Human and nature symbiosis: Biomimic architecture as the paradigm shift in mitigation of impact on the environment.

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INTRODUCTION

I was born in the Upper Silesian part of Poland (South), in a city called Chorzow. The city has a population of 111 314[i] and lies in the Silesian Highlands. It is part of the Upper Silesian Metropolitan Union - a metropolis with a population of 2 million. Although the city witnessed more than 800 years of history, it flourished after the founding of a steel mill named Huta Kosciuszko (Königshütte) in 1802. From that point, the city grew around the mill, literally and figuratively. As many generations have grown up walking alongside plant's four chimney stacks, watching them belch filth into the sky, I too had the same unpleasant opportunity. Every evening there was a section in the local news channel dedicated to showing the amount of air pollution in the city. Each day, for about 10 years of my teenage years, the pollution levels varied between 180% and 220% of allowable amount of pollutants (maybe dropping to 170% on Sundays). One day, a group of foreign environmentalists came to conduct research and determined that it is unbelievable that Silesians can live fairly healthy lives in such a polluted environment. Shortly after that, the 200 year old mill was partially closed. Four stack

Figure 1. Huta Kosciuszko steel mill as seen from the main artery of the city. © Author unknown, 1982

chimneys were gone from the city's skyline. After reporting the pollution levels at around 60% for several consecutive months after the mill's closing, the news station stopped announcing those reports as they were not relevant anymore. I never thought that someday I will return to that issue in some way, but that shows the environment as one living organism. Wherever you go, you will find ecological issues: air pollution problem, waste problem or water pollution or its deficiency.

Earth's climate is changing. We, humans, dwelling on this planet are responsible for taking care of our environment, as we are the only species that impacts it negatively. Yet, we still have to care enough to want to be educated about that responsibility. This is not an opinion of environmentalist, nor a fact that can be ignored. That is a fact confirmed by many studies[ii] and admitted by many scientists. According to the IPCC 2007 climate report, building sector's carbon emissions including those from energy used to power buildings, have increased annually by 2% since 1970, and from commercial buildings by 3% since 2002 (IPCC, 2007a).[iii]

Can we completely prevent it from happening? The answer is no. Can we adapt to it, and mitigate our architectural contribution to it? The answer is yes.

Every architect is taught in school that eventually he or she is the person responsible for a project, he or she is the capstone of the project. Masons, constructors, engineers, and steel workers, are all important cogs in the machine, but an architect drives the machine. The aforementioned working relationships, although necessary, are not the future for the architectural discipline. Instead of those craftsmen, architects will be working with biologists, geologists, physicists and environmentalists. The future holds a shift in architectural thinking.

Can biomimicry be a future of architectural thinking that goes beyond aesthetics of the façades and functionality of the spaces leading to symbiosis between the human built and the environment? The goal of this paper is to address the issue of climate degradation, and, through biomimicry, present an architectural solution towards environmental education as well as mitigation of our impact on the environment. I strongly believe biomimicry can provide design strategies that benefit the climate by reducing the carbon footprint of the built environment, reducing the artificial Greenhouse Gas Effect, recycle waste into substances that can be further used, and filtrate air and water.

Firstly though, to avoid any confusion, I must provide an explanation of how I will use the term biomimicry. Biomimicry was first introduced in scientific literature in 1962: its origin is explained in some detail by Bernadette Bensaude-Vincent, Herve Arribart, Yves Bouligand and Clement Sanchez[iv]. Over the years, materials' scientists preferred and used the term "biomimetics" or rarely "bionics". The difference between biomimetics and biomimicry concerns the following: the users of biomimicry are more focused on developing and researching sustainable solutions while biomimetics is more widely used, for example in such fields as military, industry. About 15 years ago biomimicry became known through the work of Julian Vincent, Professor of Biomimetics at Shumaker College and biological-sciences writer Dr. Janine Benyus. Vincent explains biomimicry as “the abstraction of good design from nature”[v] while Benyus as “The conscious emulation of nature’s genius”.[vi] For the purpose of this paper I would like to define biomimicry as copying nature’s strategies as faithfully as possible in the process of developing symbiosis between architecture and environment.

