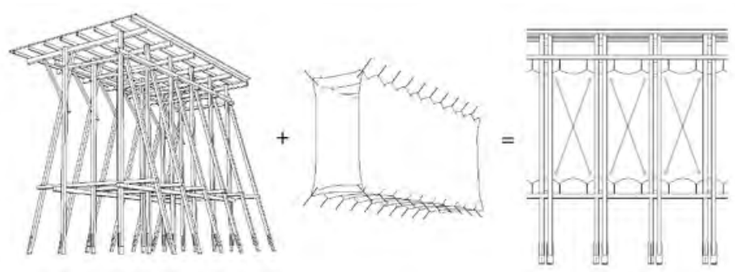
Tectonics in the 21st-century

In the building industry of today the process of building, has become much more complicated than when Semper formulated his theories in 1851. Today a larger variety of professions, from architects to engineers, and specialized craftsmen makes the process ever more complicated. Likewise, the owner or developer is rarely a single person, and often has advisors of their own. On top of this, materials and construction techniques are becoming ever more specific and optimized for different purposes, requiring specialized craftsmen and engineering knowledge. (Beim 2004)

This process puts the architects as the generator of meaning and concept in an ever more demanding position. In order to be successful and carry the design ideas through from concept to finished building, the architect is now required to have a general knowledge of many fields beyond his specialized knowledge. This is true for the tectonic vision as well as other intents which are part of the architectural concept. A closer collaboration and mutual interest between architects and engineers can be a solution to how architectural intents and tectonic visions can be preserved throughout the process. Advancements in technology should potentially also offer new and more approachable ways of designing while meeting demands of energy consumption, structural firmness and so on. Ultimately a more integrated design process is desirable, if the initial intentions shall be relevant throughout the process.

In the later years new digital technologies of designing and fabrication have again raised the discussion of what tectonics can be and whether these new tools offer a new way of thinking tectonics. In this project the digital tools will be incorporated as a part of the integrated design process. This will enable the tectonics of the structure to be visualized by ensuring correct dimensions and likewise in the continuous development of the architectural expression. These tools enable one to work integrated with the structure and helps visualize the atmospheres, which the tectonic expressions must support and be part of creating. Atmospheres which should essentially end up providing the architecture with an identity of its own.

Ill. 15a Steilneset Memorial by Louise Bourgeois(left) and Peter Zumthor(right)



Ill. 15b Situated in an Arctic climate, the memorial is elevated from the ground and the structure, roof and climate shield are separated.

Initial case studies

In order to see how the notion of Nordic and new Nordic architecture can be interpreted into built architectural form, a case study is done. This exemplifies some of the theory discussed in the previous chapters about how place, atmosphere, culture and identity are connected.

National Tourist Routes of Norway

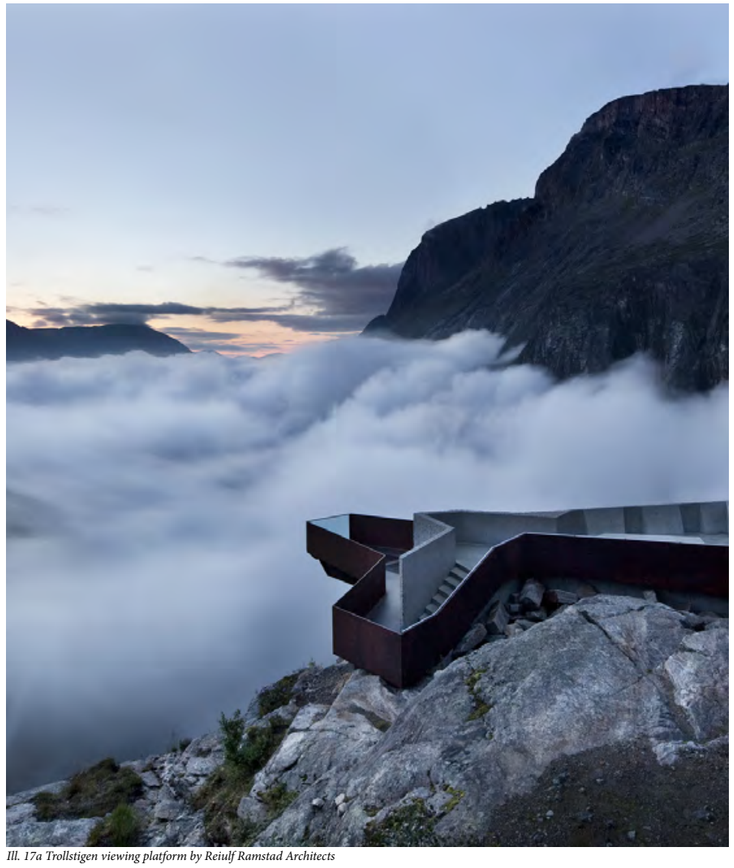
A nationwide project that seeks to corroborate the intimate link between nature, place and Nordic architecture through developing 18 routes which takes the visitor through some of the most diverse and scenic places in Noway. Common for these projects are that they become part of the place and its identity while addressing atmosphere and human interaction in their own individual ways.

Framing nature

The two projects of Trollstigen and Sohlberplassen are examples of lookout points along these routes. In these two projects the architecture stages the relation to nature and tastefully creates a platform for experiencing it - like a postcard.

These projects represent the more traditional way of understanding place and architecture in an aesthetic perspective. The materials relates to the raw tactility and expression of the rocks and cliffs, and the detailing responses to that of the surrounding nature. Where Trollstigen chooses to imitate the landscape in its formal language using prismatic cut geometric shapes, Sohlbergplassen hovers over the landscape and seems to be shaped around the existing nature. This hovering and duality between a connection and dissociation to the immediate environment creates a strong experience of the forest, which in it self is not distinctive from any other forest.

Ill. 16 Sohlbergplassen by Carl-Viggo Hølmebakk



Ill. 17a Trollstigen viewing platform by Reiulf Ramstad Architects

Framing an interaction

Nappskaret takes a different approach to the task of creating a place and an experience. Instead of focusing on the view itself the walk to get there and the interaction with the architecture becomes the experience. Even though the materials and the detailing is not directly responding to the place, there are some under laying layers of information. For example the yellow colour is taken from the beak of the Black-backed gull, a common bird in the area. And in doing something like this the architecture becomes part of the experience by both showing the way an encouraging the users to interact with it on the way. (Lousiana 2012 p. 113)

Ill. 17b Nappskaret by Jarmund Vigsnæs Architects

Programme

Basis for further development of the project is the original competition programme issued in 2014. The Brief is analysed and the function and typology is further investigated through general literature and case studies. Finally a room programme is defined, based on the competition brief and own observations.

Ill. 18 The sea off of the site

Brief analysis

The project brief was made in relation to the competition for a new maritime centre of knowledge held in the autumn of 2014. A large part of the Norwegian population live in close proximity to the sea, and as such the sea is often associated with recreational activities. But the Norwegian Sea is also one of the main places of employment and one of the most important sources of income. The interrelation between the activities at sea and on land has in many ways created a culture which defines the modern Norway. (Program 2014)

Function

The science centre will have three main themes: Coastal navigation, aquaculture, and marine industry. On top of communicating these themes which all have the sea and the coastline in common, the centre must also function as place of gathering for conferences, cultural events, and private functions.
As a science and learning centre the brief uses the following definition: "A science centre is a popular scientific recreation- and learning centre in the fields of mathematics, science and technology where visitors learn by experimenting themselves. In a Science centre children and adults can explore phenomena related to nature, the environment, health and technology through their own activities and in collaboration with others" (Program 2014 p. 8).

Besides the function as a science centre the institution will also serve as a museum and as such also attend the basic museum tasks, such as collection, preservation, research and dissemination.

Users

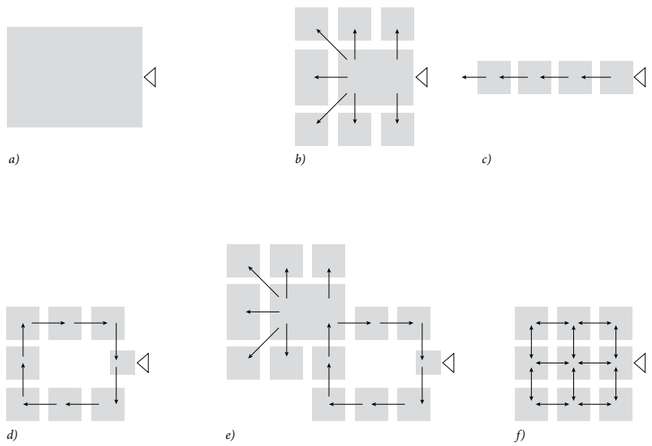
The learning centre seeks to target children and young people who still have not chosen their path of education. "In a Norwegian survey amongst freshmen in science at universities and colleges 20% answers that science centres has inspired or motivated their educational choices. Science centres were stated as a more important factor than counsellors at schools and advertising campaigns. This science centre may therefore be a recruiting institution to the maritime industry" (Program 2014 p. 9).
Along with children and their parents/grandparents the centre must also accommodate other users in relation to private and cultural functions, the employees, and the scientists who have their daily life at the centre.
The estimated visitor count is 50.000 per year. (Program 2014)

Architectural intent

The program calls for a distinctive architectural work, which simultaneously fits into the natural surroundings between land and sea. (Program 2014)

Museum & science centre architecture

The maritime centre of knowledge is a mix of a museum and a learning centre. In order to investigate the public institutions it is relevant to see how museums have previously been organized and what demands and functions such an institution typically has to meet.



Ill. 20 Genetic plans for exhibition areas: a) open plan, b) core+satellites, c) linear procession, d) loop, e) complex, f) labyrinth (Adler 1999)

Museum architecture

Institutional role

Museum: An institution devoted to the procurement, care, study, and display of objects of lasting interest or value (merriam-webster.com)

Museums as public institutions have an important role in the cultural landscape. They are propagators of culture through the exhibition of objects which can have scientific, artistic, cultural, and/or historical value to a society. Today many museums are more than a simple exhibition of artefacts in exhibition cases, the role of media and interaction with the stories being told through new means of exhibiting are offering new opportunities for the format. However, the role of the institution as a conveyor of culture and information remains the same. (Alexander 2008)

Expressive architecture

"Museums like churches create an expectation in the wider public. The project is expected to be a work of architecture, and the architect is allowed to express himself more freely. This is especially true of museums since they lack a distinctive archetypical image. At the same time it is fortunate for an architect to work on a theme considered principally as the place for mastering light, a fact brilliantly proven by Aalvar Aalto and Louis Kahn." (Ciriani in Frampton 2007, p. 381) The use of daylight is also an important aspect in the Nordic tradition, since it generally is a scarce resource in the darker months of the year.

Typology, functions and organisation

"The museum as a type was born from the use of the compositional figures of the palace and its concatenation of rooms. This typology suffers from the fact that today the entrance no longer follows a unique ceremonial route but has to demonstrate the complexity of its program, and simultaneously inform and visually indicate internal distribution." (Ciriani in Frampton 2007, p. 381)

The museum typically has a public part and a 'backstage' part which can only be accessed by the staff. The size of these functions varies depending of the type of museum and which responsibilities it has when it comes to collection and preservation of items. The organisation can vary, but generally it should be possible to separate the flow of the staff and backstage activities from the flow of the public in a traditional museum. This can be done in plan as well as in section. (Adler 1999) In a science centre however, there might be situations when one could disclose the backstage activities as part of the exhibition since a more hands on approach to the exhibition often is the case.

Another concern is the expansion of exhibition area, storage facilities, etc. over time. One can look at different ways of expanding, and by thinking it as part of the concept the building can be more robust. Historically organising flows of the public and addressing the need for expansion have led to some interesting projects. "Seeking to avoid the palace archetype while acknowledging the importance of circulation in a museum, the great modern masters, Le Corbusier and Wright, used the spiral form to produce continuous movement. In wrights case it was a descending motion which entailed a loss of relationship to the entrance. In Le Corbusier's projects, the relation of the centre to the exterior of the building is lost as one has to circulate under the building before reaching its centre, in order to develop a centrifugal circuit. The periphery was left deliberately open because of the assumption of unlimited growth of the museum. These solutions, while being spectacular, failed to create a convincing model." (Ciriani in Frampton 2007, p. 382)

Technical requirements

As Museums are often a place where artefacts of importance are stored, the specific artefacts can generate different requirements for the technical performance of the building as well as the users can. Security is often a concern since the value of the artefacts can be very high. Another requirement is the air humidity, temperature and daylight. Older artefacts often require a steady condition and different things can have different need for humidity, temperature etc. Generally direct sunlight cannot be tolerated, and objects especially sensitive to light can require down to 200 lux in light level. The objects in a science centre though, fall under the category objects insensitive to light, and can be exhibited in light levels around 950 lux. Another concern is acoustics and sound transmission between rooms. This has a lot to do with creating the right atmosphere and being able to accommodate a variety of activities in the different zones. Generally low frequency sound can be reduced by structural mass, middle frequencies by diffusing and absorbing surfaces and high frequency by eliminating small scale gaps in doors, windows and partition walls. (Adler 1999) From an aesthetic point of view, light and acoustics also have an important role to play as to how spaces are perceived, and the above mentioned should therefore not be regarded as much as a checklist as a guide to what have been working in previous projects.

Atmosphere

The classic museum has some built in expectations for what experience the different functions should provide when it comes to spatial qualities and parameters such as acoustics, daylight, tactile sensations etc. These expectations vary between the foyer, exhibition areas, café, and all the other functions a building like this holds. A science centre as well has these predefined expectations as a place where the architecture might reflect the mood and atmosphere of the functions of the building. The challenge is to create an architecture which can meet the need of the institution and its functions, and simultaneously create some added value to the place and the users. Both when the centre is open, but also outside the opening hours.

Ill. 21a Exhibition spaces in the Danish National Maritime Museum

Learning environments

"Educational theorist Howard Gardner has suggested that a good design model to keep in mind for the learning environment of the future is the children's museum, where teaching and learning is based on the ideas of apprenticeship and learning by doing. In a children's museum children are encouraged to touch and explore interesting objects in a carefully arranged setting scaled to young people" (Taylor 2009)

The architecture itself can play an active role in conveying the information which it's trying to distribute by emphasizing a structural clarity, and breaking down the barrier between the interior and the landscape outside, the landscape in which the very truth which is on display inside takes place. In the case of a maritime museum it is therefore relevant to emphasize the connection to the sea and possibly integrate connections to it in the design. Connections can be both spatial, visual, auditive, or in other ways experienced by our senses.

In this sense, the atmosphere is very important. In a science centre, the atmosphere should support learning and create a space where one can be both actively participating, and be amazed at the same time.

Furthermore the exhibition design can reflect the theme in its way of telling the story and how it is meant to be experienced and interacted with. The role of the building is to enable a large variety of different exhibition models to function in the same spaces over time.

Ill. 21b Exhibition spaces in the Danish National Maritime Museum

Ill. 21c Outdoor educational area at Marine Education Centre

Case studies

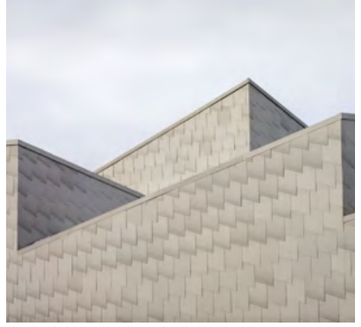
The following case studies seeks to find potentials and investigate different ways of creating spaces for exhibitions and learning. Though the projects may vary, they offer some insight into the problem at hand. By their way of organizing functions, thinking materials, relating to place, spatial experiences etc. The observations can be brought into the design phase as potentials and inspiration.

Ill. 22a Museum exterior, scale adjusted to context

Porsgrunn Maritime Museum by COBE

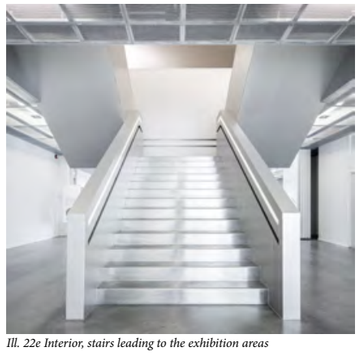
The city of Porsgrunn has a long maritime history. The harbour front where the building is situated is characterized by being the industrial backside of the city which is generally characterized by small wooden houses with each their own different roof angle. As a maritime museum and exploratorium the building seeks to both fit into the scale and context and at the same time bring something new to the place. By dividing the volume into 11 smaller cubes, and giving each its own unique roof angle the building accommodates 2000 sqm of program without breaking the scale of its context.
In the plan the building is divided into two floors. The ground floor has a very open character towards the surroundings, and contains all the public facilities such as Foyer, classrooms, auditorium, canteen and so on. It also has a large flexibility towards adapting for different sizes of functions. On the first floor the exhibition rooms are placed as one big open area which can then be programmed according to the changing exhibitions. A significant feature in these rooms are the ceiling which follows the angles of the roof. (Cobe.dk)
The material might at first seem strange, given the context, and it is indeed an element which brings a contemporary look to the building. However the aluminium cladding is actually produced locally, and the pattern brings fish scales to mind. The interior continues the raw materials in a contemporary industrial look in the ground floor while the first floor is more subtle as a backdrop for exhibitions.

Ill. 22b Ground floor plan



Ill. 22c Cladding of locally produced aluminium

Ill. 22d First floor plan

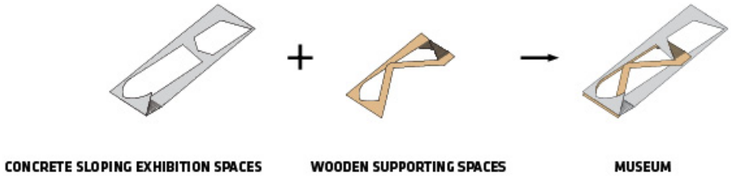


Ill. 22e Interior, stairs leading to the exhibition areas

Ill. 23a Danish National Maritime Museum situated in an old dock

Danish National Maritime Museum in Helsingør by BIG

Situated in an old drydock, this national maritime museum is a pragmatic answer to a design challenge. The museum itself is situated underground around the drydock rather than inside it. This offers a greater possibility to get daylight horizontally into the spaces, an important factor in both the backstage offices as well as the foyer and other visitor related areas. The exhibition spaces are organized in a circular motion around the dock. By twisting the geometry slightly so the spaces expand in width when you follow the exhibition and sloping the floor as little as 1:72 a clear sense of direction is experienced by the visitor. The exhibition is split in two parts, with the cafe as a natural break, the cafe furthermore has its own entrance making it accessible to people who might not be visitors to the museum.
3 spaces/bridges span the dock. Two of them acts as an entrance path and a space for smaller temporary exhibitions as well as shortcuts between the two main exhibition spaces. The third bridge supports the path to the Kronborg castle, while containing an auditorium.
The materials are very modern, mainly glass aluminium and concrete. Generally references to maritime signalling colours and construction is used in selected details and functions. (Peter 2014)
By building underground the museum solves the circulation with a downwards spiralling movement without losing the relation to the entrance. Indeed one can speak of entering a different world in this museum.



Ill. 23b The primary functions and supporting functions

Ill. 23c Bridges in the dock providing different functions

Marine Education Centre in Malmö by Nord Architects

This project in Sweden is significant in its way of working with the landscape and integrating the building into the landscape.
The institution focuses on marine life and the relationship between the sea and the land, and on humans effect on the marine life.
As such the idea is that experiments and hands-on experiences take place outside in the natural setting and hereafter are brought inside where the findings can be further investigated.
A variety of functions are placed under a large roof plate, which creates a horizontal connection between the educational facilities inside and the learning landscape outside. The roof plate also has the feature of making the many smaller volumes seem like one building.
The landscape is designed as part of the proposal and did not exist on the site, but sand-dunes are a familiar phenomenon to the place.
The learning landscape features a lot of small places for activities such as floating laboratories on small removable pontoons, teaching signs on the seabed and underwater sea binoculars.
Inside, the building is thought as being flexible and able to accommodate changing needs and new technology. The skylights are part of a sustainability strategy and at the same time a key architectural feature giving the building a unique identity. (nordarchitects.dk 2015a)

Ill. 24a Landscape as part of the educational environment, roof as an embracing gesture

Ill. 24b Landscape and building planned together

Ill. 24c Building concept

Natural Science Centre in Bjerringbro by Nord Architects

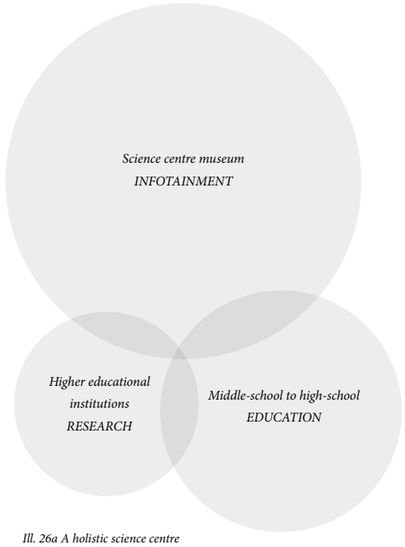
This building is similar to the Brief in the sense that it was also built with the purpose of attracting more young people to a specific field. In this case it is the field of science.
The building is meant as a place where, on one hand, teachers can come to attend courses in how to make science classes more relevant, intriguing, and exiting for their pupils. And on the other hand classes can come here, meet companies and scientists and get a taste of what real life science is about.
The building is generally designed with the approach in mind that it is part of the science lesson as well. This has meant the all constructions and technical installations are kept visible, and used as a part of the aesthetic expression. Pupils can then study it and experience how the building is put together.
The architects have worked closely with producers to make the house a showcase for the latest technologies in the building industry.
(nordarchitects.dk 2015b)

Ill. 25a The architect has worked with material producers to incorporate the newest technology

Ill. 25b The building provides a new setting for teaching and learning

Room program

The room program is developed on the basis of the existing program.
A research part is added and demands are further specified to create a holistic experience of all levels of science by integrating the possibility for research and education in the actual centre.



Ill. 26a A holistic science centre

The holistic science centre

Through the case studies different approaches to communicate and showcase the sciences have been investigated and the basis of this a new plan for the holistic science centre is created. The aim is to incorporate production and communication of knowledge on all levels in order to form a synergy in a maritime science centre which embraces the many goals a science centre can have. The science centre will consist of three parts in one institution.

Museum and science centre
The main role is a museum for maritime science. As a museum the centre will take care of typical museum tasks like historical research and exhibiting items of cultural and historical importance to its field. This museum will have mainly permanent exhibitions which should last around 10 years. These can be backed by smaller changing exhibitions relevant to the time.

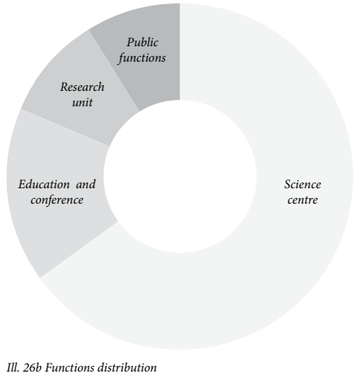
Educational & conference facilities
As an educational institution the science centre shall convey knowledge to all kinds of students from kindergarten to high-school level. These teaching sessions should take part in classrooms as well as in the exhibition itself.
The conference unit should furthermore meet the need for a place of gathering for the local community during special occasions and therefore a flexible unit is preferred.

Research function
As a knowledge institution the research function is essential to be able to produce and procure knowledge at all levels, and create a synergy between the popular scientific exhibitions and the latest knowledge in the field of maritime sciences. This unit should encompass different working spaces such as laboratory, office and study facilities. As an institution the research function and science centre should optimally be part of a network of companies and researchers in the maritime sciences, and create a platform for sharing of knowledge and innovation across specific fields. Furthermore it is the aim to create a close connection to the museum function.

Public functions
Apart from the science centre functions the building also holds a café which functions both together with and separate from the other functions. The café could make use of the local produce such as fish and farming products to further emphasize a connection to the theme of the science centre, and in some aspects act as an active part of the knowledge platform.
Furthermore the building must, as a public institution, be open and inviting and give something back to the users of the place. Some parts of the exhibition could be free, and exhibit parts of the local history or other relevant information specific to the place.

Program analysis

From how the area is distributed between the functions, it is clear that the science centre is the main function and the rest serve as sub-functions to this. Since most of the program relates to this function and is publicly accessible, it makes sense to make this the key functions which connects the rest. While some functions such as the café and the staff might need a separate entrance as well, most of the functions can hereby be served by the exhibition spaces, and in this way further emphasize the holistic approach to a 21st century science centre institution.



Ill. 26b Functions distribution

Function	Space	Area in m²	Notes
Science centre	Exhibition spaces	1500	Should be able to accommodate a large fish-tank and objects which require high ceilings. Permanent exhibitions as well as temporary ones.
	Shop/Reception	50	
	Office and Staff rooms	70	Office for 10 persons.
	Wardrobe and staff toilets	30	
	Workshop	50	
	Goods reception and storage	200	
	Technical room	100	
	Cleaning	30	
		2030	
Educational and conference facilities	Visitor reception including wardrobe and toilets	80	
	Auditorium	200	100-150 seats.
	Class room	100	
	Group room	50	
	Meeting room	50	
	Teaching resources	30	
		510	
Research unit	Offices	80	Clusters in open plan office. 6-10 workplaces.
	Library with group rooms	50	For meetings and studying.
	Labs	180	Flexible space to host different kinds of research related tests , experiments and workshops in close connection to the exhibitions.
		310	
Public functions	Café with own kitchen	270	Serve 150 persons, 70m² kitchen - 20m² cold store - 180m² dinning.
		270	
Outdoor and landscape	Exterior activity area		An area which connects to the exhibition themes inside and the sea outside. Including an open air platform/amphi theatre.
	Parking		7 spaces for disabled and 50 for bikes near the entrance.
Total Area		**3120**	

Ill. 27 Room program (Program 2014), further developed by author

Place

A thorough introduction into the geography, climate, culture, and identity of the site at which the Maritime Centre of Knowledge is to be situated.

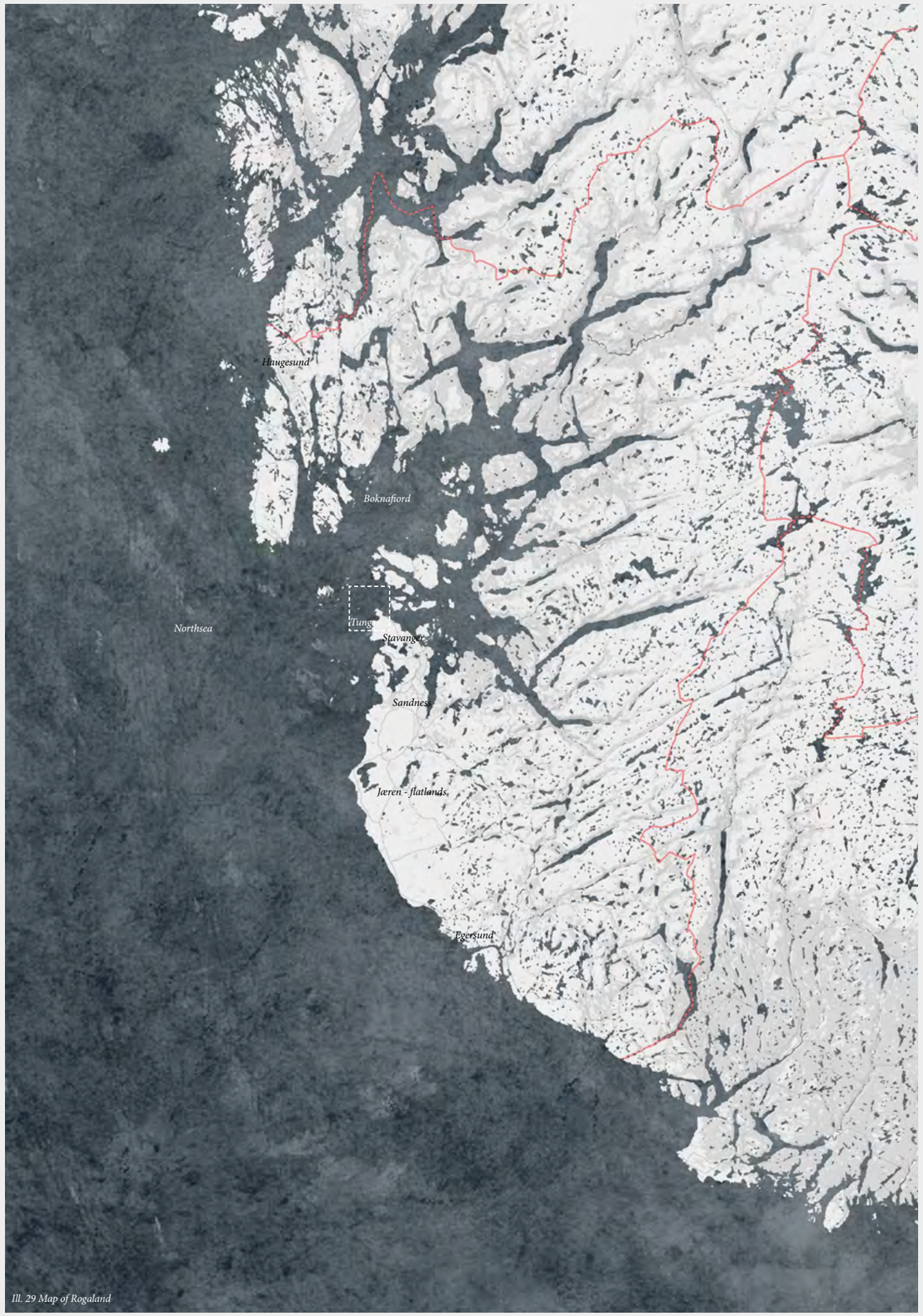
Between sea and fiord

The West coast of Norway is one of the longest national coastlines in the world, it stretches all the way from Egersund in the south and to well above the polar circle to the north. Several places large fiords cut into the landscape, among others the UNESCO heritage protected fiords of Nærøyfjord and Geirangerfjord. Boknafjord is the sourthernmost of the big fiords and is situated in the county of Rogaland. (fjordnorway.com 2015a)

Rogaland

Rogaland is situated on the southern part of the west coast. It is a county characterized by a mountainous landscape towards the north and eastern parts, and large flatlands, much similar to the Danish landscape with beaches, lighthouses, and agriculture towards the west. Stavanger is the main city of the region and together with Sandness it represents a population of more than 200.000 inhabitants, making Rogaland one of the most urbanized regions of Norway. (destination-rogaland.com)

At the northern tip of Jæren, the flatland along the coast south of the Boknafjord inlet, the site is situated some 15 kilometres north of Stavanger, where the sea meets the fiord. (Program 2014)



Ill. 29 Map of Rogaland

Tungenes

Tungenes is situated around 15 kilometres - a 20 minute drive north of Stavanger. Today the place is intact with small villas, a marina for recreational sailors and local fishermen, and a light-house towards the sea. The existing light-house was built in 1862 and was operational until 1984 - when a larger more modern light-house was built on a rock in the middle of the inlet to Boknafjord. Today the lighthouse functions as a small museum and place of cultural heritage.
The area is very affected by the weather. On stormy days people often come here to experience the forces of nature. (Program 2014)

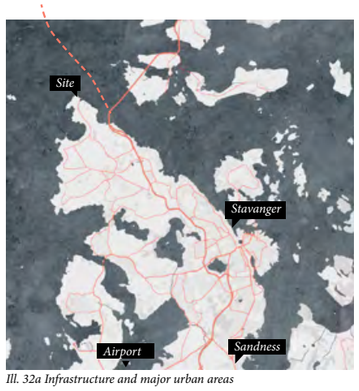
The site is situated between the marina and the sea, and involves the demolishing of two existing barns adjacent to the site. Situated on the edge between the agricultural landscape of Jæren, and the cultivated fiord, the site connects to the story of how man has cultivated nature in this region.

Ill. 30a The site between farmland and fiord

Ill. 30b Tungenes

Mappings

Following the theory James Corner, mappings are developed to create an overview of the areas surrounding the site, and the site itself. The mappings clarifies various challenges and potentials related to the planning and later the concept.



Ill. 32a Infrastructure and major urban areas

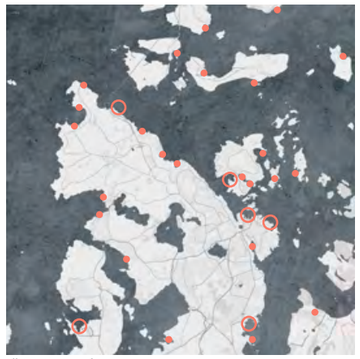
Infrastructure

The area of Stavanger and Sandness is very populated compared to many other parts of coastal Norway. Together the urban area of Stavanger and Sandness makes up 203.771 people (ssb.no 2015b). A highway runs along the edge of the cities, and a new tunnel is under construction connecting under the inlet of Boknafjord and further up the coast towards Bergen.
People are most likely to arrive to the museum by car, and park in the nearby parking lot since the highway is only about 3 km away from the site. (Program 2014)

Ill. 32b Museums in the area

Museums and cultural institutions

1. Tungenes lighthouse is a cultural hub, with small exhibitions and events, but other museums in the region tell the same story. (Prospekt 2014)
2. Vistnestunet, 19th-century farm. Part of the Jær-Museum, a place where visitors can experience the traditional farming culture.
3. Museums and collections in Stavanger:
   - Stavanger Maritime Museum
   - Norwegian Petroleum Museum
   - Valbergtaarnet & Vektermuseet
   - Stavanger Museum
   - Norwegian Childhood Museum
   - Archaeological Museum of Stavanger
   - Breidablikk
   - Norwegian Canned Foods Museum
   - Norwegian Graphical Museum
   - Ledaal Museum
   - Telecommunications Museum
   - Missionary Museum
   - Stavanger School Museum
4. Rogaland Museum of Fine Arts
5. Coastal culture collection in Tananger



Ill. 32c Ports and marinas

Industrial harbours and marinas

• Marina ○ Industrial Harbour

With its urban areas and industrial importance, the region of Stavanger has a high degree of connection to the sea. The many islands in the fiord and along the coast make this an area where many people own boats. The larger industrial harbours services many industries, from passenger ferries to Denmark and Bergen, to goods transport and oil industry related business.

Ill. 33a Tungeneset hiking path and attractions

Local Hiking path - Tungeneset

Along the coastline is a 6,3 km. hiking path. Apart from the nature hikers can experience some cultural places of interest along the route. (randaberg.kommune.no)

1. Gun positions from WWII
2. Burial mound
3. Toilet
4. Parking
5. Bus stop
6. Golf club
7. Camp site
8. Beach

Ill. 33b The site and immediate context

Points of interest

The lighthouse functions today as a cultural house with a variety of activities. An exhibition shows the life of the attendant and his family in the 1930's. Furthermore, there is a small cafe.
A burial mound is placed close to the lighthouse, this is one of many found along the coast of Rogaland, from the first Norwegian settlements.
The marina is home to around to 20-30 private boats.
A new parking lot is planned near the marina by the main access road.
The site is located on a field behind some of the existing houses, between the marina and the sea. (Program 2014)

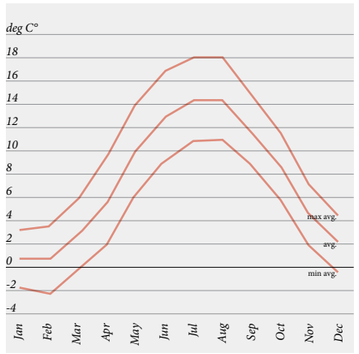
Ill. 33c Flooding datum according to brief

3 metre flooding datum

As part of the task the program states that construction made below 3m above sea level can be subject to flooding, due to rough weather, surge, and generally increasing water levels. (Program 2014)
Investigations show that severe increase in water level can hit some of the existing houses around the site.

Climate

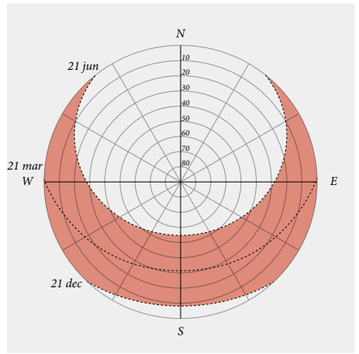
The climate has a lot to say for how we build in and perceive a place. Weather affects us on a physical as well as a psychological level, and it is part of characterizing the customs of our culture whether it is grounded in an extreme or milder climate.



Ill. 34a Temperatures through the year, with average max. and min.

Temperatures

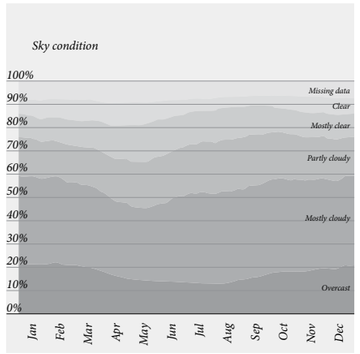
Situated right at the sea, the region has a mild humid temperate climate with warm summers and no dry season. Due to the proximity to the sea, the winters are milder than most other places in Norway, and the temperatures are more constant. (weatherspark.com)



Ill. 34b Sunpath diagram

Daylight

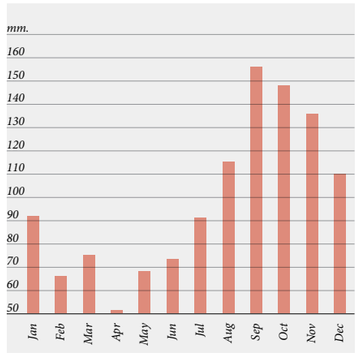
The length of the day differs with more than 12 hours during the year. The dark winters culminates with only 6:11 hours of daylight on the 21st of December, till bright summer nights with 18:28 hours of daylight on the 20th of June. (weatherspark.com)



Ill. 34c Cloud-cover diagram

Clouds

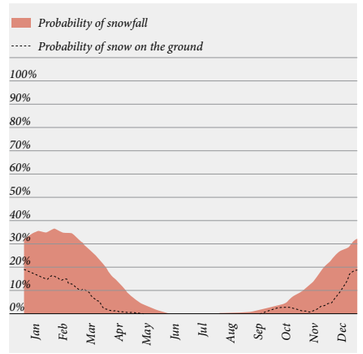
With the sky and the sea as dominant natural features, the texture of the sky becomes truly important. With 'mostly cloudy' and 'partly cloudy' as the main types of cloud cover, counting for over 50% of the time, the changing skies are a very important aspects of the experience of the place. (weatherspark.com)



Ill. 35a Precipitation diagram

Precipitation

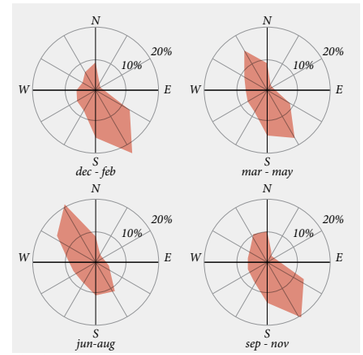
There is a significant increase in precipitation during late summer and through the autumn, while the spring is relatively dry in comparison. The number of rainy days per month reflects the rainfall of the given month, and the precipitation is mostly categorized as moderate rain maxing out at almost 18 days of rain in November. During winters small amounts of snow is also possible. (weatherspark.com)



Ill. 35b Snow diagram

Snow

Compared to many other parts of Norway, snow is not a big factor in this coastal region. With a maximum probability of snow on the ground on January 1st being 19% and a maximum average snow depth (when there is snow on the ground) being 8,3 centimetres on January the 7th the snow cannot be said to be a defining climate factor. (weatherspark.com)



Ill. 35b Wind distribution according to season

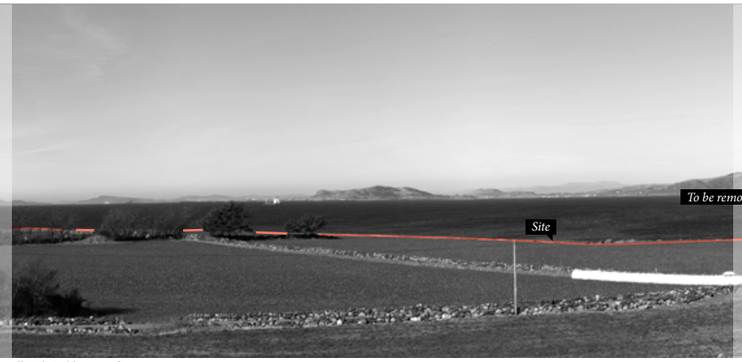
Wind

Wind is a defining feature in this landscape. The average daily windspeed varies between 4 and 5 metres per second (gentle breeze) with the highpoint in January. At the same time the average daily maximum is 9 metres per second on January the 13th. The direction of the wind changes between the seasons, from dominantly North-North-Western in the summer, to South-Sout-Eastern in the rest of the year. Apart from this there is generally more wind coming from the ocean towards the west than the mountains and Fiords towards the east. (weatherspark.com)

Tungenes and Tungevågen

The tip of Jæren.
The illustration below shows from right to the left the typical movement through the area. From the parking lot along the coast towards the light house.

Ill. 36a Tungenes lighthouse



Ill. 36b Fields, stone fences, site

Ill. 37a Tungevågen, small houses

Ill. 37b Arrival, parking, and road from Randaberg

Lighthouse

The Light house itself attracts a lot of visitors and stand as a historic beacon in the area.
Beyond the lighthouse on the coast further to the south, it is the wind and the rocks which are the dominant features in the landscape.

Fields

This part of the landscape represents the typical landscape of Jæren. Small fields in a cultural landscape which has been cultivated for thousands of years. The Stone fences are built over time from stones collected from the fields, and are used to separate the lands and keep the cattle in place. (Gurandsrud 2015)

This is where the site is, with the fiord towards the north-east. On this stretch of the path the wind in not quite as dominant, it is the light sound of waves and sound of the gravel path under ones feet which is in focus.

Dwellings

The small gathering of houses by the marina are the first buildings the visitor meets, when approaching the place. These dwellings are simple wooden houses, all painted white and with a pitched roof. These houses are typical for the region, where you are almost always able to see small settlements in the hilly landscape.
Despite of these houses the area feels very quiet and there is a clear sense that not much happens here.

Arrival

One arrives to Tungenes by car or bus. In the near future the parking lot will be expanded and a new bike path from Randaberg will be completed.

Registrations

Arriving and moving along the path, one encounters different buildings and landscapes, some of which will be removed before the completion of the centre.

Ill. 38a Images from the walk from the parking lot towards the lighthouse

The journey

The walk along this part of the coast is very accessible compared to further along the Tungenes walk where there is no path and one has to climb fences, and jump on rocks across little streams. At this section the sea, the sky, and the wind are the main elements adding to the bodily experience. Walking on the edge between the rock and the fields, one is closely connected to the two elements which man has been cultivating and harvesting from in this region for ages.

Ill. 38b The path, the fields, and the ocean

The sea

The sea here has a certain darkness to it. When the waves hit the rock, they turn black and shiny, one can see how deep the waters of these fiords are and which great powers they posses. The sound of waves is a constant backdrop for the atmosphere of the site. It adds a distinctive calmness to the place being near these forces of nature.

Ill. 40 The coast just off of the site

The sky

The sky is the second most influential element on the place. The horizon here is wide and deep, and with the sunset over the ocean it adds an aspect of greatness to the place. The cloud formations are constantly changing and with it the mood and light which affects the experience of the surroundings.

Ill. 41 The deep horizon

Institution of light

Tungenes light house is both culturally and historically the most prominent building in the area now. While it is not operative, its exhibition, café and occasional concerts attracts an audience. Furthermore artist can apply to get a small room for a period of time, to go here for inspiration and a calm place to focus.
Despite the light not being on, the white volumes stand out and has a light of their own in this scenic coastal landscape.

Ill. 42 Tungenes lighthouse from the south

Ill. 44 Tungenes lighthouse facades

Illuminating the landscape

The vertical wooden facade cladding is seen everywhere in the region. The classic Jærhouse was built like this. A small wooden house with a pithed roof and two small additions at the end, typically made of stone, which guides the wind over the house and minimizes draught inside the house.
The white colour really makes the building stand out in the landscape, and the arrangement of the small windows adds to the village atmosphere.

Ill. 45 Stone wall and heritage building by the lighthouse

Maritime presence

Just of the tip of Tungenes, all ship traffic going in and out of the fiord is visually present. This means that large vessels carrying everything from cargo to cars and passengers pass by just of the shore line. The presence underlines the connection between the cultural landscape on land as well as off-shore.

Ill. 46 Ship sailing by the site

The mix of scales

In Stavanger and the region in general there is a presence of different industries and infrastuctural programs which can be categorized as mega-scale. The contrast is especially evident in Stavanger where the small wooden houses are present in close proximity to these elements. These contrasts of scale are part of creating an image of a lively industrial city rather than a small town, and reflects the spirit of the region.

Ill. 48 Stavanger city

Ill. 49 Stavanger city

Sections and surfaces

Sections through the site gives an understanding of the topography. Below the surface texture and the different zones creates an image of the transitions in the landscape.

Ill. 50a Landscape section A 1:2000

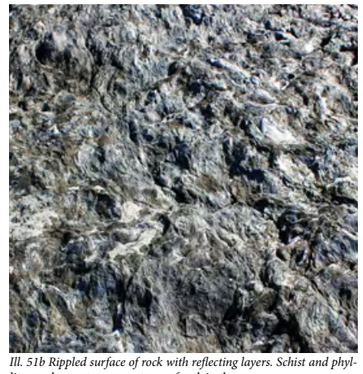
Ill. 51a Landscape section B 1:3000

Ill. 50a Sections through the site

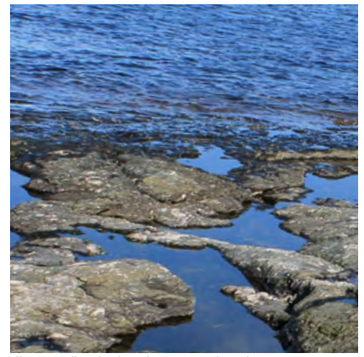
Ill. 50b Stone fence, these are seen all over Jæren

Ill. 50c Grassy field for forage

Ill. 51a Moss growing on the rocks



Ill. 51b Rippled surface of rock with reflecting layers. Schist and phyllite are the most common types of rock in the area.



Ill. 51c Small pools where the sea meats the rock

Regional culture

In the theory of performative regionalism the local culture is an important part of the place. This chapter seeks to create an brief overview of the culture of the region as well as the history and the economy of today. Secondly a chapter investigating the three areas of aquaculture, navigation at sea and maritime industries creates and overview of the three main subjects which are to be focus of the exhibition at the maritime centre of knowledge.

History and cultural landscape

Before 1965
The flatlands along the coast named Jæren, was home to some of the first settlements in Norway. Hundreds of grave mounds dates back up to 3000 years, and some findings are far older as well. (fjordnorway.com 2015b) Stavanger, as the main city, has it's establishing date in 1125, with the completion of the Stavanger Cathedral. The agricultural landscape here was important to the church and the bishop, and remains a significant sector till this day.
From the mid 18-hundreds lighthouses where built all along the coast of Jæren as part of a plan to improve navigation in the area, where many sandbanks makes it difficult to navigate. (visitnorway.com) Kvassheim as the last one was finished in 1912. (See ill. 53b) Furthermore, the fishing industry and maritime industries such as ship building and sail making where predominant industries in Stavanger. (Stavanger.kommune.no)
Stavanger and the region has experienced a long history of economic booms and recessions. In the first half of the 20th century the fishing industry and shipping industry was at a high point, and canning of these products, especially herring, made the city the canning capital of Norway. This is reflected in a museum in Stavanger today. (museumstavanger.no)
On the 9th of April 1940, the Germans attacked Stavanger Airport as the first attack on Norway. By the end of the day the Germans had taken over the city, after some resistance from the airforce. The evidence of the German occupation is still visible today along the coast of Jæren, where many gun positions where built by the Germans to protect from an invasion from Britain. (Stavanger.kommune.no)

The oil boom
In 1965 agreements of borders in the north sea were established between Norway, Britain and Denmark and the hunt for oil began.
After some discussion Stavanger was appointed to be the capital of oil industry in Norway, and after finding oil in 1969 a reformation of the Norwegian society began. (Stavanger.kommune.no)

The rich cousin
In a Scandinavian context Norway stands out. Where Denmark and Sweden, to a large degree, operate with free markets. Norway has embraced a kind of state capitalism since the end of WWII. With its abundant natural resources the strategy has been owning stock majorities in most of the major companies, and a large public sector accounting for 52% of GDP has been built up over the years. With 30% of revenue coming from oil, the government have through the years kept the social-democratic spirit, and established the worlds largest wealth fund, with the purpose of preparing Norway for a post oil-economy. The fund accounts for 1% of all the worlds stocks. Despite this wealth, Norway has a great focus on human rights and have not developed inhumane cities dominated by tall buildings as seen many places where oil wealth is large. The focus of the oil industry in the later years has been on developing technologies, and knowledge for deep sea drilling. Expertise for which the demand is booming internationally. (Economist.com)

Other industries
The same strategy of developing knowledge in industrially based sectors have been applied to the fish farming industry among others. In this case the expertise is exported to countries such as Chile. In general entrepreneurship is encouraged."The government is promoting new businesses through bodies such as Innovation Norway and university science parks" (Economist.com).

Stavanger today
While Norway is trying to move away from an economy based on oil, Stavanger remains the oil capital. The largest company in Scandinavia, Statoil, has its headquarters here as well as thousands of other companies related to the oil industry. Several of them are internationally based, and where 11% of Norwegians were born outside Norway, 20% of the population in Stavanger is. (Stavanger.kommune.no)
The region is still referred to as Norway's food region, due to the agriculture and seafood. Every year the largest food-festival in Scandinavia attracts more than 200.000 visitors to Stavanger and the region. (www.fjordnorway.com 2015b)

Education

With a general level of education reflecting that of other bigger cities in Norway, Stavanger had 40% in 2012 who attended higher education. (statistikk.stavanger.kommune.no)
Also in the educational sector the oil economy has made an impact. "The oil sector is monopolising the nation's technical talent, with more than 50,000 engineers currently being employed offshore" (economist.com)
Specifically for Stavanger the newly announced cuts in oil-sector jobs will hit both manual as well as highly specialized labour, and as a result other servicing sectors as well. (Skarsaune 2015)
Therefore, this region in particular, could very well emphasize the need for spreading the risk. Using the same strategy as the government does when it seeks to support innovation and development in a wide variety of sectors, the maritime centre of knowledge can be part of positioning the maritime industries in a more visible and attractive educational situation.
Furthermore, the need for expertise in sciences, and ways to encourage young people to study science, are a constant in many countries, including Norway. (ssb.no 2015a)

National tourist route of Jæren

The 18 national tourist routes of Norway are famous for featuring the most scenic natural landscapes Norway has to offer. For most people this recalls views of mountaintops and deep fiords, but the national tourist route of Jæren is different.
The route stretches along the coast for 41 kilometre between Ogna and Bore at the southern part of Jæren. The landscape here features high skies, wide horizons, and the endless sea. The weather and light is constantly changing and sandy beaches and dunes are the dominant coastal nature. The climate is mild year round and the beaches are popular for swimming in summertime. The many lighthouses from the 18-hundreds tells a story about the life at sea, and the dangers connected to sailing these waters. (nasjonaleturistveger.no)
A potential lies in connecting this story of the relationship between the cultural landscape of Jæren, and the cultural landscape which is the Norwegian sea. The maritime centre of knowledge, though not right on the national tourist route, could be a part of the experience while showcasing the possibilities which are below the surface of the ocean.

Ill. 53a Friluftshuset in Ore

Ill. 53b Kvassheim Lighthouse

Ill. 53c Ore beach

Ill. 53d Verhaug old cemetery

Ill. 53e Stavanger downtown, significant for its heritage small wooden houses.