The origins of biomimicry as a notion, not just the definition of word, according to Michael Pawlyn’s “Biomimicry in Architecture” lay far before our recent interests: “While there is no proof, it is quite likely that the forms of eggs inspired the first human-made domes, and in this sense biomimicry is far from being a recent idea. Leonard da Vinci was clearly a pioneer, and his visions were hundreds of years ahead of his contemporaries. … In the field of naval architecture there are examples such as that of Sir George Cayley, who in 1809 studied the streamlined form of dolphins and trout in order to develop ship hulls with lower coefficients of drag.”[vii]

Recently, there have been attempts to rethink the idea of biomimicry as a way of learning from nature’s research and applying those learned strategies to design. Therefore, by researching theoretical principles and also investigating strategies found in designs following the principles of biomimicry, I will look into successful ways to incorporate biomimicry to tackle the most significant contributors to the climate change.

IDENTIFYING THE PROBLEM

The process of climate change is caused by many factors. Some are caused by humans, but some are not. An ongoing argument exists between scientists and even ecologists whether we should be so arrogant and give ourselves credit for the majority of climatic issues that contribute to climate change. Some scientists believe our impact on the planet is not relevant enough to cause climate change on such a scale. Wherever the truth may lie, I believe we can still look in the mirror and start the process of retribution from within. On the path to identifying the problems, I would like to refer now to the statement mentioned at the beginning – Fossil Fuel Age vs. Ecological Age. This is a very broad starting point of our climate problems. The Fossil Fuel Age, also referred to as The Industrial Revolution with all its great inventions changed the world as we saw before. Unfortunately though, vast abundance and convenience of fossil fuels has allowed great inefficiencies to occur as well as tampered our ability to cope with and adapt to different and new situations. Nature driven designs were abandoned in favour of mass produced goods and built environments. Now, since it is clear that fossil fuel resources are not infinite and our ability to harvest is hindered by more violent atmospheric events, we have to come to terms with The Ecological Age.

Fossil fuels' use relates to climate change greatly. Their aggressive extractions, burning of those fuels in the process of energy creation, leads to GHG (Greenhouse Gas) effect and therefore global warming. Greenhouse effect is divided into two categories: natural, and artificial. It occurs when gasses (that absorb and emit infrared radiation: water vapour H_2O, carbon dioxide CO_2, methane CH_4, nitrous oxide N_2O, ozone O_3, and chlorofluorocarbon CFC) emitted from the surface of the planet do not pass entirely to outer space, but are reflected back instead, to the surface, warming the temperature. Although this effect, appearing also naturally, is partially responsible for existence of life as we know it, there is an artificial component to it that causes global warming. Artificial GHG effect is caused by releasing extensive amounts of previously mentioned gasses in a man-made processes like fossil fuel burning (CO_2), land use change and direct emissions (CO_2, CH_4 and N_2O)[viii]. World GHG Emission Flow Chart[ix] shows, that although there are many different contributors to artificially induced greenhouse effect, building industry (residential and commercial) is solely responsible for 17.9% of artificial CO_2 emission. Carbon dioxide (CO_2) is naturally present in our environment, yet because of its chemical property of transmitting short wavelength (visible) radiations and trapping longwave infra-red ones (heat) in the lower atmosphere, it causes global warming. This, on the other hand leads straight to increase of global average temperature by an estimate of 1° C every 50 years. The same research shows with an increase in global temperature by 3.6°C, the polar ice caps will melt, hence rising sea levels by at least 100m (328 feet)[x]. This chain reaction of global events leads not only to extensive flooding but also to increased precipitation, unprecedented and violent weather events. Since the emission of carbon dioxide is the built environment's most significant contribution to the artificial greenhouse effect, from the architectural perspective, it is the biggest concern. As above figures illustrate, even if only successfully applied to designed environment, biomimicry can have a very significant impact on reducing GHG effect and global warming.

PARADIGM SHIFTING UNDERSTANDING OF BIOMIMICRY

According to organismic biologist and author Dr. Baumeister, in order to fully understand biomimicry as well as its possible great impact on design process, there are some crucial definitions and explanations that have to be put forth and differentiate. Idea of biomimicry embodies three interconnected ingredients called Essential Elements of Biomimicry[xi]. When we combine those three essentials together, bio-inspired design becomes biomimicry. First element is the ethos. It is the essence and ethics, it includes intentions and underlying philosophy as to why biomimicry is being practiced. Ethos also represents respect, responsibility and gratitude for our fellow species and our home – Earth. ”There is no “us” and “them”. We are nature.”[xii]

Second essential element is the (re)connect. It represents understanding that although seemingly separate, people and nature are actually heavily intertwined. (Re)connecting is a way of practicing and a mind-set that explores and strengthen connection between humans and nature. The third element is the emulate. It is the binding agent that brings principles, strategies and solutions found in nature to inform the design.