Exhibition themes

Three themes are pointed out to be the subjects of the maritime centre of knowledge. These three themes reflect the maritime history of the region and are all important parts of the Norwegian coastal economy in general.

Coastal navigation
The coast of Rogaland has always been particularly hard to navigate and many ships have wrecked here. The lighthouses, navigation industry, and pilotage services therefore have a long history in this region. In the exhibition different themes within the field of navigation will be highlighted and interactive exhibitions will let the visitors engage with some of the challenges of navigating. Specifically an installation using a scaled down version of the landscape with lighthouses will let the visitor navigate him or herself through a room. Other installations shall feature elements of competition and let the visitor take part while explaining about phenomena like the curvature of the earth's surface, optics of the lighthouse, coordinating traffic at sea etc. (Prospekt 2014)

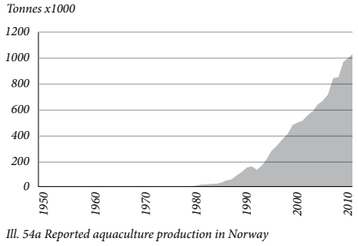
Aquaculture
While agriculture on land has been around for thousands of years, aquaculture – farming the oceans – has not been used to the same length. Fishing has, but fish farming on an industrial scale has been developed in the last 50-60 years. From 1950 and on to 1970 the technology developed from a long process of trial and error into becoming a major industry along the coasts of Norway. Today the industry accounts for 30.6 billion NOK a year, is the third largest sector of export, and still growing. (Prospekt 2014)
Though the industry has some environmental sustainability issues, it is still the most sustainable and effective way of producing protein. The Norwegian government has identified five areas where aquaculture may potentially have a negative impact on the environment:

- Escaped fish/genetic interaction
- Pollution and discharges
- Diseases and parasites
- Use of coastal areas
- Feed and feed resources

While these are serious issues, it is the same ethical discussion as seen in the case of agricultural methods. The Norwegian government estimates that the sector along with supporting sectors employs around 21.000 people in the small municipalities along the Norwegian coast. Thus, the sector is also an important part of maintaining jobs in these areas of the country. (Fisheries.no)

Through a critical and informative exhibition these stories are part of the subjects displayed at the Maritime science centre. Practically the visitor will see the process from small fish eggs to finished product, and tours by boat to local fish farms will create a connection to the real world industry. An industry where the people of Rogaland have been pioneers. (Prospekt 2014)

Maritime Industry
The third theme of the exhibition covers the technological aspect of industries at sea. Rogaland is the region with the biggest part of Norwegian maritime industries. As such the exhibition will take the visitor through the history of the regional maritime industry and its accomplishments.
The exhibition will also have a special focus on emerging technologies within the field in and the visitor will be able to interact with these as part of the learning experience. Echo localisation as an example is used to localise fish in the ocean and remotely operated vehicles (ROV's) are taking over some of the work that were earlier carried out by divers. (Prospekt 2014)



Ill. 54a Reported aquaculture production in Norway


Ill. 54b Typical fish farm in Norway

Summary

Framework

A Nordic way of thinking architecture has been investigated and a definition sought. Building in a Nordic context, one is adding to a long tradition of place thinking. Traditionally the Nordic was inaugurated as a countermovement to the non-regional modernism, and defined by its relation to place. The Nordic countries where especially signified by their changing quality of natural light, and an architecture said to reflect the flat hierarchy of society. In the later years a Nordic identity and the methods of place thinking has been challenged by younger architects. Where place used to be seen as a result of the natural scenery and geography, today a more comprehensive understanding has been introduced. Culture and the ever changing landscape of human interactions and cultural exchange is a part of what makes a place, and this places the humans in a much more central role than before.

Another quality which has been said to be significant for Nordic architects among others, are the ability to design with an honest tectonic clarity. Tectonics can be understood as the concept of connecting the structurally stable with the beautiful, and as such it puts a lot of responsibility on the architects to know how materials work and how buildings are built today. In a building industry where solutions and demands are becoming ever more specific and specialized, this creates a need for thinking in integrated design solutions. New digital tools, and a closer collaboration between disciplines can be part of the answer to how we can maintain concept, ideas, and tectonic visions throughout the design- and building-process.

Programme

The maritime centre of knowledge is a mixture of a science centre with museum functions, a conference centre/educational unit and research unit. The three units are meant to form a symbiosis where knowledge is developed and taught in the natural setting where it takes place. The research unit, exhibition unit and educational unit combined makes for a small science village.

The science centre has the purpose of conveying three maritime sectors of business important to the region of Stavanger. Coastal navigation, aquaculture, and maritime industries. As such the aim is to inform, educate and entertain children and young people, and possibly open their eyes to this world of possibilities. Secondly the centre will be the host of cultural functions, public as well as private. This creates a demand for flexibility in how spaces are used and connected at different times. The brief calls for a distinctive architectural work, which simultaneously fits into the natural surroundings between land and sea.

The museum as a typology has been around for many years, but is undergoing changes these years. A larger variety of types are developing, and the preconception of a museum is challenged by means of new types of communication and interactive technology. The learning centre has an approach based on the 'learning by interacting' and should architecturally create an atmosphere which encourage this.

Through case studies different architectural solutions to the challenges involved in creating a building which meets the demands above is investigated. A potential is using an element like a roof, which also encompasses tectonic qualities, to gather the different function into a formal whole. Japanese architecture often emphasises a horizontal connections between landscape and interior, this could be a potential here as well. Plan organisations vary between the science centres, but there is a potential in using smaller, more intimate functions such as classrooms and temporary exhibition spaces to create breaks and shortcuts.

Materials are very unique to each project, but plays an important role in how the building connects to the place, culturally and visually.

Place

The site is situated at Tungenes, between the Norwegian sea and the inlet of Boknafjord on the Westcoast of Norway. Tungenes features a few villas, a marina and a heritage lighthouse from the 18-hundreds. The main feature of the site is its proximity to water, and the forces of nature which are evident as one walks along the coast.

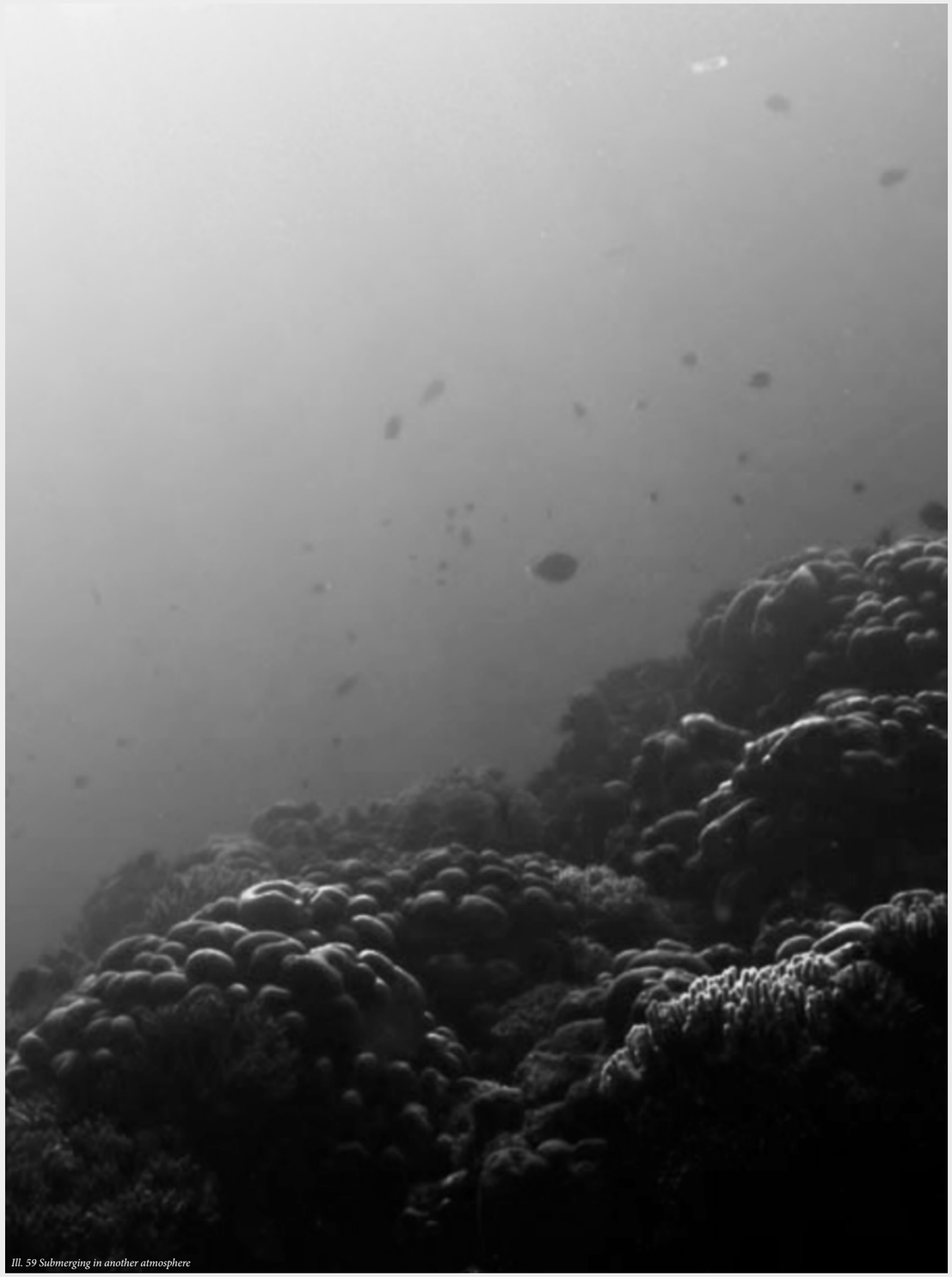
The lighthouse, as many other buildings in the region, is a white wooden building. These buildings seem to standout in the landscape with a light of their own. The region is segnified by a cultural landscape of fields, hills, and stone fences, which tells about the agricultural tradition.

The culture of the region is characterized by a long history for agriculture, and maritime industries. Stavanger has experienced a history of economic booms and recessions, and has been the centre of Norwegian oil-economy since the 1960's. This has had an impact on the culture, but not to the extent as seen in many other countries which experience a sudden growth in wealth. Norway has successfully been using it's wealth to build a society with social-democratic Scandinavian values and using the funds to empower development in other sectors.

Ill. 57b Large rock on the cliffs off of the site

Vision

The new maritime science-centre in Tungenes shall provide and frame a variety of activities. As a science centre it shall let the visitor submerge into a world of educating and entertaining information. It shall encourage discovery and learning through participating, and create an atmosphere where the visitor feels that he/she can speak freely, move around and take part in the activities.
The adjoining research and educational functions which makes the holistic science centre shall be a natural part of the centre and support the aim of a platform for knowledge on all levels.
The architecture can teleport the visitor into another world, by its means of using architectural features such as spatial organisation, transitions, daylight, materials, and structure. This should emphasize a variation of atmospheres which can be experienced beyond purely visual sensation.
The building must seem accessible and inviting and offer experiences outside opening hours as well as within. The local nature, and climate should be emphasized and incorporated as potentials for creating a place and an identity for the building.



Ill. 59 Submerging in another atmosphere

Ideation

Concept

Form

Organisation

Atmospheres

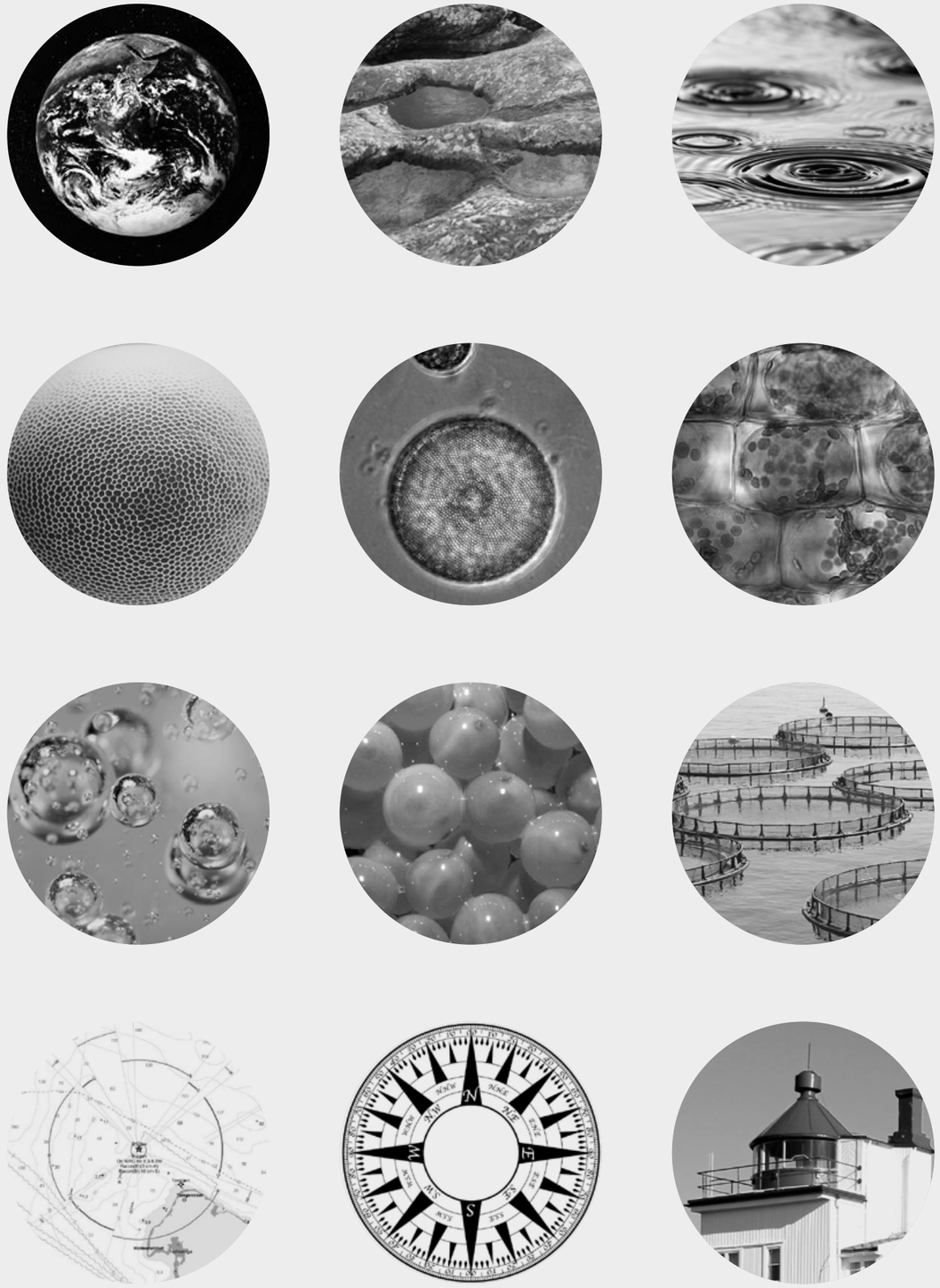
Concept

The concept combines the idea of a lighthouse with a courtyard building
By isolating a part of the landscape where all the elements of the site are present, the visitor becomes aware of the duality between the sea and the land.
The different adjoining functions creates an introverted organic shape towards the courtyard and underlines the relation between the holistic science centre and the natural world.
Seen from a distance the building is thought as a Fresnel prism like the ones used to focus the light in lighthouses. The transparent prism is suspended between two floating planes, with the upper one relating to the flat horizon-line and the lower to the waves of the ocean which the building is floating above.

Ill. 63 Concept of capturing and framing the essence of the landscape.

Circle

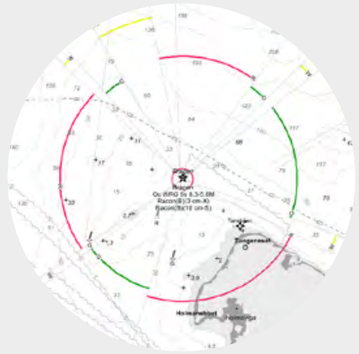
In science and in nature the circle and organic shapes are the norm. From the smallest cell to the earth itself the circle is a symbol of life. Ecosystems work in circles, where nutrients as well as water circulates between different states and forms. This form can truly be said to be relevant for a science centre.



Ill. 65 Circular references

Organisation

The Science centre is conceptually thought organised as the segmented lighting diagram of a lighthouse. The Museum function as the basis forms a circle, with the three exhibition themes represented through three different spatial qualities.
Towards the courtyard the adjoining functions of the cafe, the research unit and the educational unit are attached to the exhibition flow. As a back the staff and service functions are oriented outwards to the land side, with easy access for staff and goods.



Ill. 67 Diagramatic representation of organisation of functions inspired by lighthouse

Atmospheres

As a part of the ideation process, atmospheres which should occur in and around the building are created through a representation of situations. The museum typology of today is much more than a fancy house for some old objects on display, it is a house of experiences involving all the senses. Especially a science centre should stage not only the objects, but the experience of interaction between the individual and the exhibition.
This variety of situations should be supported by the architecture and the spatial experiences and transitions created by the building. As such they can be seen as ideas informing the design in its evolving stages.

Playing by the coast

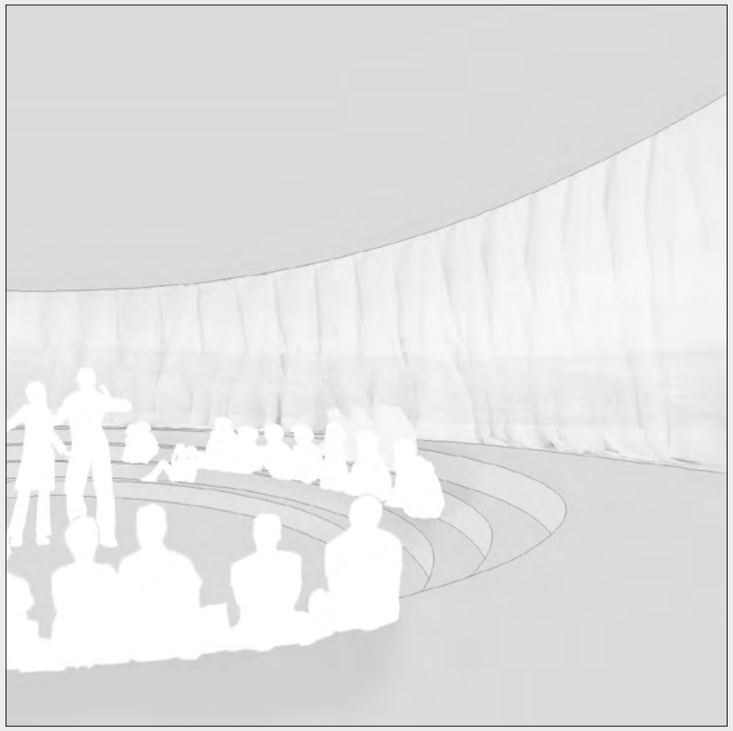
Activating the natural setting and in a safe way using the actual nature rather than a simulated environment should enforce the experience of a connection to the applied sciences present in the exhibitions.

Experiencing science

By bringing research in the maritime sciences into the centre, the visitors gets a full picture of the world of science rather than a staged and artificial one which can often be the case in non-thematised science centres. This also lets the visitor experience production of real knowledge up front. This experience should be supported by visual and spatial connections.

Taking a break

While the building in general is introvert and information heavy, with loads of impressions acting on the visitor, the natural setting can be utilized to create little breaks with the possibility to enjoy the serene scenic views over the ocean and the fiord.



Educational hubs

For the educational part of the centre it is important that it distances itself from the standard classroom in order to underline a new atmosphere with new opportunities for the students. The educational unit should be a flexible one using curtains and/or flexible glass walls to create a variation of possible spatial combinations.
Apart from the dedicated education spaces, little pockets such a stairs with seating and small amphitheatres, could give the opportunity of combining exhibition with informal educational sessions rather than traditional up front class lectures.

Dinning with a view

Apart from being part of the museum functions the café has the potential, due to its placement in this natural setting, to become a place of extraordinary gastronomy with both local agricultural and seafood produce. As such it should function as a separately accessible unit in open connection with the museum. Also different intimacies in atmospheres can be supported by a variation in ceiling height and orientation towards the surrounding landscape.

Presentation

The Lighthouse

The maritime centre for science stands as a beacon at the entry to the Boknafiord. By addressing both the Maritime side as well as the land side, with its illuminating character of changing transparencies, the architecture creates a dialogue between the land and the sea. Situated nearby both the new lighthouse at Bragen further out, and the heritage lighthouse of Tungenes, the building inscribes itself naturally in the context with its fluid horizontal and light character.

Ill. 76 The new maritime science centre seen from the fiord

Siteplan

With its relatively remote location by the small village of Tungenes, the centre becomes a destination where getting there is part of the experience. By placing the centre along the coastline and letting it interact with the existing path, the journey is further emphasized. The aim is to let the visitors distance themselves from the busy everyday life and immerse themselves in the natural environment which is the cornerstone in the centre for maritime sciences. A trinity is established with the marina, and the existing lighthouse as the two existing elements, and the new centre as the third, further emphasising the spirit of the place as a point where the fiord meets the sea and the maritime environment is primary.

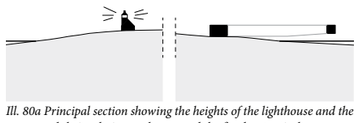
Visitors will park their cars in the newly expanded parking lot by the marina, or arrive by bike. Either way they will experience the approach to the centre and immersion in the maritime feeling at an appropriate pace as they move along the coastline towards the entrance through the courtyard.
The flow goes through the science centre, and continues towards Tungenes lighthouse as an integrated part of the experience.
A secondary access road behind the centre caters for parking for the physically challenged, and bikes, should they wish to park there. This road also serves as a service entrance and staff access for the employees and researchers.

Ill. 78a Arrival, access and flows

Ill. 78b Tungenes. Topography per 1m

Arrival

Moving along the coast, the old lighthouse and the new centre are both visible. By maintaining the views to both while moving along the coast, the relationship between these two cultural institutions are strengthened. Even though the buildings at first can seem very different, they seem to speak together as results of their distinctive times and traditions. The past and the future seems to coexist, with the history of the life that used to be along these coastal areas represented by the old lighthouse, and the present and future represented in the modern transparent knowledge institution.
The building lifts itself off the ground in a welcoming gesture and guides the visitor naturally into the courtyard. Through the transparent sections of the facade the life inside is revealed, but not disclosed, waking a curiosity to move closer and experience what is going on inside.



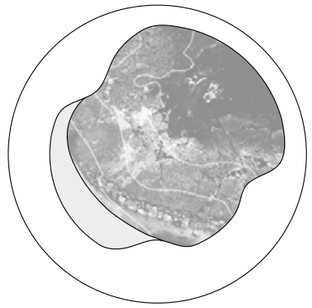
Ill. 80a Principal section showing the heights of the lighthouse and the centre and their relation to the sea and the fiord respectively.

Ill. 80b Approaching the building

Courtyard

The courtyard serves as the main entrance for visitors. This outdoor space is the heart of the centre. While being a untouched piece of the landscape, places for rest and activity are incorporated as part of the building geometry. The large terrace, looking out onto the water inlet and the floating part of the building, serves as a multifunctional platform. It marks the difference between the man made and the nature by floating, above the ground, separated from the rock below. By forming a part of the bottom plane, which defines the building volume, the terrace blurs the edge between inside and outside, and can act as a natural part of the activity area in the summer. The special zinc cladding on the two edges, continues as steel flooring both outside and inside, to underline the idea of two planes suspending a prism in between. As another feature connecting inside and outside, the indoor amphistairs continues outside, marking the entrance, just next to them.
Towards the courtyard the building has a much more inclusive and transparent character, providing a natural overview of all the activities which takes place in the centre.

Ill. 82 The internal courtyard with the large terrace.