In order to be able to implement the paradigm shifting designs and processes, one have to deeply understand what biomimicry is about. However, at this point, it is easier to realize what biomimicry is not. Dr. Baumeister introduced two terms that help distinguish practice of biomimicry. Sometimes practicing biomimicry is mistaken with bio-assistance and bio-utilization. Bio-utilization occurs when we talk about sustainably harvesting product or producer (wood for floors, plants for medicine). We can refer to design strategy as bio-assisted when we “reach out” to nature for help or domesticate organism to help accomplish certain goal (bacterial purification of water, breeding cows for milk). Instead of harvesting product/producer or breeding/domesticating, biomimicry consults nature and its organisms as they are inspired by an idea, either if it’s the physical form, process step of a chemical reaction or the whole cycle in ecosystem. Dr. Baumeister’s Resource Handbook emphasizes also another distinction to be understood. The difference between well-adapted and mal-adapted practices. Bio-assistance and bio-utilization if well adapted can be very useful, but it cannot be called biomimicry. As to biomimicry itself, there is a disturbing trend, based on lack of understanding of what biomimicry actually is. This occurs unfortunately especially among well recognized so called “starchitects”. We talk about mal-adapted biomimicry when it mimics form alone and uses the same old and unsustainable, life unfriendly practices to do so.

To be able to fully implement biomimic strategies into design, thus helping recuperate the environment, six “life’s principles” have to be followed. Dr. Baumeister’s “Life’s principles” is a tool for integrating nature’s solutions into design environment. “Evolve to survive” teaches to incorporate, absorb and understand information to secure enduring performance. “Adapt to changing conditions” is to follow and respond to dynamic, specific conditions and contexts. “Be locally attuned and responsive” is about fitting into and fully integrate with the surrounding environment. “Integrate development with growth” means investing in strategies that promote both – development and growth. “Be resource efficient (material and energy)” is about skilful and conservative use of resources and opportunities. “Use life-friendly chemistry” – this principle, although mainly referring to materials’ science, encourages using chemistry that supports life processes – not pollutant, using water as solvent (water-based chemistry to produce materials).

LEARNING TO OBSERVE

In our fast paced world, it seems difficult to appreciate and draw from the nature’s genius. However, it is crucial to the practice of biomimicry. Observing is learning from nature, and that is the essence of biomimic design. As mentioned in Janine Benyus’ “12 sustainable design ideas from nature” lecture, we often try to find solutions to the problems that have already been solved in nature. The lecturer gives an example of her walk on the beach and chatting with engineers who tried to solve the problem of scaling in pipelines. Scaling is the process of crystallization of minerals leading to formation of calcium carbonite. As a result of that crystallization the aperture of the pipe closes over time more and more preventing the flow of liquid. A seashell, is exactly that – a calcium carbonite structure formed in the process of crystallization. So what is it that stops seashells from growing infinite in size? At some point the seashell releases a protein that literally adheres to the face of the calcium carbonite crystals, and stops further forming. In the same exact way, engineers developed a product that stops pipe scaling today. Lesson learned.

However, if we take into consideration problems connected with climate change and Greenhouse Gas Effect, we might have to become more patient and keen observers. As we know all life on Earth is subject, among others, to sunlight, whether directly or indirectly. The electromagnetic field reaching us from the sun unleashes chain reaction without which no life would be possible. It provides the heat supporting metabolism of millions of species who are unable to warm themselves internally and supports those species who can. The variability of the heat amount resulting from the planet’s moving from night to day drives the ocean currents, the weather, the climate and the natural water cycle. These in turn influence the evolution of life strategies in order to survive. The protons reaching us from the sun also provide light on a periodic basis. As we know, sunlight is the essential provider of energy for most of the life on Earth. Plants, marine algae, some bacteria – all directly use sunlight in the process of photosynthetic reactions. Every year, those organisms convert over 100 billion tons of CO2 and hydrogen from water into sugars[xiii]. The waste product of these reactions is nothing less than pure oxygen. This shows not only nature's ability to utilize greenhouse CO2 but also purification of the environment providing essential to life oxygen.

In our pursuit to provide sustainable future and take advantage of biomimic possibilities we need to take a closer look at our surroundings, the environment with all its living diversity that has been around for over 3.8 billion years. Nevertheless during our observations and later design process, it seems that the time has come to invite biologists to the table and broaden the interdisciplinary aspect of architectural design.