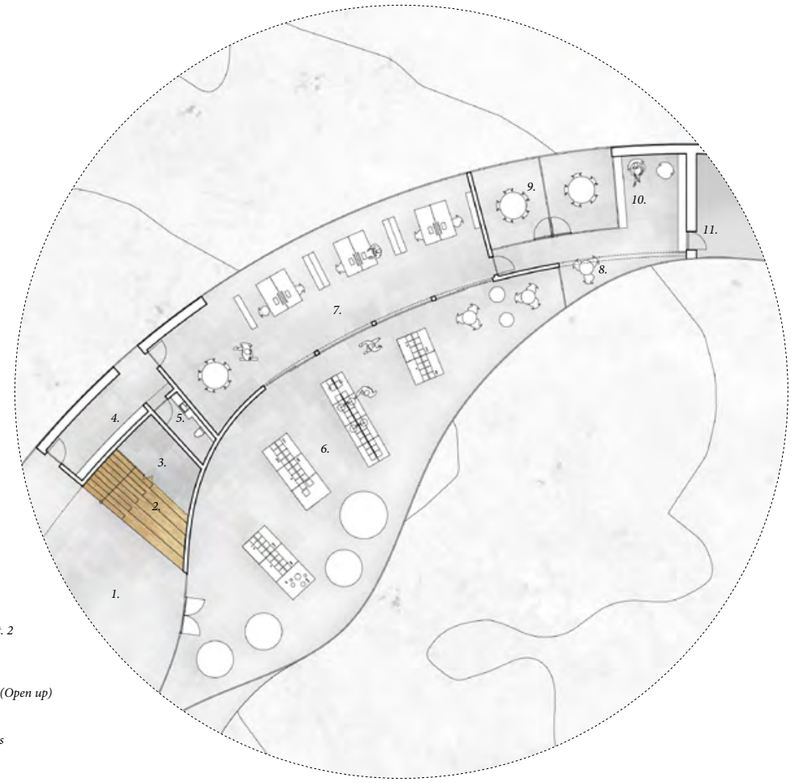
Ill. 83 The internal courtyard magnifying the landscape

Groundfloor

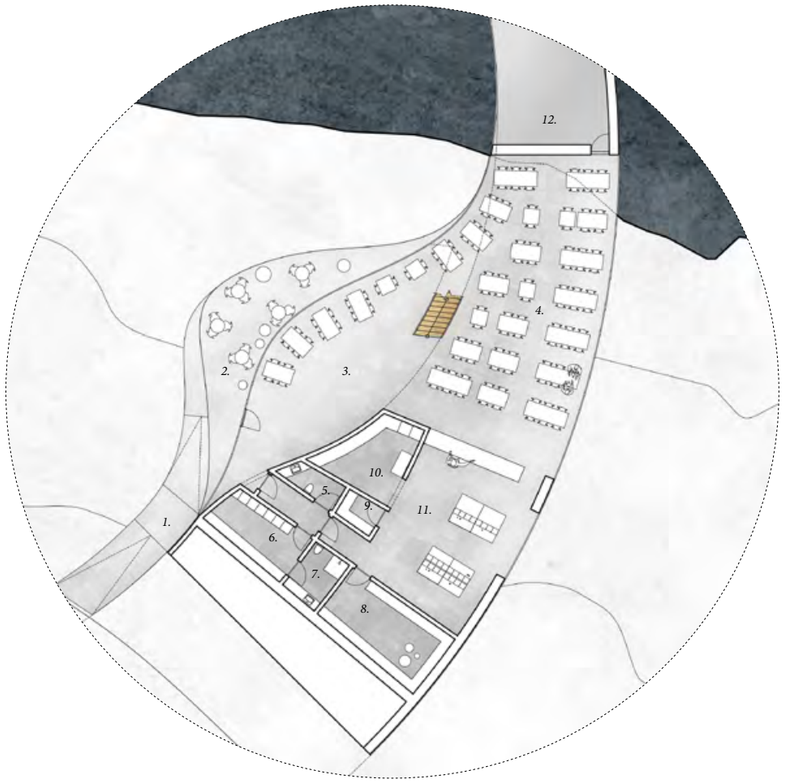
The ground-floor is situated three metres above sea level, making it safe against surge and storm floods. Coming from either the courtyard or the entrance towards the lighthouse, the visitors enters the foyer. From here wardrobe and toilets is easily accessible, and the shop is installed in the double height foyer space. The first part of the exhibition contains large artefacts and focuses on the Aquaculture. The research unit is placed with a close visual connection towards the exhibition, and features more private offices and a meeting/library/study section towards the ocean. The café sits opposite facing the fiord, and is accessible from the outside too via the small terrace. The staff and service unit features offices towards the life and views in the courtyard, and storage, workshop and laundry towards the service entrance opposite. A technical room is placed under both stairs and the cantilever, serving the respective parts of the building.

1. *Terrace*
2. *Foyer*
3. *Exhibition pt. 1 (Open up)*
4. *Lab/Workshop space (Open up)*
5. *Offices*
6. *Library and meeting/group rooms*
7. *Dining area*
8. *Kitchen*
9. *Staff workshop*
10. *Cleaning*
11. *Staff offices*
12. *Storage*
13. *Technical*
14. *Toilets and wardrobe*

Ill. 84 Ground floor plan 1:500



1. *Exhibition pt. 1*
2. *Stairs to exhibition pt. 2*
3. *Technical/Storage*
4. *Wardrobe*
5. *Toilet*
6. *Lab/Workshop space (Open up)*
7. *Office for researchers*
8. *Niche*
9. *Meeting/Group rooms*
10. *Study/Library*
11. *Technical*

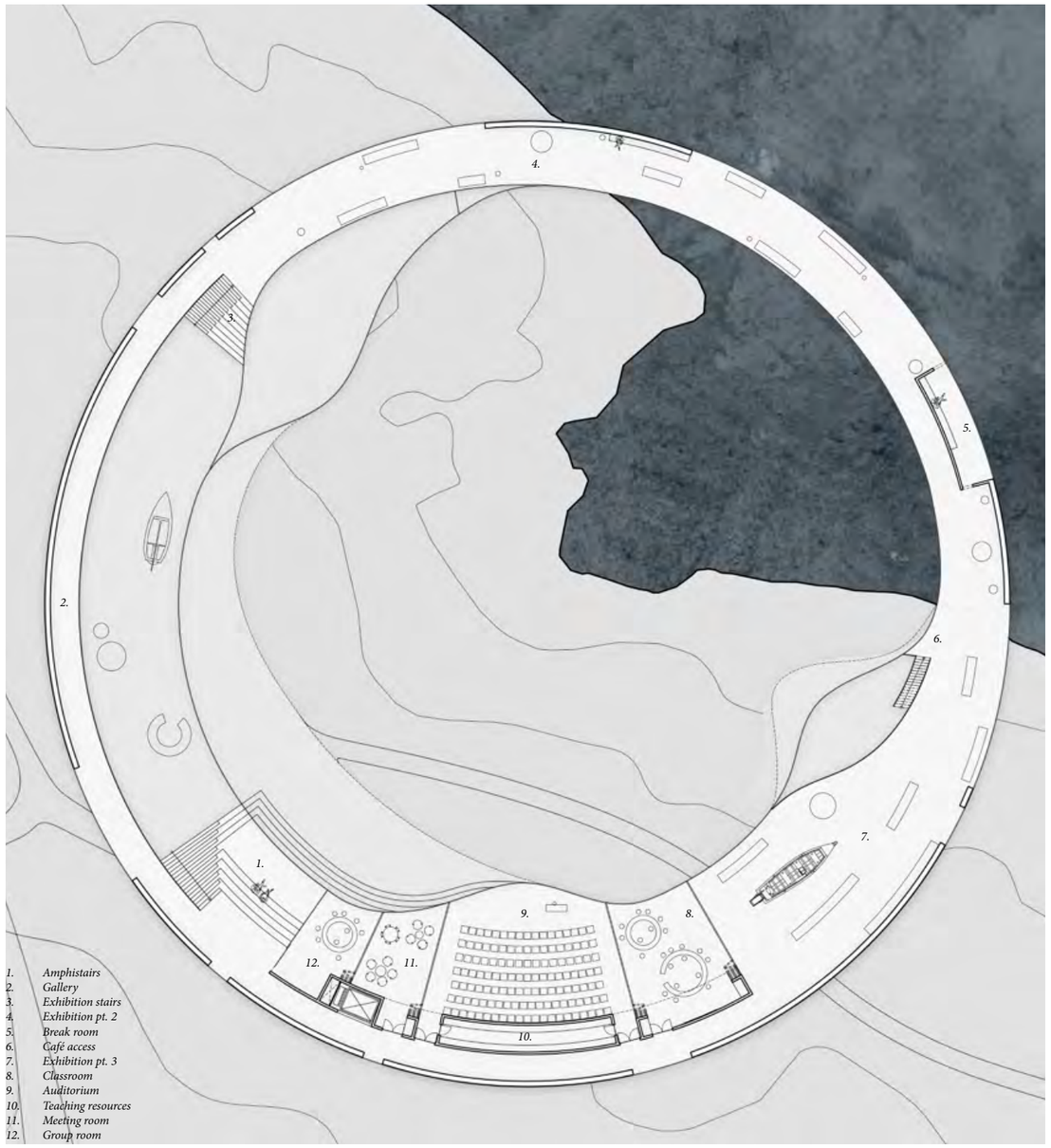


1. *Ramp for access*
2. *Terrace*
3. *Dining (Open up)*
4. *Dining*
5. *Toilet*
6. *Staff wardrobe*
7. *Staff toilet and shower*
8. *Cold store*
9. *Storage*
10. *Dishes*
11. *Kitchen*
12. *Technical*

Ill. 85 Zoom-ins. Research (top) and Café (bottom) 1:300

First floor

The first floor is dedicated to exhibition and education. The natural flow continues from the exhibition part on the ground floor up the stairs which also acts as a kind of large scale furniture in the building, providing larger steps for people to sit and rest on, and a clear transition from the first to the second part of the exhibition. The second part of the exhibition focuses on the navigation theme, and continues past the raised part with views down into the laboratories, out onto the bridge. Before moving into the third part of the exhibition another transition is created by a small break room, where the views can be enjoyed. The narrow space opens up to a wider, with natural access down into the café, and an exhibition focusing on the maritime industries. Finally the educational part is placed as a flexible unit with partition walls in frosted glass, and with easy access to the foyer and amphistairs which also acts as an active part of the education unit.

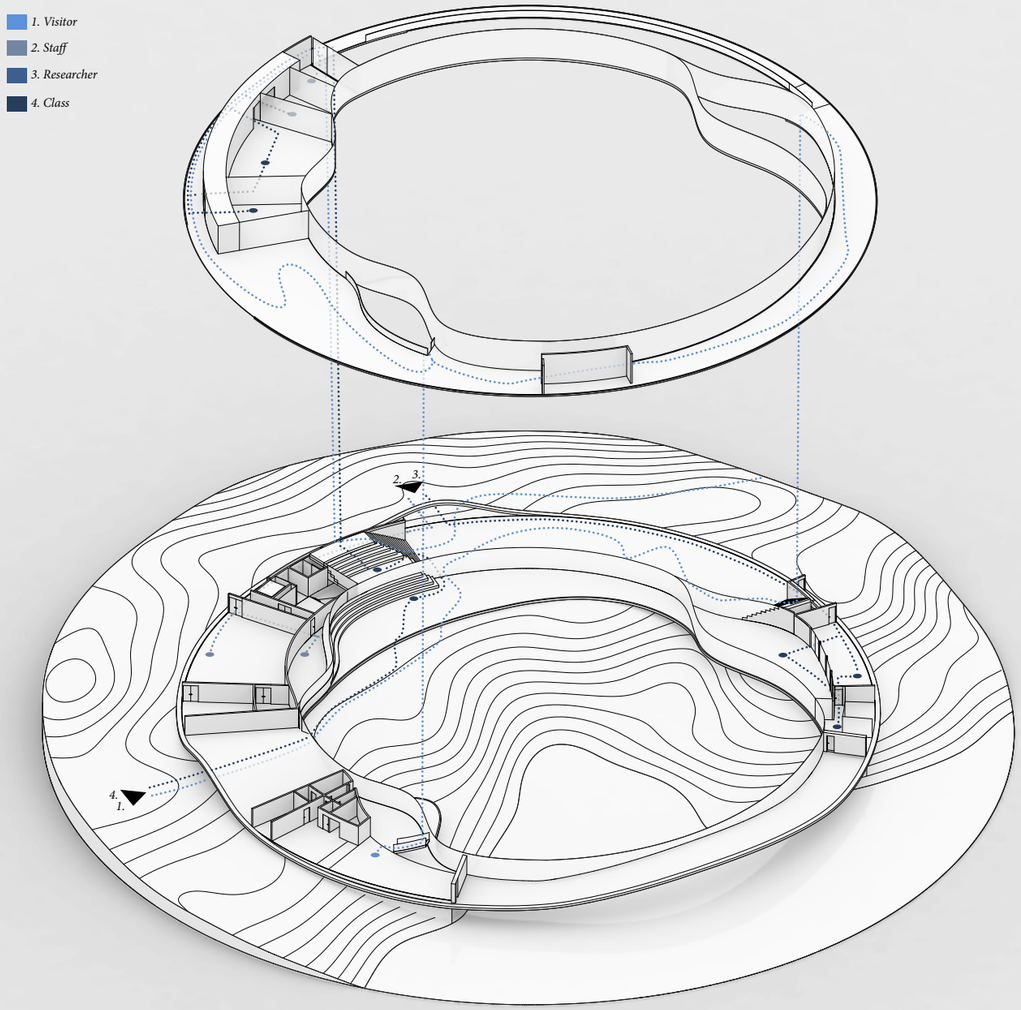


1. *Amphistairs*
2. *Gallery*
3. *Exhibition stairs*
4. *Exhibition pt. 2*
5. *Break room*
6. *Café access*
7. *Exhibition pt. 3*
8. *Classroom*
9. *Auditorium*
10. *Teaching resources*
11. *Meeting room*
12. *Group room*

Ill. 86 First floor plan 1:500

Circulation

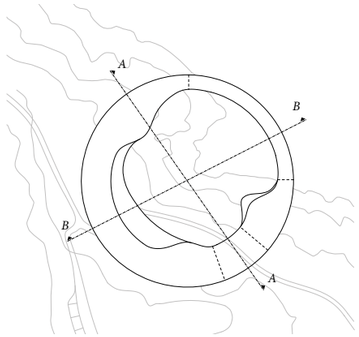
The centre is designed for a large variety of users and with the aim of interaction among these in mind. To accommodate this, a single entrance point, which can be accessed from both sides, emphasises the feeling of activity in the centre.
An important concept is that the visitors are naturally guided into the courtyard. From here they can either continue straight through the public foyer, or make the loop to see the exhibition, and then continue on the path along the coast. This makes the centre a natural part of the experience of the place, and creates a more interactions with the visitors of Tungenes.

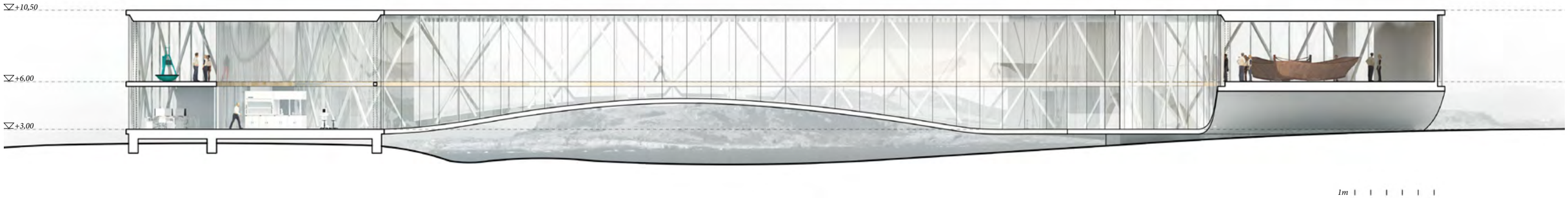


Ill. 87 Circulation diagram

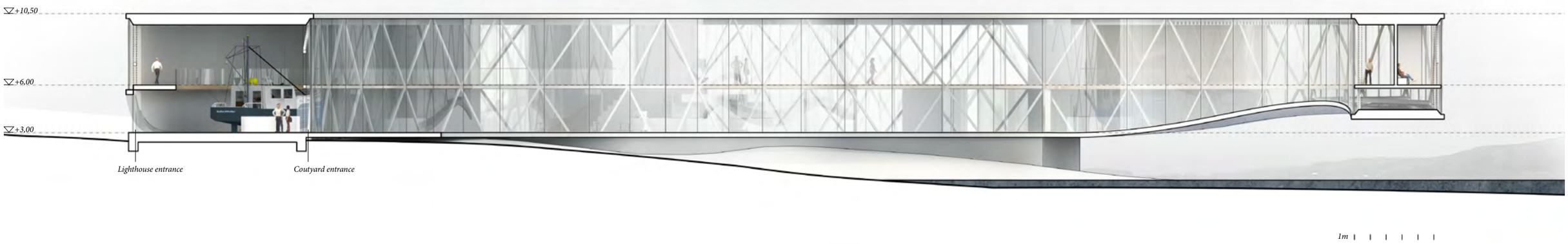
Capturing the nature

The building volume captures a piece of the local landscape inside the courtyard. This interaction with the landscape, magnifies and strengthens the identity of the place. The first section shows how the entrance to the courtyard is created by lifting the building, and how the research department is visible opposite from it. The view under the bridge emphasizes the framing of the natural landscape in the courtyard, and across the fiord.
Section BB show the bridge, cantilevered over the water with the room for enjoying the views over the fiord, and opposite the foyer where users enters.





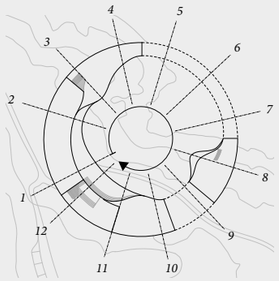
Ill. 88a Section AA through entrance and research 1:250



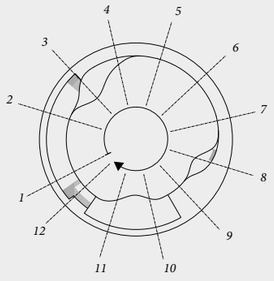
Ill. 88b Section BB through foyer and bridge 1:250

A spatial journey

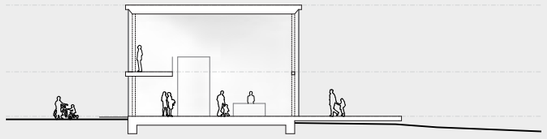
As a natural part of the coastal walk, and with such a prominent location right on the shore, it is important that the centre provides spatial experiences which emphasises the place, and offers different atmospheres and views. The investigation shows the different types of spaces, and how the visitor moves clockwise through the exhibition, naturally encountering the full diversity of uses which the centre caters for.



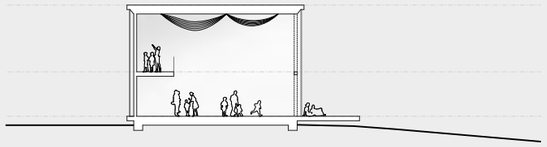
Ill. 90a Section cuts, ground floor



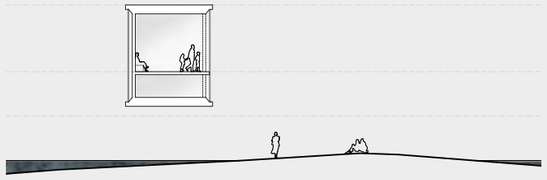
Ill. 90b Section cuts, first floor



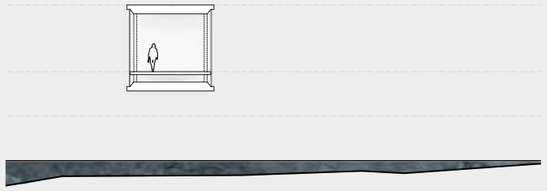
1. The entrance which is accessible from both sides, is a public passage through the building. The terrace serves as a natural transition to the interior space. The gallery walk, which runs along the exhibition space, creates a connection for the physically challenged, as well as fine views to Tungenes Lighthouse towards the west.



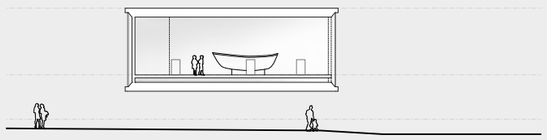
2. The large exhibition space creates the possibility to have large items such as a boat or the large fish tank on display. The gallery can be used for smaller temporary exhibitions. This part of the museum is closed towards the outside, and open towards the courtyard, to emphasize the orientation towards the maritime.



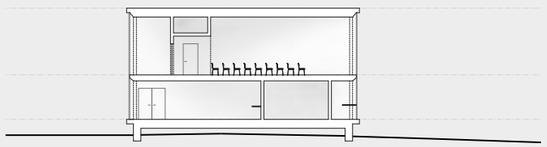
5. The second part of the exhibition has begun, and the space is starting to build up the sensation of being on the bridge of a large ship, though still only opening up towards the life in the courtyard. Along the exhibition small places for rest is provided. Outside, people can experience the building and the water up close at the shore of the fiord.



6. At he middle of the bridge the full maritime experience is achieved by opening up towards the water below on both sides of the building, and creating a sensation of almost hovering over the water.

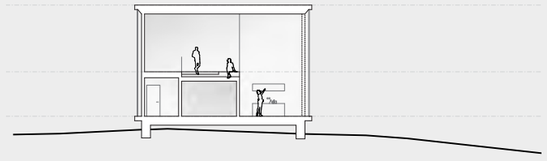


9. The wider exhibition space provides a third experience for the visitor, who can experience industrial maritime artefacts close up. At this place, the building has lifted itself, to provide the entrance from the east and into the courtyard.

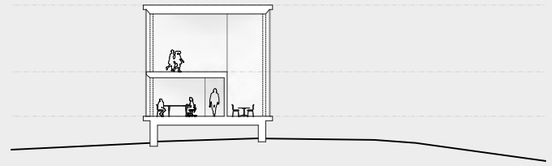


10. In the last part of the exhibition flow the visitor passes by the education unit, where classes and events can take place, but also movies and other exhibition related activities from time to time. Below the service and staff have their offices, workshop and cleaning facilities.

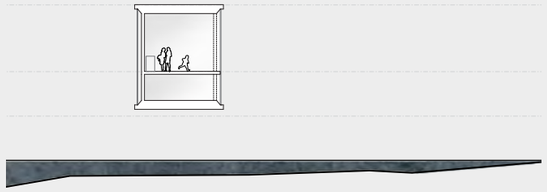
Ill. 90c Sections 1:400



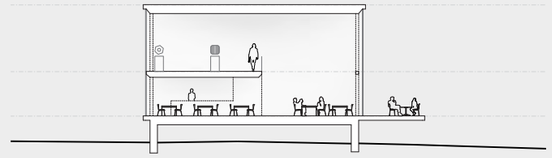
3. Moving on to the second part of the exhibition, the research department is visible through the glass wall. Under the stairs, private wardrobe and a toilet for the researchers are placed. The openness is still oriented towards the central courtyard.



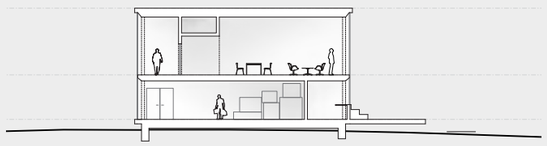
4. The building starts to provide glimpses of the sea which is now visible outside the window. In the research department below, the office and meeting room section has excellent views towards the sea to the Northwest.



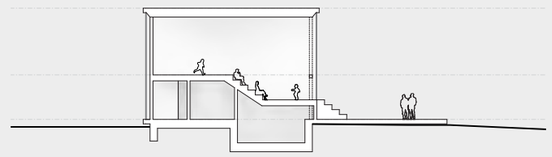
7. Back towards the land, the space turns more introvert again, to focus on the exhibition. Here the visitor has passed the small break room, and has entered the third theme of the exhibition, the maritime industries.



8. Here the cafe and exhibition area exists with an open double height space providing the connection. The terrace is part of the lower floor which continues out like at the bigger terrace by the entrance. In the more private dining area under the exhibition, guests can enjoy their meals while looking out towards the fiord with its backdrop of mountains.



11. Still a variation of flexible rooms for educational purposes with great views towards the courtyard and the water. Below are the large goods storage and the staff offices. The staff office is an open plan solution with flexible touch down workplaces. The long desk running along the window seems to grow out of the amphistairs outside.



12. The second and largest staircase is the largest furniture in the house, with its multiple levels connecting inside and outside, providing a final place to rest and get informal lectures, all while enjoying the views towards the ocean. The stairs also creates a close connection between the entrance, foyer, and the educational unit on the first floor.

Ill. 92 Exhibition space and research department

A holistic science centre

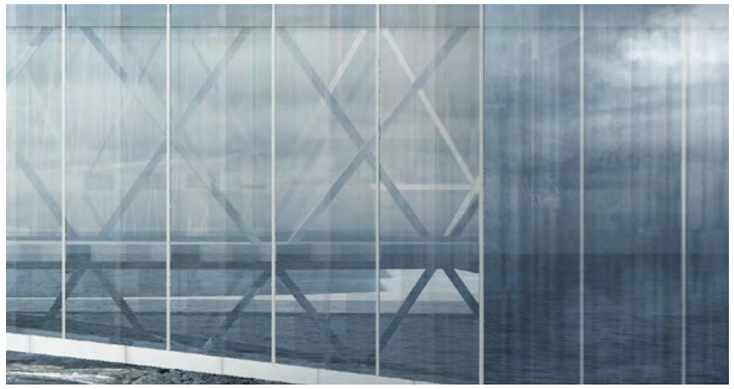
Inside the exhibition space, the full experience of the centre becomes evident. As a platform housing research as well as science centre, the close contact between the two functions creates a symbiotic effect. By having them so close together the laboratory becomes a flexible space, which can also be integrated for workshops and other activities if a specific research project is not ongoing.
The materials and spatial flow supports the atmosphere of a maritime centre. The industrial material of the floor and the ceiling, is supplemented by a wooden slab which connects to the stairs, making them large pieces of furniture for sitting, relaxing and informal learning. The exhibition design should further emphasize the atmosphere by visually providing informative and intriguing knowledge. Integrating the visual identity in a maritime theme further strengthens the unique identity of the centre.
The atmosphere created by the materials, and the open character of the building invites the visitor to interact and participate, and to engage in informal learning situations. The curves controls the flow and draws references to the sea just outside.

Materials

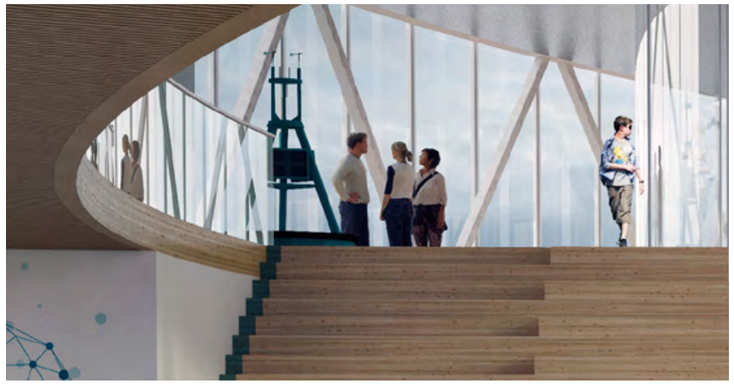
In the experience of the spaces and their atmospheres, the materials are of utmost importance. The atmosphere the architecture aim to create is one that draws references to the maritime in a contemporary manner to support the vision of a holistic science centre, while providing different spatial experiences.
The concept for the materials are developed from the concept of the building. The two planes which are the roof and bottom, are created with a hard, industrial finish in steel and zinc. The reference to the maritime construction is clear, since steel is the most common material in industrial ship building. Suspended between the two surfaces are a wooden slab. The first floor slab is not expressed on the facade, but connected to the ground floor, through the wooden stair elements. The wood, being another maritime material, used in more refined vessel designs, caries another line of references to being on the deck of a ship. Furthermore, the wood offers a warmth to the colder materials and a softer tactile sensation. The roof is of the same character as the bottom, but the ceilings are clad with perforated steel, to enable acoustic absorption and a feeling of depth. The glass is used in many places inside the building, and seeks to create a emphasized experience of the horizontal elements. Frosted glass is used on the closed parts of the exterior facade, as well as for flexible separation walls in the educational department. The structure is painted white, with fireproofing paint, to create the sense of a light separate system.

Ill. 94 Concept for materials. Two hard surfaces with a soft in between

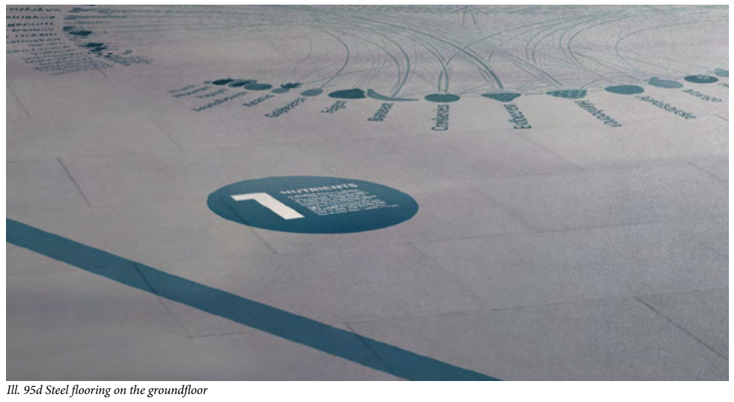
Ill. 95a ceilings in perforated steel.



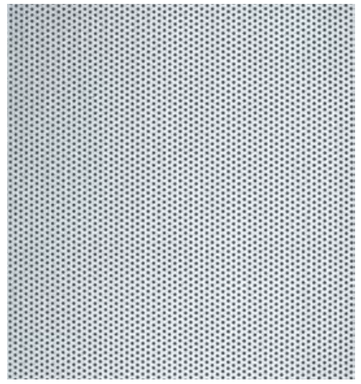
Ill. 95b Frosted glass on parts of the facade and in the educational section

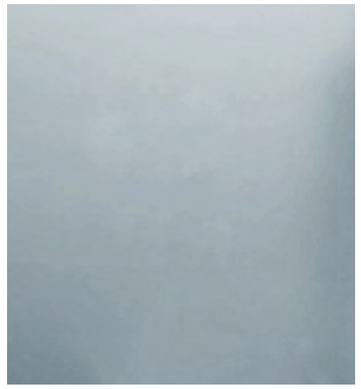


Ill. 95c Wooden 1st floor and stairs



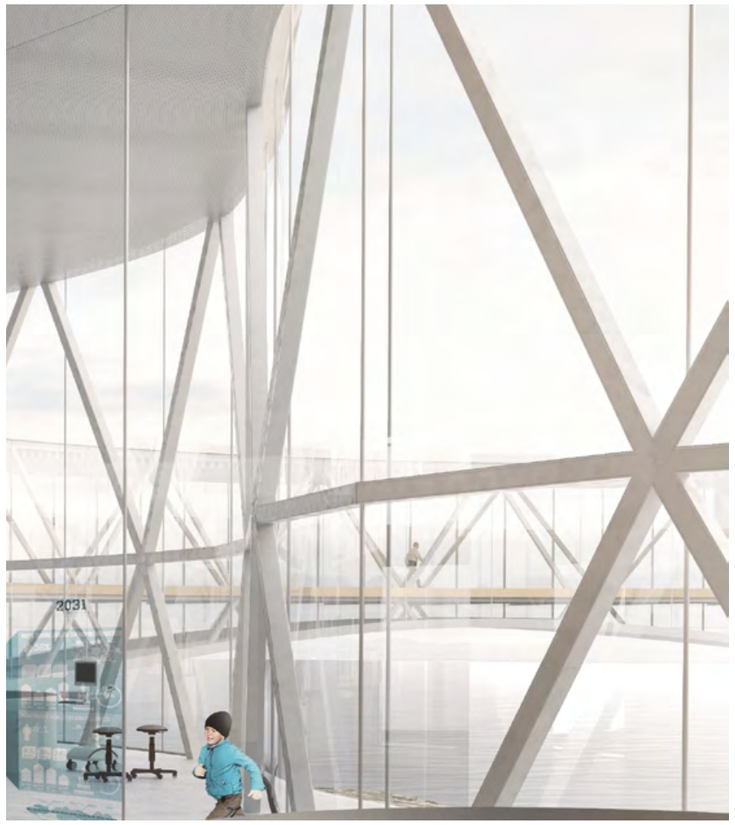
Ill. 95d Steel flooring on the groundfloor





Construction

As a house of science, the structure has been an important part of the expression of the building. The concept, and the structural challenges inherent, have benefited from an integrated approach to designing, where these technical considerations are thought as aesthetic potentials, rather than challenges.
The building consists of several layers, conceptually as well as physically. In the analysis an approach to the understanding of the tectonic field was defined, and in this section Semper's four basic elements of architecture will be used to describe the build-up of the different elements while Frascari is more used in the way materials and transitions in atmosphere are thought.
Frampton was also mentioned, and in line with his thoughts of the building as being first and foremost a construction, the expressive potential of the structural system have been used in this project. The structure emphasizes the buildings function and identity as a science centre, and creates a guiding gesture along the circular flow due to its dynamic shape. For calculations on the steel structure, see appendix.

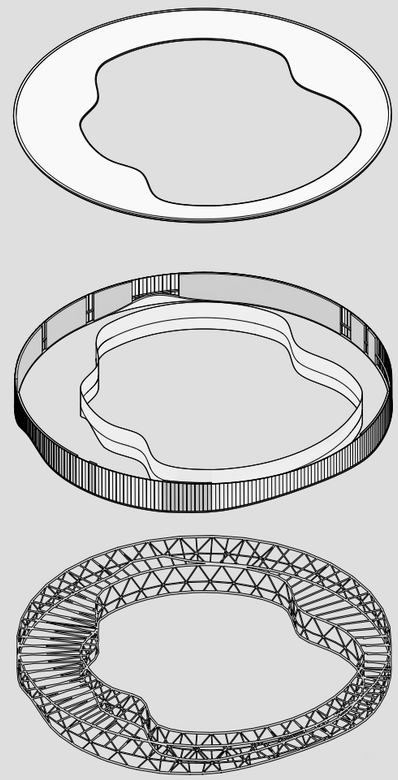


Ill. 96 The expressive potential of the structure utilized

The 'roofwork' is the top facade, protecting the building against weather from above. Conceptually it works together with the lower slab, to define the boundaries of the building. The light structure and the base in general work as oppositions, to further emphasise the contrast between the light floating structure and the heavy base connected to the ground.

The facade or the 'infill wall' consists of an interior system towards the courtyard, and a exterior towards the surroundings. The exterior facade caries the concept of a Fresnel prism, due to its faceted character, and division in sectors, as seen in the lighthouses. The interior facade is all glass to strengthen the connection between the different functions. Both facades are fastened to the structure to ensure stability.

The 'woven structure' is a filigree truss structure of two trusses wrapped around the interior and the exterior facade respectively. Where the truss meets the base, pinned joints support it while allowing for the necessary flexibility in the rigid structure. Seen in section the system is seen as a two hinged frame due to its stiff fixed joints.



The first floor slab, is clad in wood, and floating inside the structure. This storey is very much an open plan, which offers references to moving around on a ship. The support core of the educational unit works as a functional support for these flexible spaces. Inside the slab, structure spans across and stabilises the structural system.

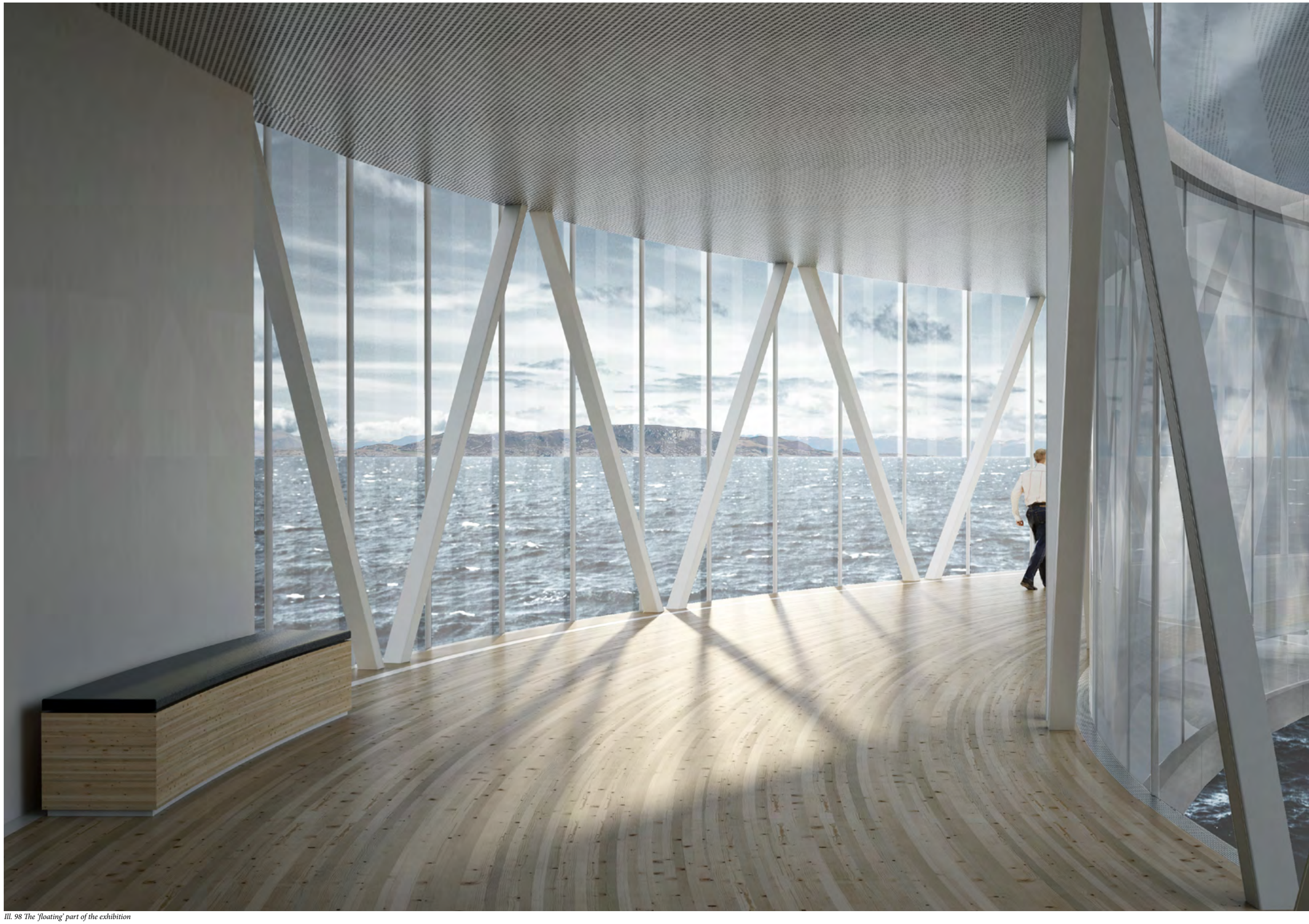
The ground floor slab is articulated in the facades, and conceptually thought as a metal disc. In reality it is not a solid construction, but the lower facade of the building, wrapping the underside of the spaces. The partition walls help stabilize the structure further where appropriate.

The 'earthwork' or podium of the building, is made as a base in concrete. The material creates a natural connection to the rock on which it rests due to its similarity in roughness, tone and tactility. The base also ensures the necessary protection from the ocean and waves. The concrete will have to be a special mix, with a pozzolanic cement or other mixes which withstand seawater better than ordinary Portland cement.

Ill. 97 The elements of the construction

The Bridge

In contrast to the larger exhibition spaces, with their many activities and high ceiling, the bridge provides a different atmosphere. The wooden floor creates a more delicate surface to move on, and windows at both sides opens up to the exterior. This feeling of floating over the water below is emphasized by the transparency of the facade and the lightness of the structure. This is where the structural system is utilized to its full potential, and the visibility of the structure gives a clear understanding of how the building physics work like a bridge. One can say that the expressive potential of the structure is utilized. The structure further emphasises the movement along the storyline of the exhibition.
In this part of the Exhibition, the focus will be on navigation and handling of traffic at sea. A theme which is supported be the proximity to the sea.



Ill. 98 The 'floating' part of the exhibition

Climatic screen

Situated on the west-coast of Norway, with a climate very similar to that of Denmark, the building needs to be able to adjust to both temperate warm summers with long hours of sun and cold winters with occasional snow.
With a wish for a uniform, transparent institution this can be a challenge, and therefore a number of concepts and solutions have been implemented.

Facade
The introverted character of the building makes it possible to utilize the concept of the lighthouse further in the facade. This means that two kinds of exterior facade exists on the building. The open parts are regular 3 layered energy windows, which have been detailed with a kink in the glass, to create and abstraction of the effect seen in the Fresnel prism, where reflections and light, is directed and bend. The closed part of the facade is clad with the same windows in a frosted glass version, and has an insulated wall covering the structure. In the gap between, a climatic feature is thought in. The space is essentially a narrow sun-space, with automatically operable windows in the top and bottom. The space can be used to preheat air in the winter for natural ventilation, or the buoyancy force of the heated air can be used as driving force to naturally ventilate during the hotter months of summer. On the interior facade an automatic sunscreen is hidden in the top edge of the construction, for especially sun exposed surfaces. This is only for the very few highly exposed parts of the interior facade. For further investigations of sun and wind, details in 1:10 and further climatic considerations see appendix.

Details and installations
A few design details have been incorporated in the interior. Along the bottom of the floor to ceiling windows, heaters are built into the floor to stop down-draft, and ensure a comfortable indoor climate. Along the top of the windows, on the inside, a strip of RGB LED lights enables the building to create its glowing character during the darker hours too.
The perforated metal ceilings are suspended from the construction, enabling them to act as an acoustic absorbent, by placing insulation above.

Construction

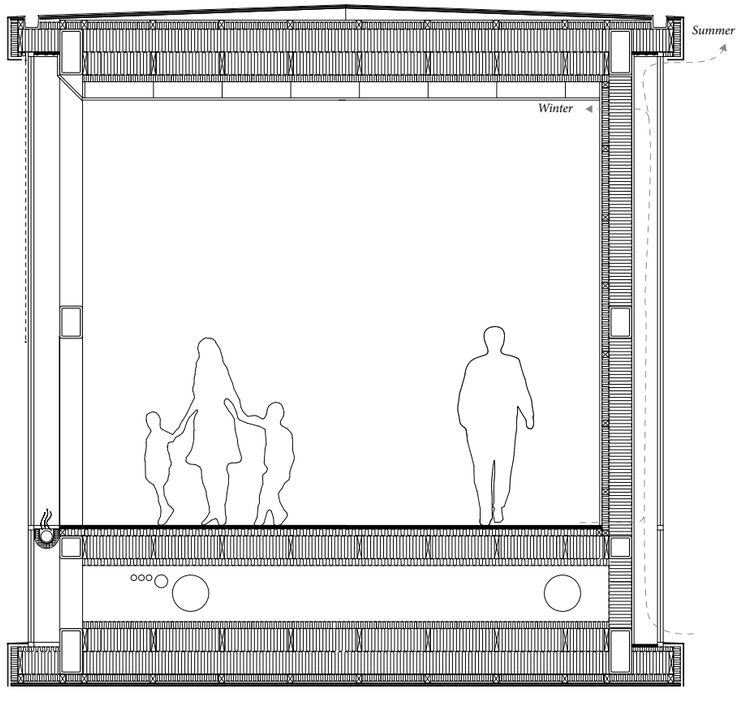
Roof and bottom
- 520mm insulation total
- Wooden laths between the steel structure, for fastening of roof, ceiling etc.
- Azengar zinc® cladding
- The cladding on the roof and bottom is securely fastened to prevent damage from suction due to wind passing under and over.
- Gutters are hidden in the construction.

Climate wall w. sun-space
- 3-layered energy window w. frosted glass
- Active sun-space with ventilation openings
- 260mm insulation total
- RGB LED in the top

Transparent wall sections
- 3 layered energy glass in windows.
- Heater to prevent down-draft bellow
- RGB LED in the top

Structure
The frame is made in S450 steel, painted with white fireproofing paint.
- Top and bottom chords: 200x400 Quadratic hollow profiles, thickness: 16mm.
- Diagonals and middle cords: 200x200 Quadratic hollow profiles, thickness: 16mm.
- Top and bottom connecting beams: 260mm INP-profile per 5 deg.
- Floor beams: 200-300mm INP profile per 5 deg. (depending on the span - 200 mm for the shortest spans)

(Jensen 2015)

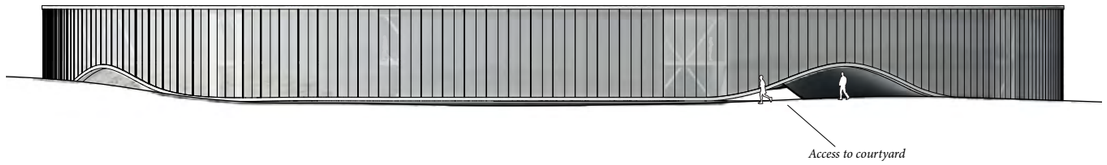


Ill. 100 1:50 section of the 'bridge' - See appendix for 1:10 details

Ill. 101 Facade seen from the seaside. The transparency of the building makes the structure visible as layers on top of each other

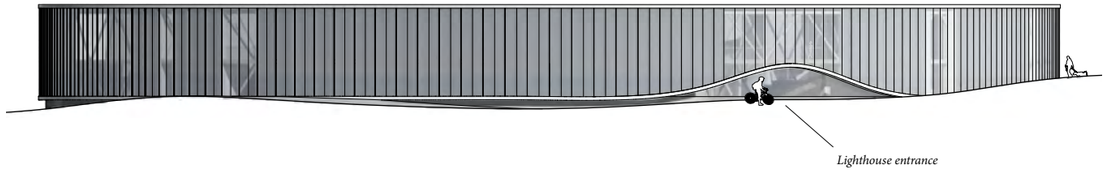
Facades

The facade shows how the closed and open parts of the facade are applied in relation to the sun study which can be seen in the appendix. The parts towards the south and west are more closed, to enable the sun-space to utilize the power of the sun and avoid overheating.
The openings invites the visitors inside, and the two entrances are clearly visible as the bottom surface lifts itself up.
The concrete base serves to separate the built from the natural, and distinguish between the culture and the nature.

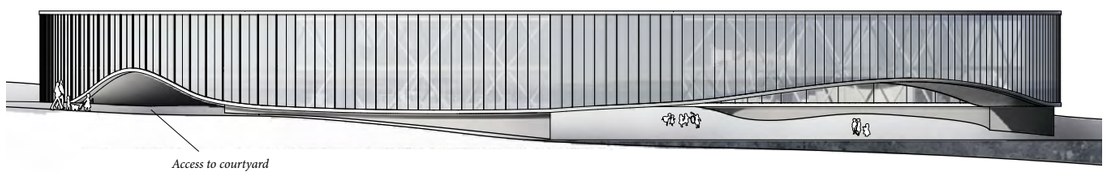


Ill. 102a Facade from the South 1:500

Ill. 102b Facade from the North 1:500



Ill. 103a Facade from the West 1:500

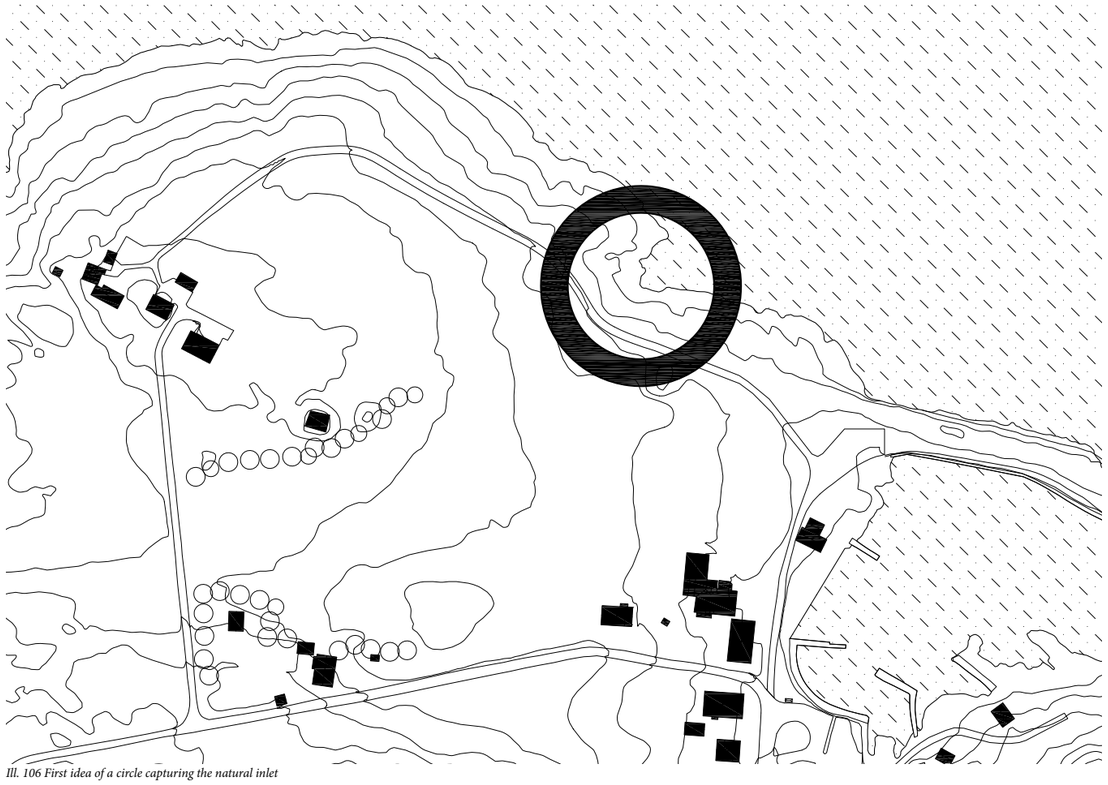


Ill. 103b Facade from the East 1:500

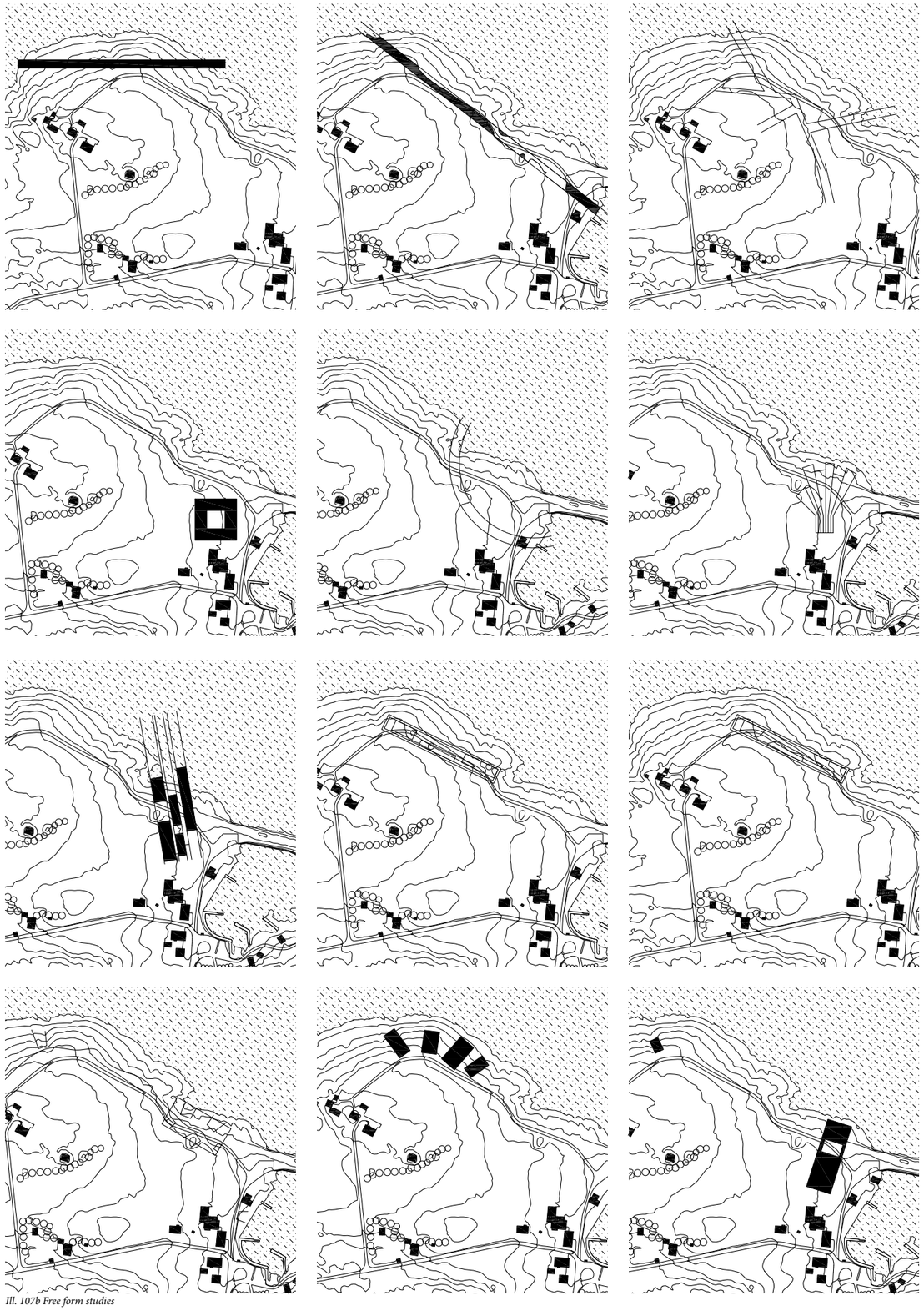
Design Process

Initial studies

The first round of sketching investigated the potentials for placing different compositions of volumes in the landscape. They where evaluated on their potential for interaction with the terrain and the transition between the water and the land.
Later studies of the program and the required connections showed the need for a connected volume, with a natural flow of a variety of rooms offering different spatial qualities for different functions.