TRANSFERABILITY – SCALE

One of the most serious obstacles in our way of drawing from nature is the aspect of scale and transferability. Amazing solutions developed by nature often occur on a nano-scale. For instance, dragline silk thread produced by Darwin's bark spider (Caerostris Darwini) at an ambient temperature and pressure is more than ten times stronger than Kevlar with the same weight ratio, and yet it's smaller in diameter than human hair. Dragline silk could be successfully used as suspension component in bridges or as various tensile structures. Yet unfortunately, we still don't know how exactly it is produced. The blue morpho butterfly's (Morpho Achilles) blue colour does not result from use of toxic pigmentation as we use to colour. The scales are in fact transparent. It is nature's play with light and its refraction on the butterfly's scales. Although refraction is well known to us as a phenomenon, this particular mechanism and its parametricity is not.

As we might discover in our pre-design research, not all strategies and systems can be translated or even work on a built environment scale. Luckily, many of them are and do work, and as our understanding of biomimicry progresses, additional solutions may present themselves. That is why a different design team paradigm is needed not only consisting of architects and MEP engineers, but also of micro biologists, environmentalists, and chemists.

Another important aspect to consider is transferability of nature's processes. Transferability can be categorized as follows: direct, indirect, and unidentified. The first category refers to a system, which can be copied exactly as it occurs in nature, with the use of similar materials, or those with the same properties, the same processes, just on a different scale (human built scale). An example of direct translation occurs later in the structural design of The Biomimetic Office case study. The indirect category refers to natural process being mimicked using human made materials with the goal to achieve the same result. This, is shown in "durian fruit" like pressurized façade of the Esplanade – Theatres on the Bay in Singapore. The last category, refers to fascinating processes like spider's silk production or butterfly's scale refraction. Systems, that potentially can be used in design strategies, but are not yet fully understood and therefore impossible to translate.

CASE STUDIES

The following case studies represent a leap forward in architectural thinking. A relatively new trend in architectural design takes precedents from nature’s 3.8 billion years of research and development, as nature has mastered the art of adaptation to climatic changes: The Biomimetic Office, and Esplanade – Theaters on the Bay.

The Biomimetic Office Building.

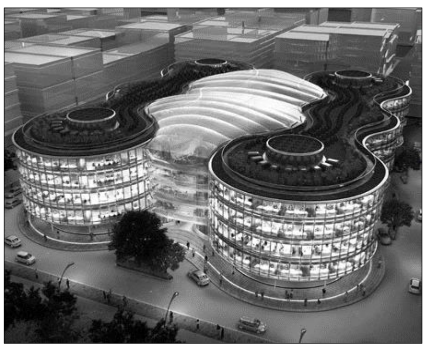
Figure 2. The Biomimetic Office. © Exploration Architecture, 2014

The Biomimetic Office Building designed by Exploration Architecture in collaboration with Arup Studio uses biomimicry to comprehensively rethink the approach to designing office environments. Since daylight was the primary driver for the building form, careful study of the biological examples such as: the Spookfish (Dolichopteryx longipes) with its mirror structures in eyes which point downwards and focus low level bioluminescence onto its retina; or the Brittlestar (Ophiuroidea) which lives as deep as 500 meters (1 640 feet) under the sea level. Its ability to evolve focused lenses that harvest the lowest amounts of sunlight into more concentrated beams; or the Stoneplant (Aizoaceae) with most of its plant actually below ground to maintain thermal stability yet its “roof light” system provides light underground to part where photosynthesis happens.[xiv]

All the performed studies informed the design of the building taking the most advantage of natural daylight. The architect’s goal for the structural design was to reduce as much material use as possible. In order to do so, the cuttlefish (Sepia latimanus) was studied. The team learned that the placement of material within the cuttlefish’s bone is extremely efficient, evolving only in places where it is actually needed and does the most important structural work. All the rest is either empty or just covered with a thin layer at the top and bottom.

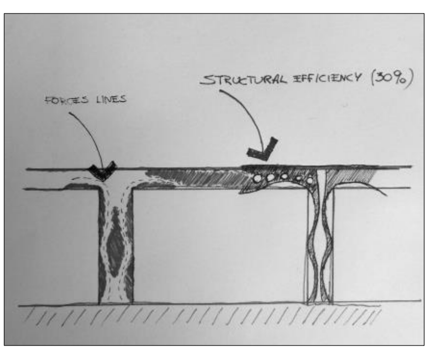

Figure 3. Structural diagram. © Szymon Szczyrba, 2015

Using the cuttlefish as means to consider the most efficient structural design for the biomimetic office, 30% less material is used to achieve the same structural properties of the building.