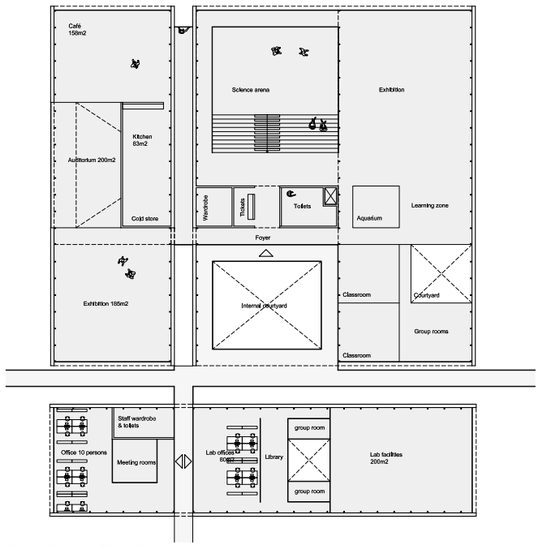
Ill. 106 First idea of a circle capturing the natural inlet



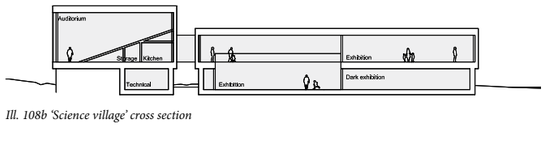
Ill. 107b Free form studies

Concept tests

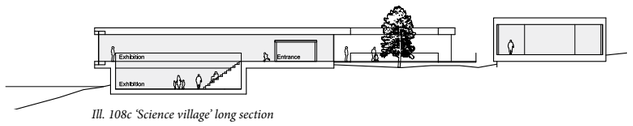
An important part of the process was the study-tour. The results of the site visit and registrations from the site is represented in the analysis.
These registrations led to the development of a variation of concepts. What they had in common was the idea of interacting with the path which runs along the coast line. Different ways of approaching the scale of the building lead to different concepts.
The first concept which was detailed worked with a notion of the science village. This proposal was dropped since it had trouble meeting the scale of a real village due to restrictions in the programme concerning large connected spaces.
Simultaneously the circle came along as a volume which had the potential to create its own unique identity to the place, while connecting to the maritime scale.
An idea which where common for these proposals where that the building should create a connection between the land and the water, and that the visitor should enter directly into the heart of the building.



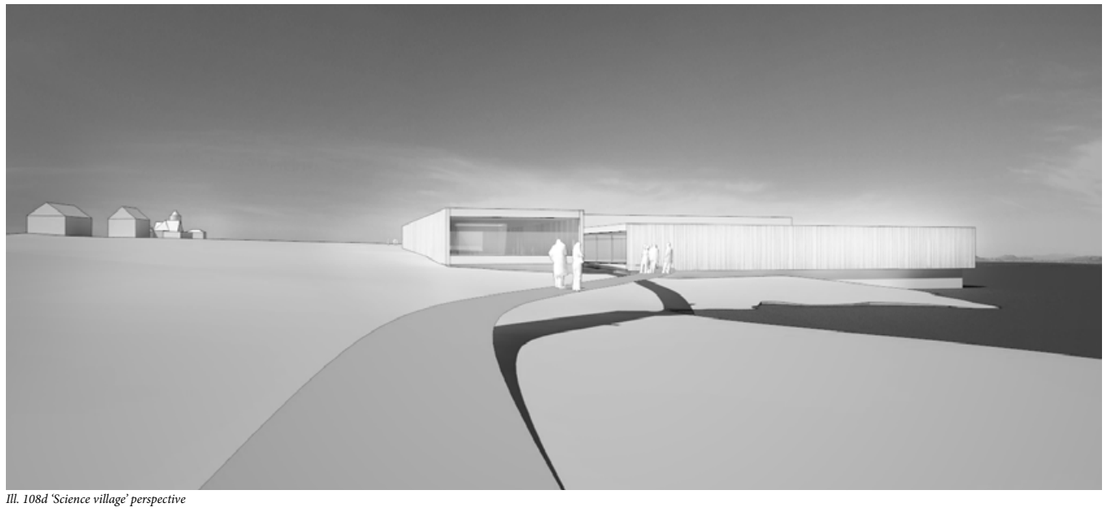
Ill. 108a 'Science village' plan



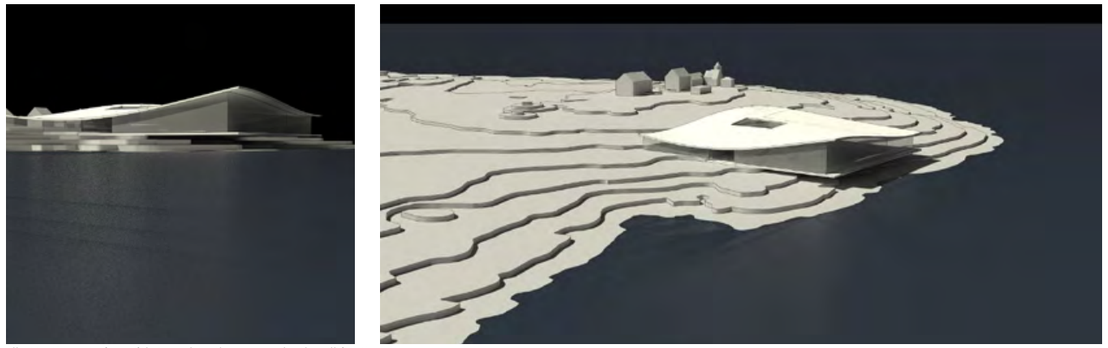
Ill. 108b 'Science village' cross section



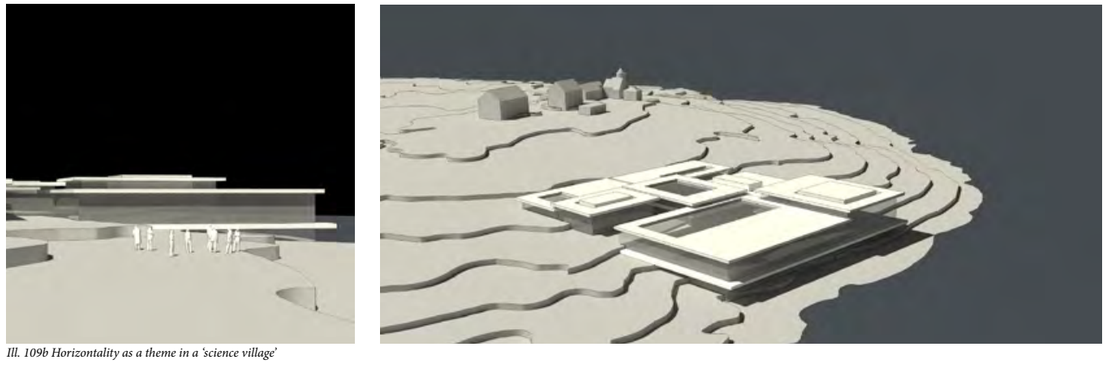
Ill. 108c 'Science village' long section



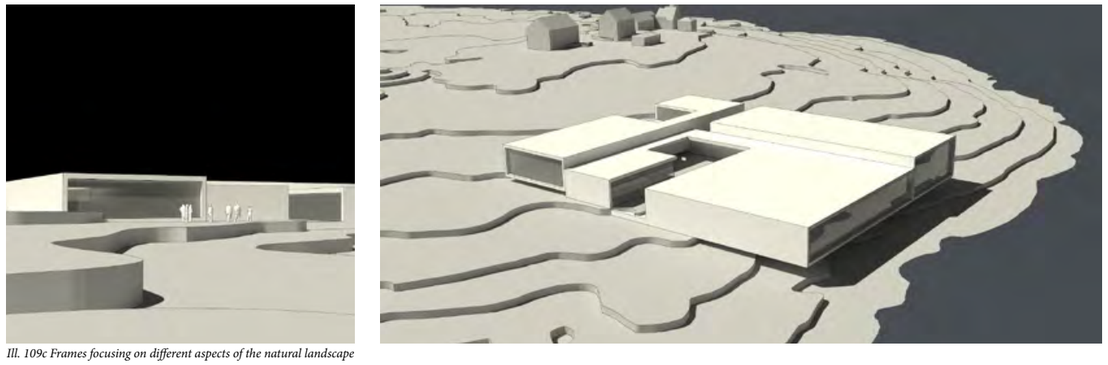
Ill. 108d 'Science village' perspective



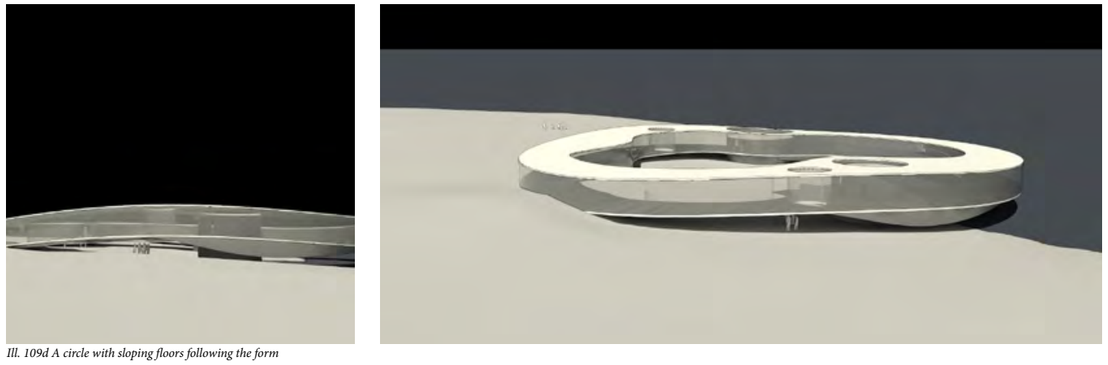
Ill. 109a Concept of a roof that simulates the waves and gather all functions



Ill. 109b Horizontality as a theme in a 'science village'



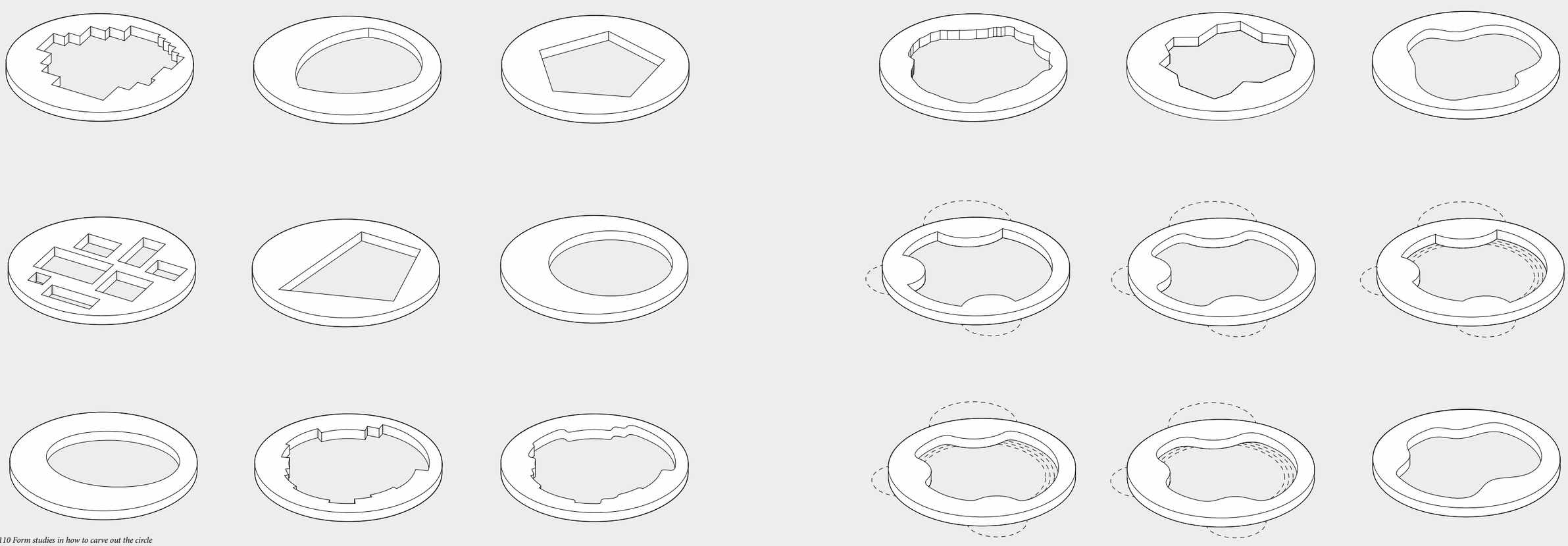
Ill. 109c Frames focusing on different aspects of the natural landscape



Ill. 109d A circle with sloping floors following the form

Form

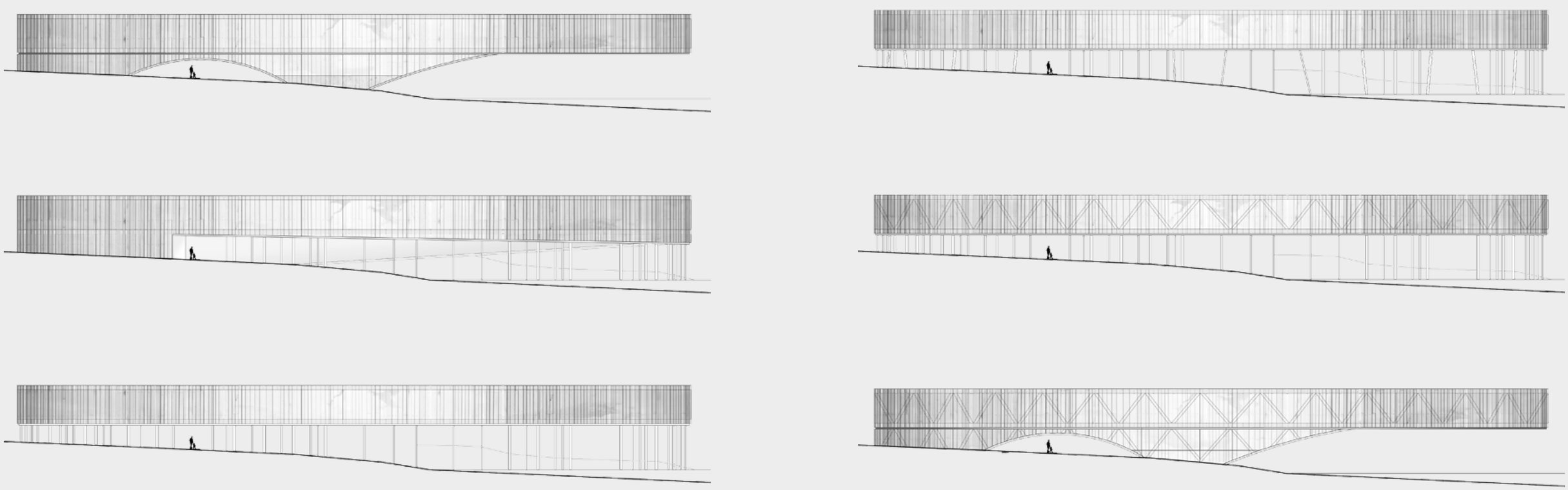
Once the circle had been settled as a form which had the potential and inherent stories to support a strong concept, the form was explored further. The courtyard was part of the concept from the beginning, but the formal language was tested in a variety of more or less contrasting shapes.
The idea was to create a balance between working with the human scale inside, and creating a contrast to the exterior facade. By expressing the adjoining function in pockets, and using an organic shape, a familiarity and contrast is reached simultaneously.



Ill. 110 Form studies in how to carve out the circle

Structural ideation

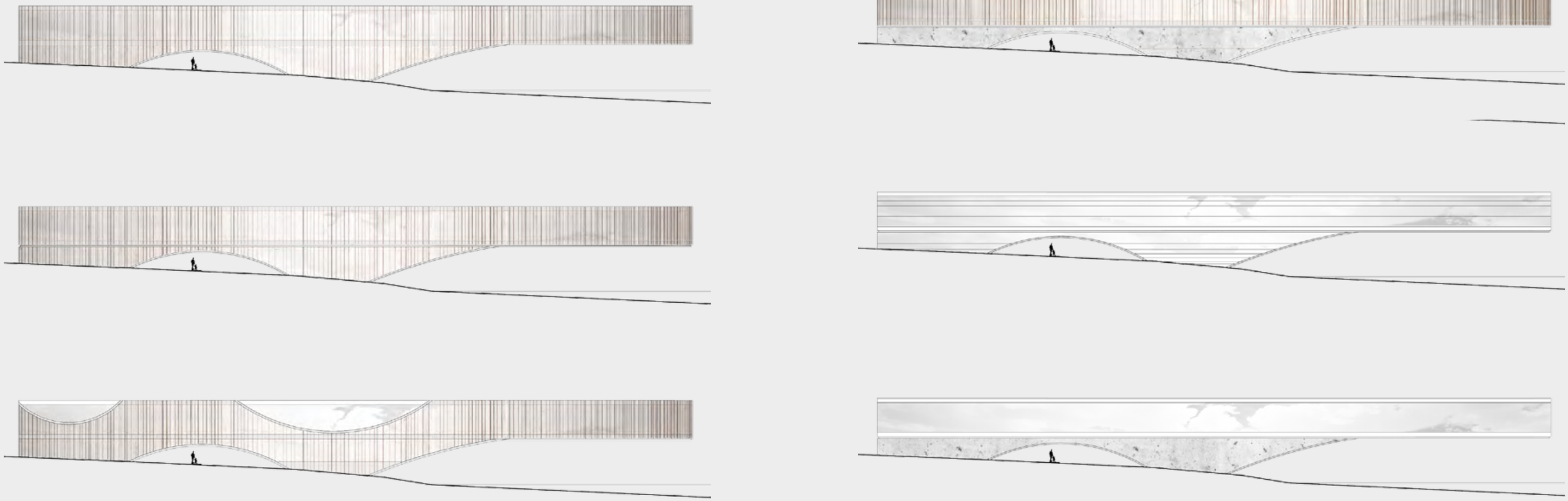
An early attempt to clarify different ways of using structure actively in a circular building volume.
Either the building plants itself into the rock, or it is held floating on columns or a base. The columns can carry a maritime reference, but also quickly turn the building into something stranger to the place.
By integrating the structure into the volume the aim is the maintain focus on the building volume itself, and at the same time create a building which lifts itself off the ground where needed.



Ill. 112 Sketches of structural systems and the building

Facade ideation

Different facades are tested. They all work with a certain degree of transparency, through materials or systems which can hold different construction solutions without revealing the changes.
The way of integrating the base in the volume or separating it by a strong contrast in materials are also investigated.
The materials are mainly drawing references from the maritime environment. Through the use of wood, metal sheeting or glass.
By emphasizing a light building volume in materials, a light filigree structure and aiming to make it seem floating over the base, the large scale of the building can be softened.

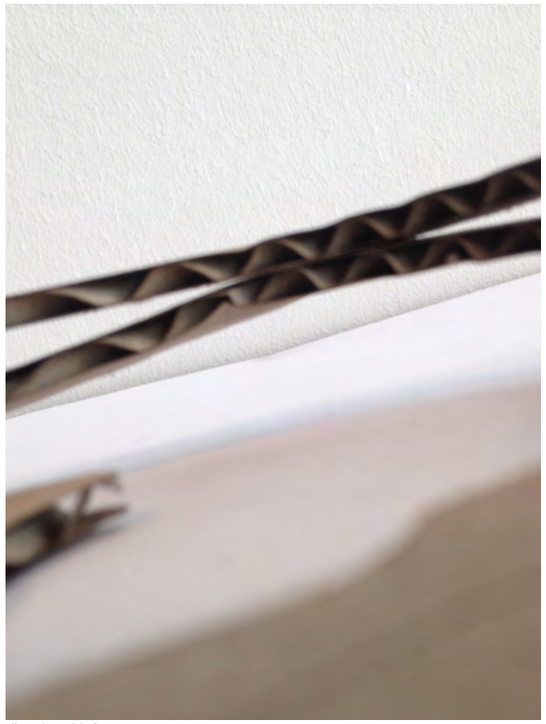


Ill. 114 Sketches of facades and materials in connection

The floating volume

The structural aim is further defined to support the idea of a floating volume. By cantilevering almost a fourth of the circle above the little inlet along the cost, a dialogue between the ocean and the land is initiated.
The model shows the intention of letting the volume lift itself off the ground as a welcoming gesture towards the visitor. At the same time the volume is broken down into two planes. A top plane which is strictly horizontal, and a lower one which lifts itself over the water and the entrance in a gesture towards the landscape and the visitor.

Ill. 116a Model of concept



Ill. 116b Model of concept

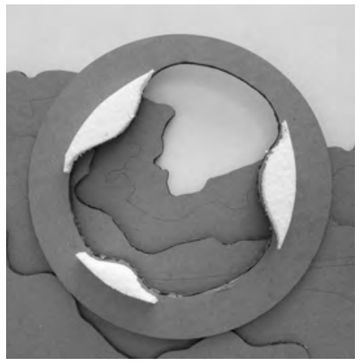
Ill. 117a Model of concept

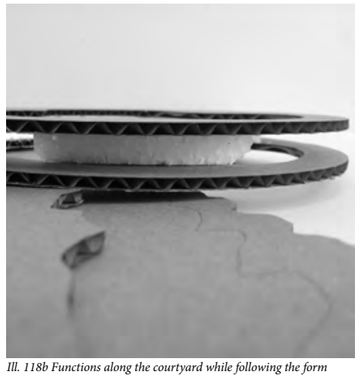
Ill. 117b Model of concept

Plan systems workshop

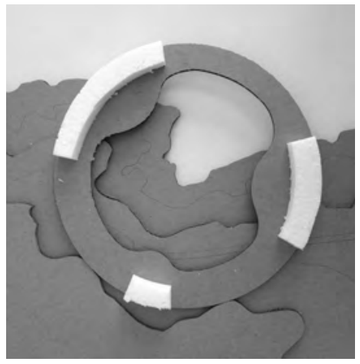
A small workshop shed some light on the possibilities in combining the shape of the circle with contrasting versus adapted spaces.
The concept of orienting the adjoining functions towards the centre and create a rather introvert building was the result of this workshop. By doing this the visitors naturally experiences these key functions such as the research department, hereby the aim to create an integrated science centre is enforced.
Also the idea of the lighthouse as a concept for organisation begins to influence the design at this stage.

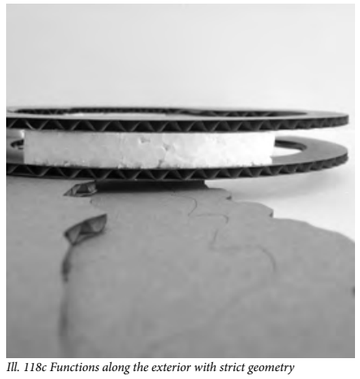
Ill. 118a Functions along the exterior while following the form



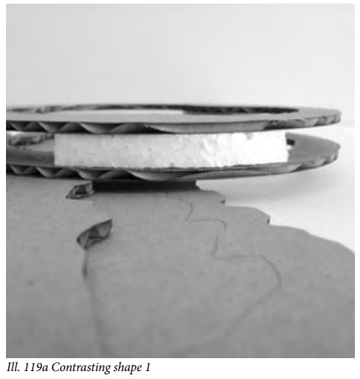


Ill. 118b Functions along the courtyard while following the form



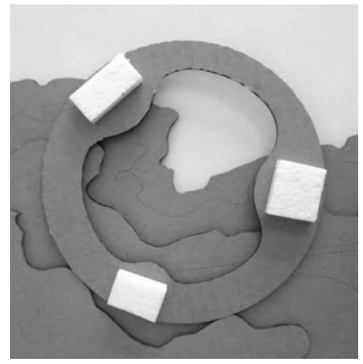


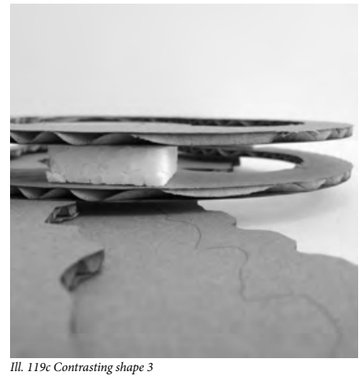
Ill. 118c Functions along the exterior with strict geometry



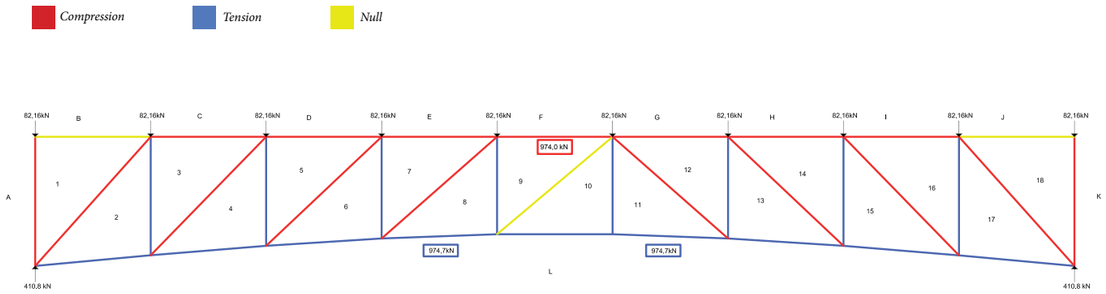
Ill. 119a Contrasting shape 1

Ill. 119b Contrasting shape 2

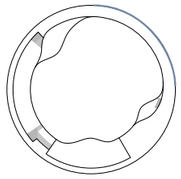




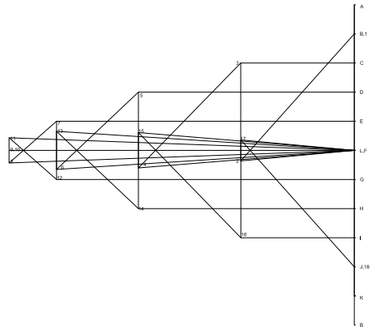
Ill. 119c Contrasting shape 3



Ill. 120a 'Howe truss'



Ill. 120b Position of the truss



Ill. 120c Graphic statics diagram for the truss above

Truss structure

A truss structure is chosen as the structural principle, since it can utilize the whole height of the building for carrying the spans where the volume is floating over the landscape.

Graphic statics

To gain an understanding of how a simplified flat version of such a truss would work, both analogue and digital tools are used. First a simple truss is investigated using graphic statics to settle where there will be compression and tension, and where the highest stresses will be. Generally it can be said that the largest forces will be in the top and bottom chords towards the middle of the span. Compression in the top and tension in the bottom respectively.

Truss development

In the later development digital tools are used to generate quick variations of the truss, and the results are held up against manual calculations.
Since the payload is the dominating load on the structure, for the sake of simplicity these examples are tested with a linearly distributed load, equivalent to 5kN/m2 of exhibition area carried by the truss on the exterior side of the building. In the examples calculated in Karamba for Grasshopper the gravity on the construction is also part of the load scheme.
To better be able to compare the results the same material and cross section is used in all these examples.
The maximum deflection is given by the span divided by 400. With a length of 64.4m this equals 0.161m. One can though discuss if it makes sense to compare deflection in this kind of test since the loads are not final and the structural members have not been optimized.
All trusses are with pinned connections.

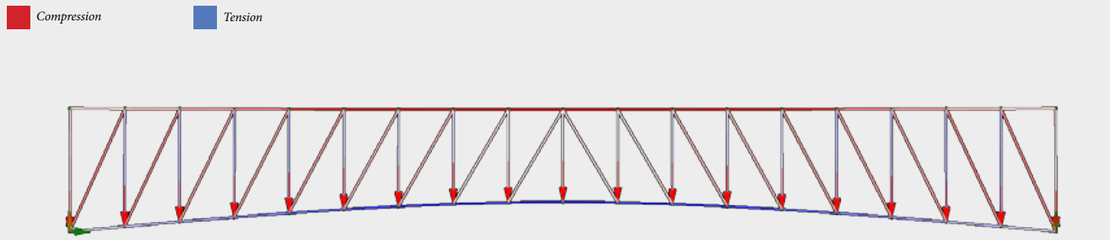
Option 1: The first variation is based on having web members for every 5deg of the circle. The truss is a basic 'Howe truss' like the one used for the graphic statics example. Aesthetically the many diagonal members are taking up too much space, and making the truss seem too solid, not in line with the concept of a transparent facade.

Option 2: Second variation substitutes the diagonal web members with wire crosses, to create a more transparent facade, but still the vertical members are too dominant.

Option 3: Here the gap between the members are increased to be per 10deg of the circle, still with diagonal wires. This model is taken further and tested thoroughly in relation to its impact on the spatial qualities.

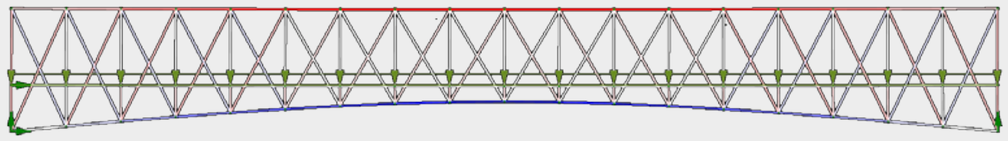
Option 4: A new test seeking to remove the vertical member by using a double intersection warren truss. Here the forces are transferred in the diagonal members, but due to the level changes of the bottom chord the height of the intersection between the web members changes too, which is not aesthetically and technically pleasing. It would be preferred if the forces from the slab could be transferred in the intersection and have a more consistent look of the structure along the plane of movement.

Option 5: Here the intersections are moved down, so the diagonal members meet at the slab. They continue with the same direction till they hit the bottom chord. An advantage with this combination is that the beams holding the slab can also act together with the bottom chord to distribute the tension forces in the bottom of the truss. Therefore the maximum tension forces in this version is almost half of those in option 4. This version is tested for its spatial qualities as well.



Option 1
Highest Compression [kN]: 974,04
Highest tension [kN]: 992,13
Maximum deflection [m]: 0,082

Ill. 121a 'Howe truss'

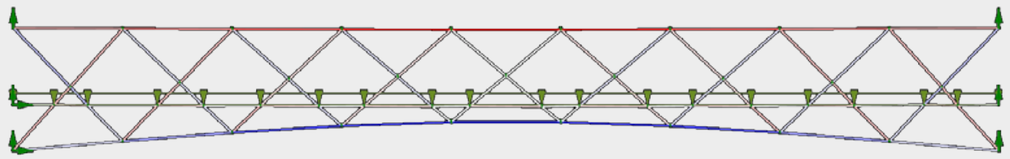


Option 2
Highest Compression [kN]: 1041,54
Highest tension [kN]: 1033,89
Maximum deflection [m]: 0,073

Ill. 121b 'Pratt truss' with wire crosses instead of diagonal web members

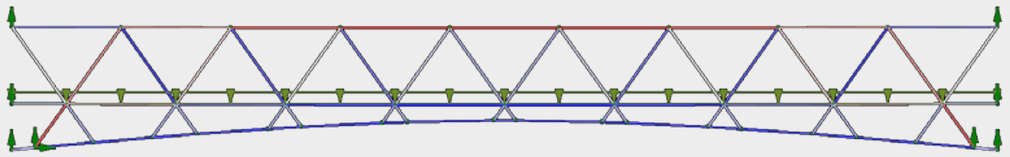
Option 3
Highest Compression [kN]: 1436,72
Highest tension [kN]: 1394,38
Maximum deflection [m]: 0,100

Ill. 121c 'Pratt truss' with wire crosses instead of diagonal web members



Option 4
Highest Compression [kN]: 1453,79
Highest tension [kN]: 1412,15
Maximum deflection [m]: 0,124

Ill. 121d 'Double intersection warren truss' with the slab resting on the web members



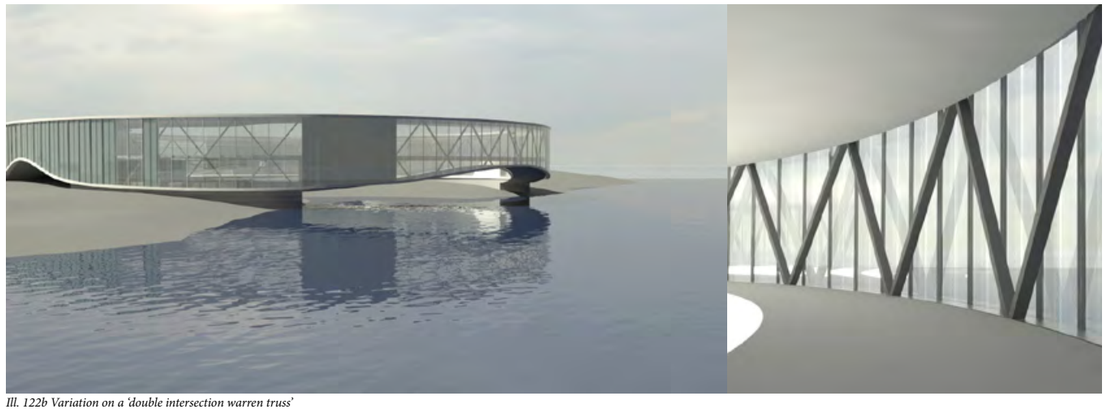
Option 5
Highest Compression [kN]: 1346,58
Highest tension [kN]: 742,41
Maximum deflection [m]: 0,083

Ill. 121e Variation on a 'double intersection warren truss'

Spatial tectonics

Two versions from the truss development is tested for their spatial qualities and influence on movement in the building. The perceptual expression from a distance is also important since the structure acts as an integrated part of the facade expression.
The first example is found to work well with the verticality of the facade, and create a steady rhythm in the space. The horizontal elements are still quite dominant though and the diagonal wires makes it difficult to place doors and openings in the facade.
The second truss, is more dynamic in its expression and seem to create a guiding gesture along the direction of movement in the spaces. It also adds another layer of information to the facade, which gives the building a more contemporary appearance.

Ill. 122a 'Pratt truss' with wire crosses instead of diagonal web members

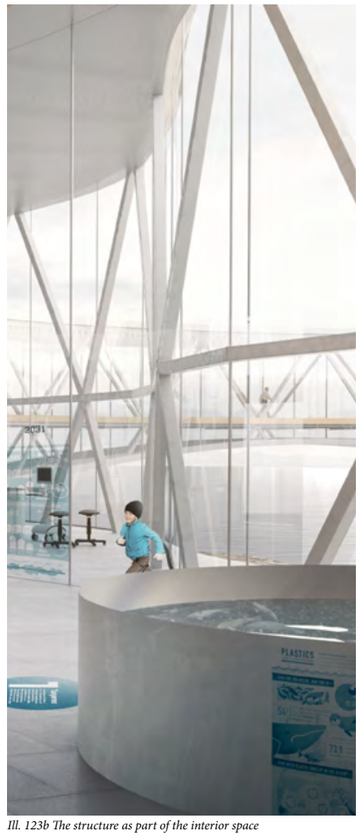


Ill. 122b Variation on a 'double intersection warren truss'

Process reflection

During the development of the design there have been a few crucial moments. Indeed the study trip with numerous site visits, and several interviews and talks with the team of initiators behind the project has been the greatest contributor to an understanding of the project and place, and hence a powerful design concept. By immersing in the place and experiencing it methodically as well as spontaneously, a greater understanding of the potentials and scales of the place was gained. Furthermore the interviews led to a deeper understanding of the programme, and it's inherit challenges as well as specific potentials.
The design process have been characterized by a mix of methods as it is visible in this chapter. The tools used have been used with the intention of creating an integrated design solution. Most importantly not only the measurable qualities have been informing the design, but also the immeasurable like spatial flows, atmosphere and the like. Some choices have been made on a basis of intuition and experience from earlier projects, then later the arguments and overall concepts have emerged and created a larger cohesive story which have challenged, sharpened and strengthened the storytelling of the project. This way of making some decisions based on 'gut feel' were found to be necessary in order to get a thorough design process with many iterations in all stages of the design development instead of trying to create the full argumentation from the very beginning.

Ill. 123a The structure seen through the facade



Ill. 123b The structure as part of the interior space

Epilogue

Conclusion

The New Maritime Science Centre at Tungenes is an answer to the need for a new institution to showcase the maritime sector which is so important to the life along the West coast of Norway, and especially the region of Rogaland. Situated at the tip of Jæren, an agricultural landscape, it bridges the cultivated natural elements which are the sea and the land. As a beacon for the maritime environment it places itself on the very edge, connecting the natural elements of the coast and the water. Apart from is geographical placement, the building and the institution it represents, also places itself in a very relevant discussion about how the future Norway should develop and how the relation to nature and its resources should be prioritized and protected. This discussion about the institutional role will be sought addressed in the reflection.

A Lighthouse

As a house of science, and with the geographical placement and architectural concept, the notion of the lighthouse is a powerful term to describe the buildings impact on the context and its visitors. The scale of the building addresses the maritime scale towards the exterior, with a clear division in sectors, drawing references to that of lighthouses. It provides a landmark, not only towards the land-side, but certainly also towards the sea and fiord, where the inlet to Boknafiord has a high degree of traffic right off of the coast.

Immersion

The building distances itself from the small village of Tungenes, to further emphasize its relation to the sea, and status as a singular institution. By not being situated in an urban context the journey of getting there is an important part of the experience of visiting the centre. In relation to a science centre and a museum, this creates a basis for clearing one's mind, to focus on the basic elements of nature and hence be ready to learn about and experience some of its wonder through the exhibitions and activities. The character and identity of the centre starts to reveal itself to the visitor during this arrival. As Morovansky said, the materials can have certain values attached to them. (Frampton 2007) The materials of the exterior facade represent the modern maritime identity of the building, and underline the science institutions relation to the concept of a lighthouse. The verticality of the cladding draws references to the existing buildings near the site, and the light transparent character can be seen as a contemporary interpretation of the illuminating white houses in the landscape, or a Fresnel prism, which directs the light and thereby views in certain directions.

The Courtyard

Directing the visitors into the central courtyard space the architecture seeks to create a multifaceted experience of the nature. First of all by removing the visitor from the surrounding nature and exposing them to an isolated, carefully selected portion of it, the intent is to create a clearer experience and understanding of how the meeting of the water and the land is so important to this region and the science centre. One can also argue how the theme of the museum being science can be said represented in this way of isolating a piece of the natural world to study it closer. The idea of science is basically to first look at simplified isolated local environments, gain and understanding of these. Then later try to understand the influence different environments have on one another. The courtyard can also be seen in relation to Fehn's statement of how the Norwegians are distancing themselves from nature as a practical environment, with which man has coexisted and been dependent on. (Almaas 2010) With the focus on a single piece of nature, in relation to an institution which tells the story of the relation between man and this nature, the focus on the practical relation to nature could be regained.

Entrance

The idea of entering into a museum can be expressed with many different approaches. The focus on the science centre's connection to the natural environment, but also its distance from it in terms of scientific models versus reality has been a motivator in this particular building. The building itself, including terraces, seem to hover over the landscape, to emphasise the distinction between the man-made and the natural environment. This way the process of entering already starts to take place once the visitor removes themselves from the rocky surface, and on to the outdoor terrace, creating an emphasised focus on the transition between institution and nature. The elevation of the building on a base simultaneously serves to secure it from the sea and possible surge. By entering through the courtyard the building benefits from the concept of a central entrance, where the visitor has a clear overview of the institution before entering, and a near proximity to several key functions and the main circulation directly from the foyer as well. A known challenge when designing museum institutions (Frampton 2007)

A knowledge platform

In the first part of the exhibition the visitor is immersed into the world of science. With a large exhibition space in several levels, and with a near proximity to teaching spaces as well as research facilities. Here all levels of science in relation to the maritime environment can be experienced. Instead of presenting a simple, popular-scientific exhibition, the museum seeks to showcase the real possibilities in the field of maritime science. By incorporating infotainment with production of knowledge in a research unit and simultaneously let the scientists teach and convey the results and knowledge to visitors - a new symbiosis is formed. The institution as a platform for knowledge makes it a more active player in the maritime sector, and creates a better starting point for it to meet the goal of showing 'science at work' and attract more talent to the maritime sector.

Outlook

The further movement through the exhibition takes the visitor out on the 'bridge'. Here the structure and the spatial experience really support each other. While the structure seems the create a dynamic flow along the direction of the movement, the visitor gets a true feeling of being on a ship out on the ocean due to its slender character, readability and reference to the industrial shipbuilding by using steel. The openness of the structure and facade lets the visitor feel a floating experience, and a more extroverted relation towards the sea and all the ships sailing by just outside the windows.

Atmosphere and materials

The building as a science centre has some preconceptions, which are taken up and developed further in this project. The materials and structural system works from a theme of maritime technology, industry, and history. These materials support the idea of a science centre as a rather informal place for exhibition, learning and activity, where kids are allowed to run around, and visitors encouraged to participate in the activities taking place. The interactive dimension, separates the building from a traditional museum, and goes well with the maritime materials which are traditionally chosen for their structural properties rather than aesthetic. This integration of the aesthetic qualities in relation to the maritime atmosphere and an aim for an active informal atmosphere fits well with steel, glass and wood as primary materials.

The journey and the place

By attaching the museum naturally to the path along the coast, but maintaining a unique identity the building becomes an integrated part of its place. Not because it is designed to mimic the natural surroundings, quiet contrary it has its own very distinctive identity and scale. But, like Zumthor says, the building must be "a tribute to the landscape". (Lousianna 2012) The building is a tribute to the maritime culture which exists along these coasts, and to the meeting between land and sea. As an institution the building has its own distinctive identity, which is so important in the modern way of defining place, where culture and geography should be understood coherently. An identity, which supports the aims of the institution and gives something back to the landscape and the culture in which it is situated.

Reflection

To fulfil its role as an institution there are a couple of questions one could ask. First of all is it a good science centre, and secondly, how does the institution place itself in the larger discussion about Norway and the maritime sector.

A good science centre

In the aim to design a good science centre, Hans Ibelings have pointed out six guidelines for what makes a good museum. (Berlage institute 2010) Though there are differences between these two kinds of institutions, there are also overlaps. The aim of both are to convey information at eye level to the wider public. Furthermore both must work in the frame of being public, accessible and transparent institutions in the society. As such the aim for a good museum can be transferred to a science centre.

1: A good museum connects with the world. In the case of this museum the entrance is an integrated part of the courtyard and the heart of the building. The terrace offers a place, to sit, wait, meet up, enjoy the view and participate in different events, and therefore makes it a unique transition from inside to outside while emphasizing the qualities of the building as well as the nature it sits on.

2: A good museum enhances the items on display. In this case the science and knowledge is the most important artifice on display, and to enhance its communicative potential, the building has a very and transparent character, which enables sharing of knowledge and a close connection between infotainment and research.

3: A good museum offers a spatial experience. The combination of larger introverted spaces and smaller floating extroverted spaces offers a contrasting experience, which further makes the visitor aware of the nature. The nature, which is the key element in the theme of the science centre. Especially the bridge space is a unique place for experiencing the forces of the sea.

4: A good museum is open and inclusive. As a part of the public domain the centre offers visitors to the site a possibility to walk through the foyer, visit the café, or participate in related activities beyond visiting the exhibition itself. Despite being and introverted building in some sense, the courtyard and foyer still belongs to the public domain, and is fully accessible to all.

5: A good museum guides visitors' journeys. The building itself is naturally connected to the flow along the coast. By providing an additional loop to this flow, the visitor is naturally guided through the exhibition, and gets to experience all the elements, atmospheres and paces it provides.

6: A good museum engages with nature and culture. The distinction between nature and 'man-made' is further emphasized through the elevation of the building on its base, and the use of materials. Simultaneously though, the building is a natural part of the cultural connection to the landscape, which is so prevalent in the region, and which the exhibition seeks to strengthen.

Societal education

Every building fulfils a role in a society. Science centres have an important role to play in informing about science, just as there are museums for history, art and other cultural subjects.

The aim is obviously to attract more talent to the sciences and to extend the knowledge of the maritime sector to the wider public. In a country and a region which has been riding on a wave of oil wealth, and the possibility of employment in this industry has been a natural choice one would have to take a stand on, many other sectors have been left behind in the sense of public awareness. Therefore the architectural challenge have been to create a strong identity for the institution which creates a platform to further develop and raise the awareness of possibilities in this sector. A Sector which is seen as very important now as in the future of Norway. By rethinking the Science centre as an architectural type, with a wider approach to specified knowledge, the centre further strengthens this identity. The architecture as well seeks to create a landmark, both from the land-side and the sea-side. All in all, the proposal seeks to offer a new holistic take on the science centre, while placing itself directly in the environment it is a part of, offering new experiences and potentials for science.

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Ill. 22a-e
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Ill. 59 (original photo)
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Ill. 63 (aerial photo)
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Ill. 63 (original photos, from top left.)
1: http://www.telegraph.co.uk/news/science/space/8093150/Galaxy-may-contain-many-Earth-like-planets.html
2: own image
3: https://robcartwrightphotography.wordpress.com 2011/08/20/work-with-water-4-ripple/
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Cutout people:
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All illustrations which are not listed above, are own illustrations.

Appendix

Loads

Results

Displacement and stresses

Compression and tension

Verifying members

Sustainability and climate

CD

Loads

Using the parametric design software Grasshopper with the plugin Karamba, the loads are added to the structure and the structure is optimized through iterative loops. Using the GH2Robot plugin the final structure is transferred into robot Structure for verification. The building is characterized by these following data: (Jensen 2015)

Consequence Class: $CC3: \ K_{FI} = 1.1$

Own-loads:
Gravity on construction: $G_{truss} =$ Defined and calculated by Robot
Roof/floor construction: $G_{construction} = 0.55 \ kN/m^2$

Variable load:
Snow Load: $S_k = 1.5 \ kN/m^2$
(NS-EN 1991-1-3-2003/NA:2008 - Norwegian Eurocode annex)
Wind Load: Terrain cat. I, $V_k = 1.3 \ kN/m^2$
Payload (category C3): $Q_k = 5.0 \ kN/m^2$
(Jensen 2015)

ULS
The 'Ultimate Limit State' combination is used when verifying the members in Robot. The combination is based on the snow load as the dominating load since this combination also factors the payload and the worst case scenario therefore is met. (Jensen 2015 p. 127) In the ULS load case the design values for material strength are used as well as design loads.

Design loads:

$$\sum 1{,}0 \cdot K_{FI} \cdot G_{truss} + 1{,}0 \cdot K_{FI} \cdot G_{construction} + 1.5 \cdot K_{FI} \cdot \mathrm{Q}_k + 1.5 \cdot K_{FI} \cdot \mathrm{S}_k + 0.45 \cdot K_{FI} \cdot \mathrm{V}_k$$

$$\sum 1.0 \cdot 1.1 \cdot G_{truss} + 1.0 \cdot 1.1 \cdot G_{construction} + 1.5 \cdot 1.1 \cdot \mathrm{Q}_k + 1.5 \cdot 1.1 \cdot \mathrm{S}_k + 0.45 \cdot 1.1 \cdot \mathrm{V}_k$$

The factors are used in Robot when defining the ULS load combination.

SLS
When calculating the deformations in the structure the the 'Service Limit State' combination is used. In the SLS case the characteristic values for material strength are used as well as characteristic loads.

Characteristic loads:

$$\sum G_{truss} + G_{construction} + \mathrm{Q}_k + \mathrm{S}_k + \mathrm{V}_k$$

The factors of 1.0 are used when defining the SLS load combination in Robot.

Displacement:
The maximum displacement and deflection of the structure is:

$$u\_max \leq l/400$$

l being the length of the cantilever. (Eurocode 3, p. 54)

Results

The calculations show that all elements can be verified using the Finite Element Method calculation software Robot Structural Analysis. The model shows that with the structure, now slightly hanging over the water, the forces are high around the middle like in the simple truss, but highest around the ends where the 'bridge' meets the base-structure.

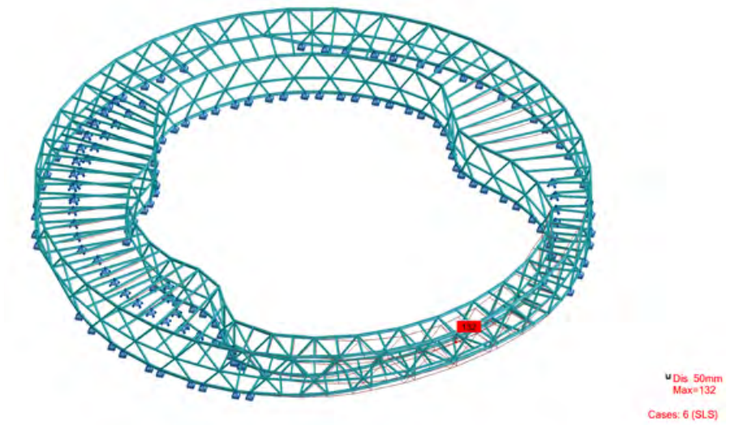
Displacement meets the need for being less than 64400 mm/400 = 161 mm.
The maximum displacement is 132 mm with SLS load combination.

The construction is thought welded together in sections and assembled on site to form the full figure. Transport can be arranged on water to the marina via the fiord. In this way a high precision in production can be reached. This is preferable since the joints are welded and therefore must meet a high standard to transfer the moment forces and ensure structural firmness.

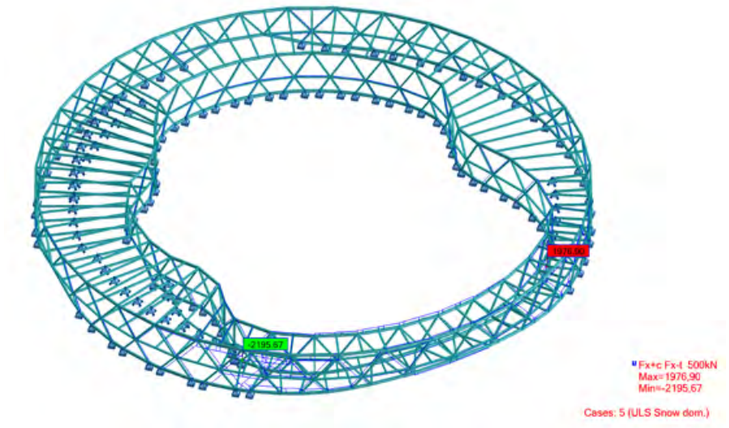
The structure has been developed to meet the need of the highest common denominator, using S450 steel. In a further process, the single elements could be taken into consideration, and a large part of the structure could be given either smaller dimensions, or made from a cheaper material like S235 construction steel.

The calculations show that a single elements is just slightly in the danger zone for buckling. Measures are taken for this member which is held in a wall. The laths in the wall construction can support the member and help keep the element in its place.

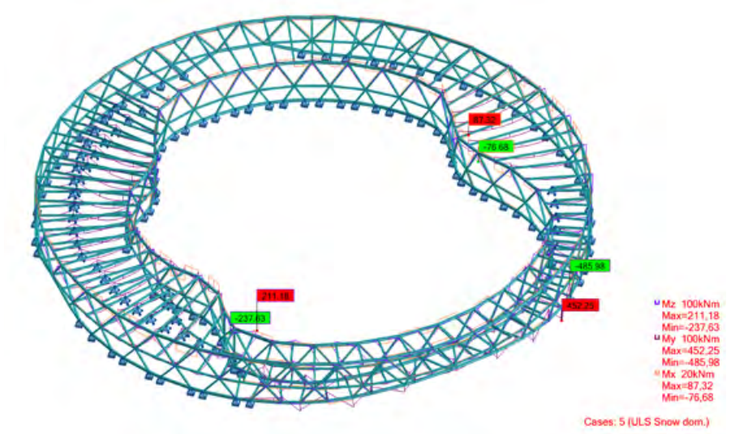
Displacement and stresses



Displacement, maximum shown in red.