Because of the biomimic ideas being implemented, The Biomimic Office Building uses a fraction of the electricity of the normal office that size. This again proves biomimicry to have a great influence on mitigating our buildings' impact on the environment.

Esplanade – Theaters on the Bay, Singapore.

Figure 4. Esplanade. © DP Architects, 2002

Esplanade, designed by Michael Wilford & Partners in collaboration with Singapore's DP Architects is a successful biomimetic performing arts center located on the waterfront alongside Marina Bay, close to the mouth of Singapore River. It contains an 1800 seat Concert Hall, 2000 seat Lyric Theatre, 450 seat Adaptable Theatre and 250 seat Development Studio.[xv] Yet, its success is not entirely dependent on its multipurpose features. The complex, completed in 2002, mimics a durian fruit on its façade tackling the aspect of significant solar gains in that area, with a very successful response.

The durian fruit uses its semi rigid pressurized skin to protect the seeds inside. A Similar idea is being mimicked in the building. Lightweight, curved space frames fitted with triangulated glass and a system of tinted sunshades protect interiors form overheating while still providing enough sunlight into spaces and views from inside out at the same time. The pattern of the triangular panels is designed in a way that during daytime panels "follow" sun path with changing angles so that interiors are appropriately shaded all the time. In the meantime, elaborate pattern provides a dramatic and very unique shade patterns inside the venue.

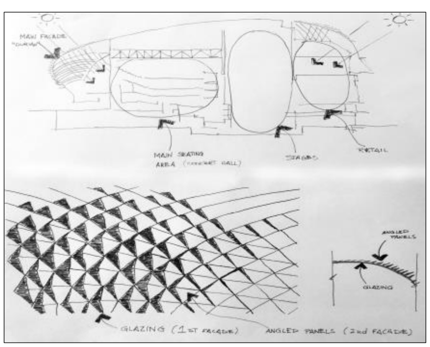

Figure 5. Section diagram and façade structure. © Szymon Szczyrba, April 2015

The Esplanade Performing Arts Center is a good example of biomimetic strategies being implemented in real life projects. The design on a scale like this (project area of 80 500sqm) not only proved to be very energy efficient (2004 BCA Award – Energy Efficient Building Award – 1st prize, 1999 Bentley Awards – Proactive Engineering

Success Award) but also aesthetically significant on the Singapore's skyline while pushing the architectural understanding of biomimicry forward.

CONCLUSION

One can consider the irony of our times: our own impact on the environment causes us to revisit the idea of saving it. The development of The Fossil Fuel Age brought us to our current environmental condition, and, now, we have to drift away from it toward The Ecological Age before it's too late for our planet. I choose to conclude my paper with two ironic examples of a paradigm shift in our thinking of nature's connection with the design process and construction. The following examples reinforce our ability to consider using nature's materials for positive environmental change.

Firstly, it was the textile industry that started the Industrial Revolution Age, yet now, it is the same textile industry that researches biomimic strategies to produce self-cleaning materials used in carpets. Secondly, Norway is the Europe's largest oil producer, the whole economy of the country is based on oil extraction and processing. And as we learn from the World GHG Emission Flow Chart[xvi] oil contributes to the CO2 emission in the amount of 21%. Yet, Norway is the undisputed leader in sustainable design strategies and the first country in the world to start biomimic research in terms of architectural implementation at NTNU (Norwegian University of Science and Technology in Trondheim). Is it guilt? No. The challenge remains – who will explore and first implement positive ecological opportunities for our built environment? The goal here is not about relying on the revenue that oil provides, it is rather about finding different strategies of producing the same energy. Strategies that do not affect our environment adversely, but are a benefit to it. The future is in our hands. The key, though, is understanding the magnitude of problems that will fall upon us if we keep affecting the climate as we do now. The theoretical elements of the puzzle are already in our grasp: understanding the necessity of radical increase in resource efficiency, possibilities of shifting from linear to closed-loop energy systems, shift from fossil fuel economy to solar one. From the architectural point of view, we have to understand the interdisciplinary aspect of our profession in a different way.

Nature benefits from 3.8 billion years or research and development. In a modern architectural environment, we are able to take advantage of that research. With all the possibilities of parametric design, scripting, rapid prototyping, digital fabrication, and 3D modelling, nothing is impossible. The much needed change lays all in our minds. With the advancement of today's technology, the principles of biomimicry can be applied as successfully as any other design strategy.