Fx forces, compression and tension in the structure.



Since the structure is welded together, some of the forces are transferred as moments.

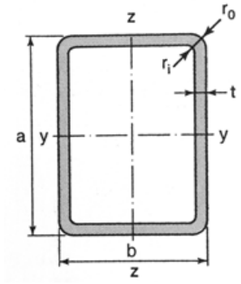
Verifying members

To ensure the stability of the structure all members are verified using Robot structure, and the most stressed element is verified with a hand calculation to ensure that the structure is calculated right.
The calculation show the same ratio of utilization of the element (member no. 170) as the digital analysis and the verification is therefore seen as valid.

Member	Section	Material	Lay	Laz	Ratio	Case
170	tube 40 x 20	Steel S450	20.29	35.39	0.85	5 ULS Snow dom.
633	tube 20 x 20	Steel S450	45.83	45.83	0.84	5 ULS Snow dom.
226	tube 40 x 20	Steel S450	17.02	31.00	0.83	5 ULS Snow dom.
505	tube 20 x 20	Steel S450	43.03	43.03	0.80	5 ULS Snow dom.
482	tube 20 x 20	Steel S450	73.24	73.24	0.79	5 ULS Snow dom.
684	tube 20 x 20	Steel S450	52.98	52.98	0.78	5 ULS Snow dom.
834	tube 20 x 20	Steel S450	213.92	213.92	0.77	5 ULS Snow dom.
533	tube 20 x 20	Steel S450	43.91	43.91	0.77	5 ULS Snow dom.
557	tube 20 x 20	Steel S450	43.92	43.92	0.76	5 ULS Snow dom.
447	tube 20 x 20	Steel S450	73.24	73.24	0.75	5 ULS Snow dom.
632	tube 20 x 20	Steel S450	76.40	76.40	0.75	5 ULS Snow dom.
835	tube 20 x 20	Steel S450	209.89	209.89	0.70	5 ULS Snow dom.
508	tube 20 x 20	Steel S450	43.84	43.84	0.68	5 ULS Snow dom.
802	tube 20 x 20	Steel S450	192.09	192.09	0.66	5 ULS Snow dom.
836	tube 20 x 20	Steel S450	199.13	199.13	0.66	5 ULS Snow dom.
571	tube 20 x 20	Steel S450	76.40	76.40	0.66	5 ULS Snow dom.
575	tube 20 x 20	Steel S450	76.40	76.40	0.66	5 ULS Snow dom.
569	tube 20 x 20	Steel S450	76.40	76.40	0.65	5 ULS Snow dom.
580	tube 20 x 20	Steel S450	76.40	76.40	0.65	5 ULS Snow dom.
833	tube 20 x 20	Steel S450	204.53	204.53	0.64	5 ULS Snow dom.
566	tube 20 x 20	Steel S450	76.40	76.40	0.64	5 ULS Snow dom.
601	tube 20 x 20	Steel S450	76.40	76.40	0.63	5 ULS Snow dom.
003	tube 20 x 20	Steel S450	104.93	104.93	0.63	5 ULS Snow dom.
697	tube 20 x 20	Steel S450	45.51	45.51	0.62	5 ULS Snow dom.
578	tube 20 x 20	Steel S450	76.40	76.40	0.62	5 ULS Snow dom.
490	tube 20 x 20	Steel S450	73.10	73.10	0.61	5 ULS Snow dom.

List of the elements with the highest ratio of utilisation. All elements er verified in Robot Structural Analysis

Box-Profile 400x200 t16, S450:



	Height	a= 0,4 m
	Width	$b = 0{,}2\ m$
	Thickness	$t = 16\ mm$
	R_i, R_0	$R_i = 16\ mm\ ,\ R_0 = 24\ mm$
	Area of cross section	$A = 17{,}9 \cdot 10^3\ mm^2$
	Section modulus	$W_{pl.z} = 1374 \cdot 10^3\ mm^3$
		$W_{pl.y} = 2256 \cdot 10^3\ mm^3$
	Strength:	$f_y = 450\ MPa$
	(Jensen 2015 p. 261)	

CC3 (high):	$K_{FI} = 1{,}1$
Control class (normal):	$\gamma_3 = 1{,}0$
Partial coefficient:	$\gamma_{M0} = K_{FI} \cdot \gamma_3 = 1{,}1 \cdot 1 = 1{,}1$

ULS forces applied:

Forces (from robot, mem. no. 170): $N_{Ed} = 1496{,}14\ kN$
$M_y = -485{,}98\ kN \cdot m$
$M_z = 63{,}75\ kN \cdot m$

Maximum capacity member:

Normal forces: $N_{Ed} = \frac{A \cdot f_y}{\gamma_{M0}} = \frac{17{,}9 \cdot 10^3\ mm^2 \cdot 450 MPa}{1{,}1} = 7323\ kN$

Moment forces, y: $M_{y.c.Rd} = \frac{W_{pl.y} \cdot f_y}{\gamma_{M0}} = \frac{2256 \cdot 10^3\ mm^3 \cdot 450 MPa}{1{,}1} = 922.909\ kN \cdot m$

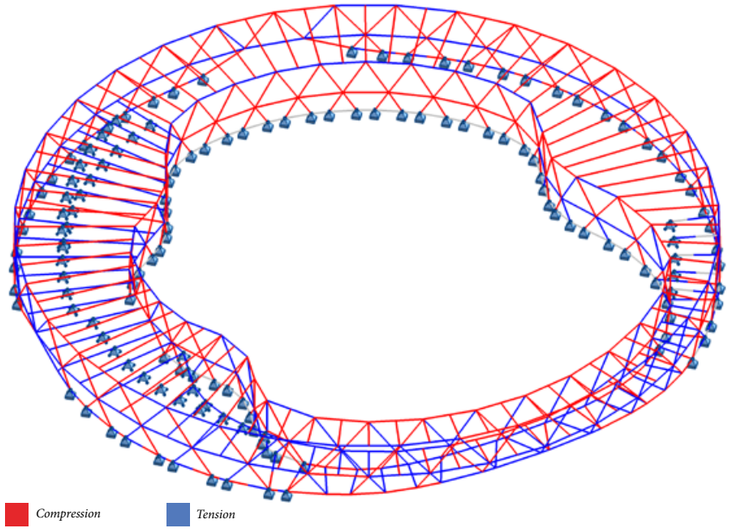
Moment forces, z: $M_{z.c.Rd} = \frac{W_{pl.z} \cdot f_y}{\gamma_{M0}} = \frac{1374 \cdot 10^3\ mm^3 \cdot 450 MPa}{1{,}1} = 562.091\ kN \cdot m$

Member stability check:

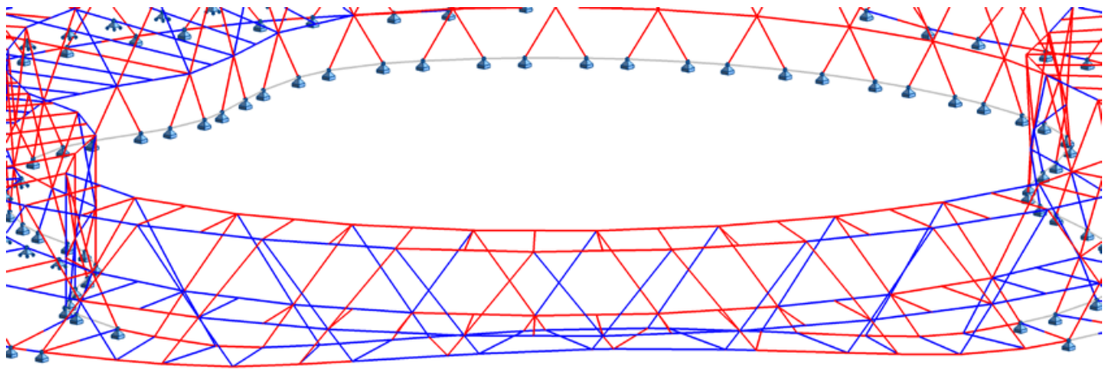
$$\frac{1496{,}14\ kN}{7323\ kN} + \frac{485{,}98\ kN \cdot m}{922.909\ kN \cdot m} + \frac{63{,}75\ kN \cdot m}{562.091\ kN \cdot m} = 0{,}844 < 1$$

Compression and tension

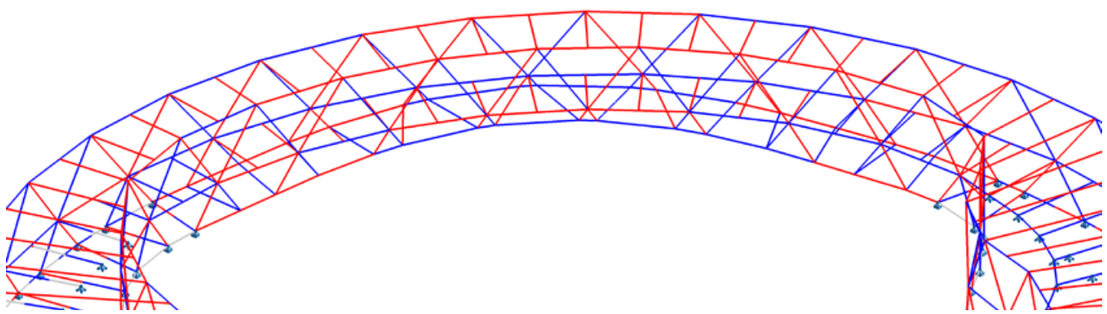
In order to compare with the findings from the simplified investigations done during the process of design development, the structure is mapped for compression and tension.
It is observed how the same pattern is relevant in the final structure when it comes to tension in the bottom chords, and compression in the top. One difference due to the curvature of the truss system is the tension which occurs in the outer top chord around the ends of the span. This tells that some torsion in the structure naturally happens due to the mentioned curvature. These forces are obtained by the grid, in the form of compression and tension, but also moment due to the method of construction where the structure is welded together.



F.x forces, compression and tension in the structure.



Compression and tension in the structure



Compression and tension in the structure

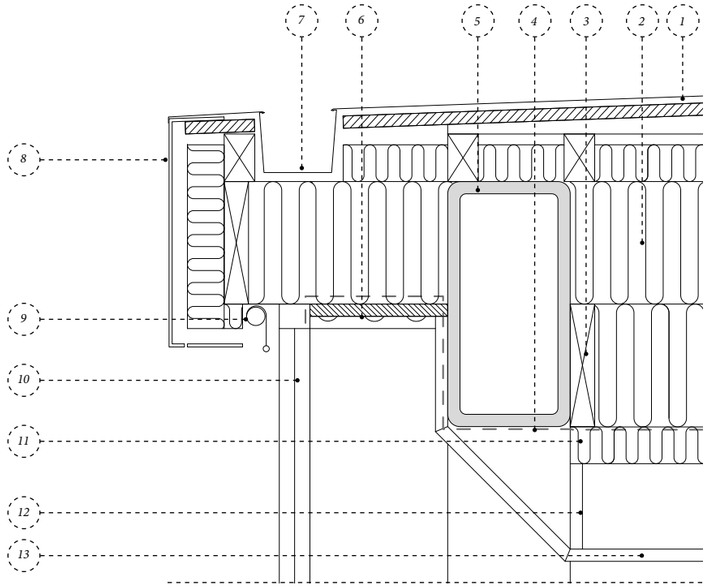
Detail drawings

Representative section of the elevated part of the centre showing relevant meetings.

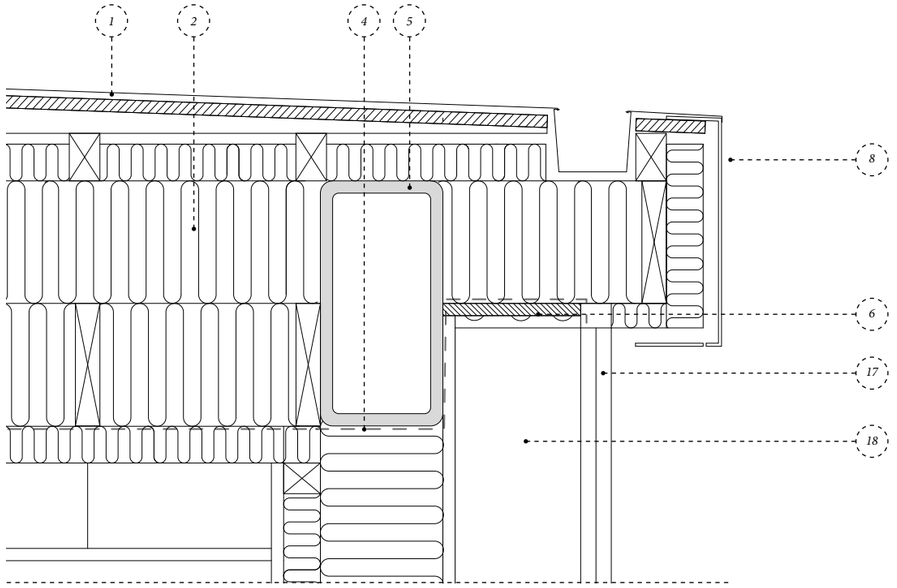
Scale: 1:10

Key:

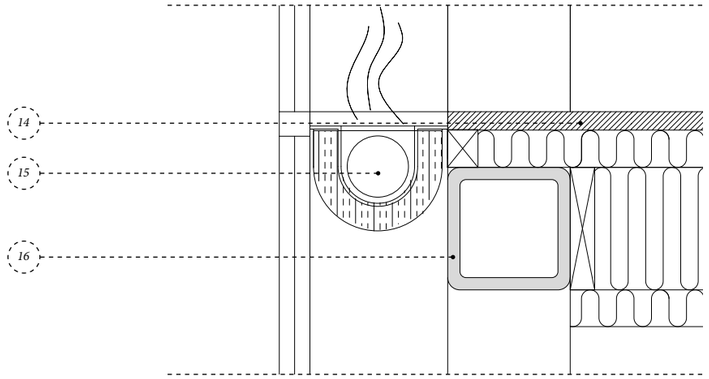
1. Azengar zinc® roofing (VM-Zinc product)
2. Insulation
3. Timber laths between INP 260 S450 steel beams
4. Vapour barrier
5. 400x200 t16 hollow S450 Steel profile
6. RGB LED lights
7. Zinc gutter
8. Azengar zinc® cladding
9. Automatic shading
10. Three layered energy windows
11. Sound absorbing insulation
12. Suspended ceilings with installations
13. Perforated steel finish
14. Wooden floors on 1st floor level
15. Heater to prevent down draft from windows
16. 200x200 t16 hollow S450 Steel profile
17. Three layered energy windows with automatic opening mechanism
18. Sun space
19. Timber laths between INP 20 S450 steel beams
20. Ductwork
21. Zinc flashing
22. Vapour drain



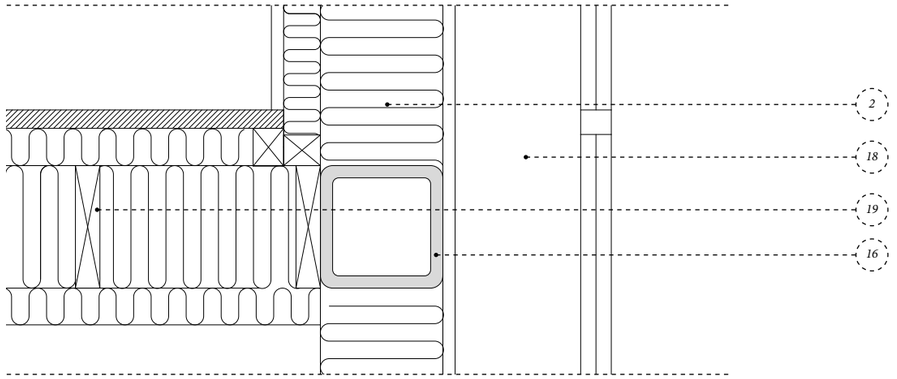
Roof to window detail 1:10



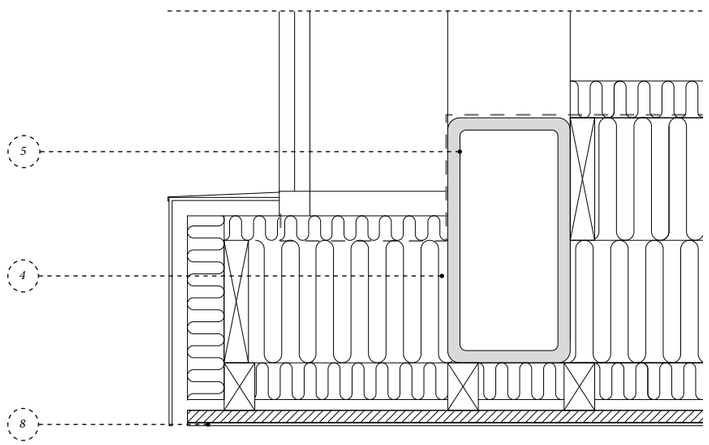
Roof to sun-space detail 1:10



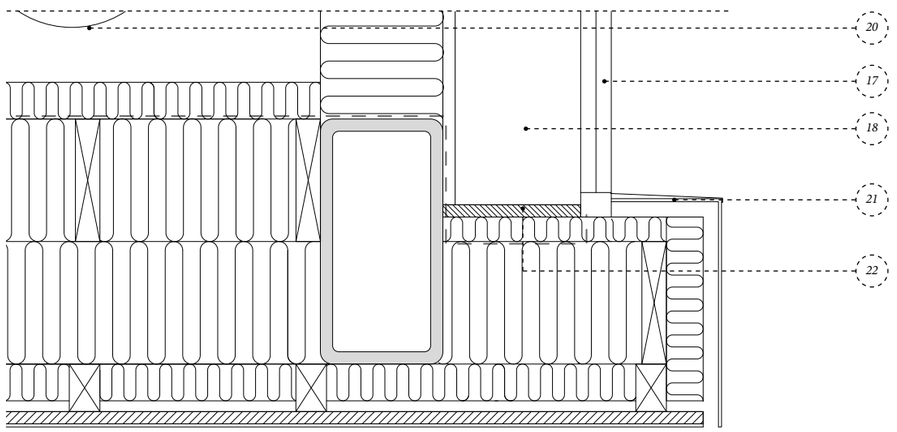
Floor to window detail 1:10



Floor to sun-space detail 1:10



Bottom to window detail 1:10



Bottom to sun-space detail 1:10

Sustainability and climate

The main focus of the projects has been on the structure and its practical implementation in the building during the architectural design process. Therefore the climatic and sustainability issues have been focusing on qualitative considerations rather than quantitative. To support those concepts for how the building is acting in its micro climate and how the loads, specifically sun, is acting on the building, a couple of test are made.

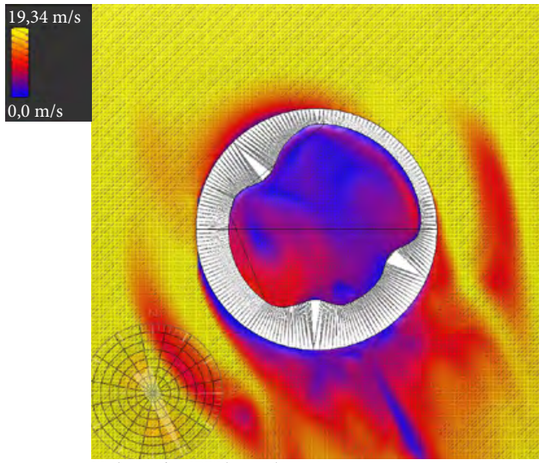
Wind
The volume is tested with the two dominant wind directions, which are NNW and SSE. These investigations support the contrast in atmosphere which was the aim for creating the courtyard as a transition space between inside and outside. This is done by breaking the wind and creating a shelter as seen on the diagrams showing the results of the analysis. The analysis is based on a base wind speed of 18,5 m/s which is in the high end of the spectrum for this site.

Sun
An important concept is the sun spaces, which acts as an active element to heat, cool and ventilate the building, in addition to the mechanical systems. Since the sun is the driving force of the system, the test of sun exposure serves to verify where the sun will provide the highest loads and where it would make sense to place sun screening and active elements to avoid overheating. The test shows that the southern and western facades are the most exposed throughout the year, when overheating can be a challenge.

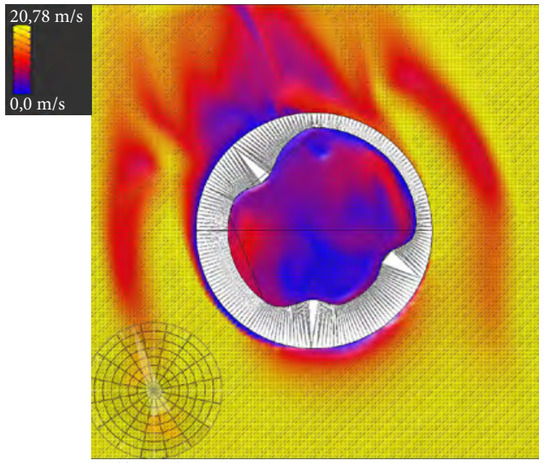
Indoor climate
The indoor climate have not been simulated since it is not part of the project aim, but as a concept a natural ventilation system is seen combined with mechanical ventilation. Depending on the time of year, the systems have their separate advantages, and a combination is therefore optimal to create a satisfying thermal indoor climate, with a good air quality.

Materials
In a sustainability perspective incorporating the inherent energy of the construction-materials the sustainability of the construction can be discussed. But the aim is that the building in its ability to adapt to future needs of the institution and with a high architectural quality should stay relevant and appreciated by the users for many years. Most of the materials are also available in Norway, which is good to reduce distances for transportation. Finally metals and zinc especially have a high potential for being recycled.

Wind analysis

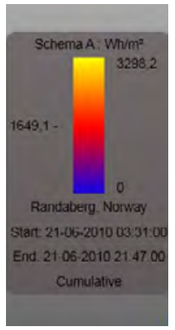


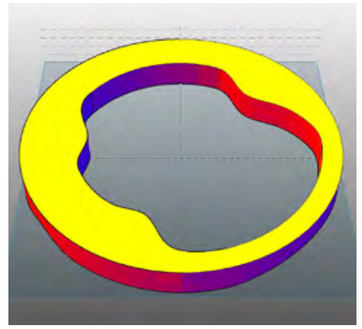
Wind coming from NNW, base speed 18,5 m/s

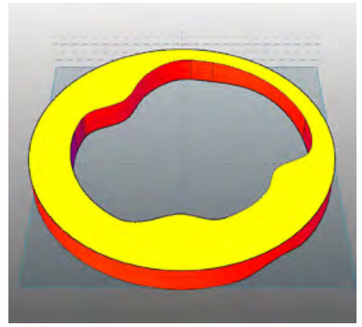


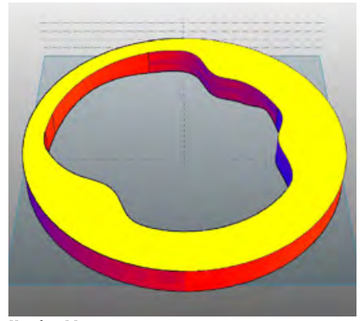
Wind from SSE, base speed 18,5 m/s

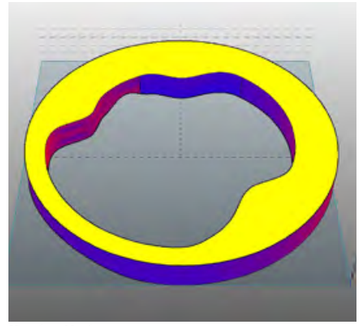
Sun exposure - summer solstice



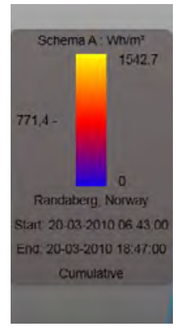

View from East

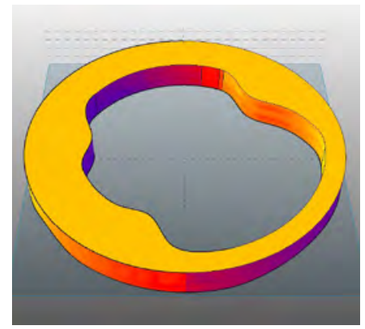

View from South

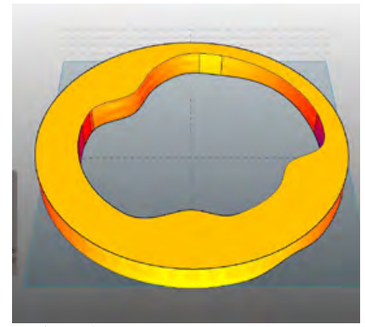

View from West

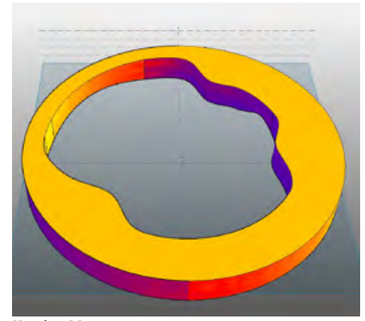

View from North

Sun exposure - spring equinox




View from East


View from South


View from West


View from North

CD

Pdf
- Report for web viewing
- Drawings

Images
- Renders in png format

Structural analysis
- Robot Structural analysis file

Recordings
Interviews and conversations from the study trip:

Eirik Gurandsrud
Initiator and author of the program and the prospect. Historian, and head of the department of Tungenes Lighthouse under the Jærmuseum.
Member of the competition jury

Anders Jaarvik
Head of culture in Randaberg municipality

Alma Elisabeth Oftedal
Architect MNAL at Brandsberg-Dahls Arkitektkontor, Stavanger
Member of the competition jury.