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[xv] "Esplanade - Theatres on the Bay / Michael Wilford & Partners & DP Architects." Designalmic: Design Signal Dynamic. July 23, 2012. Accessed March 10, 2015. http://designalmic.com/esplanade-theatres-on-the-bay-michael-wilford-partners-dp-architects/.

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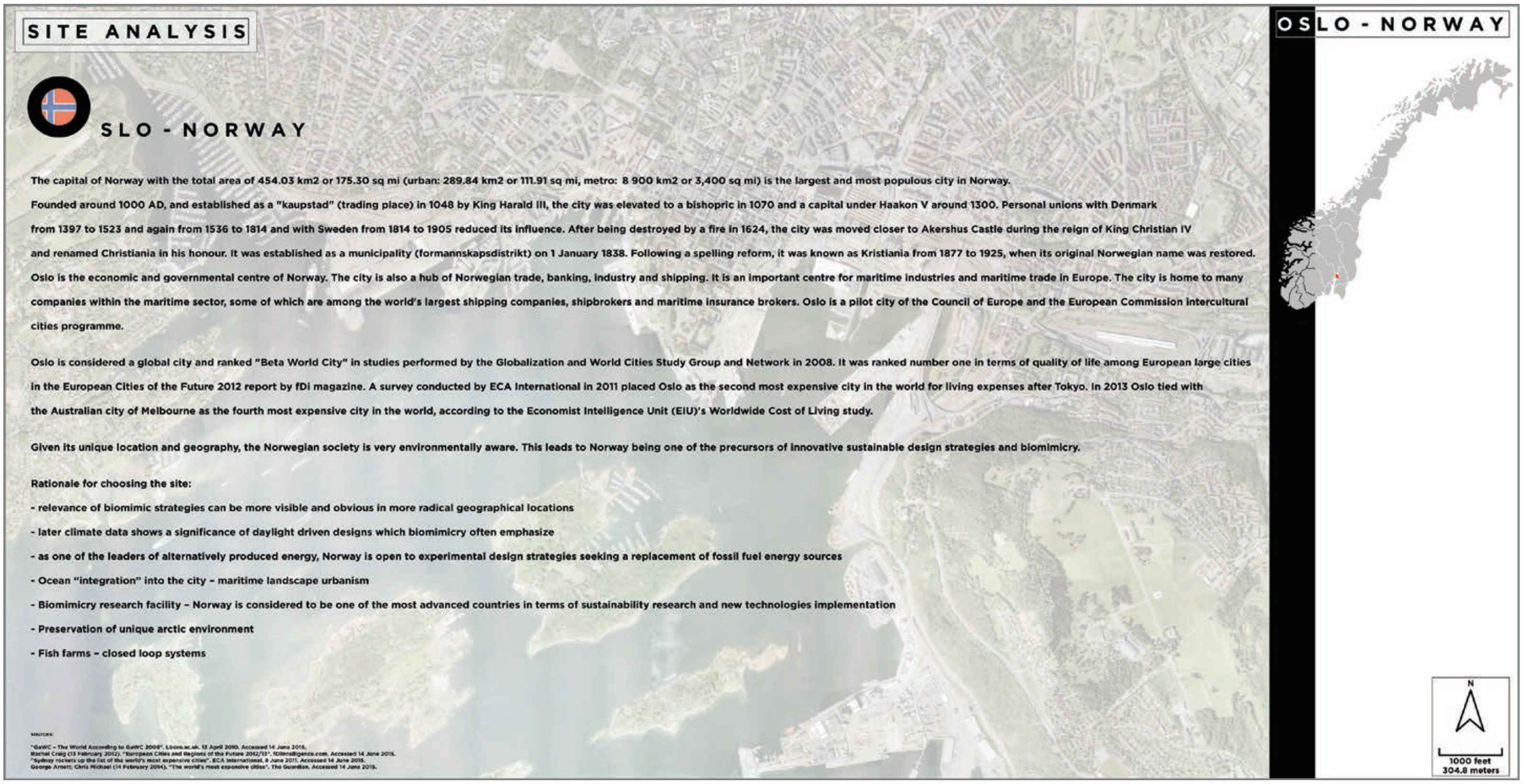
ARC 701 – SITE ANALYSIS AND INITIAL DESIGN PROCESS - FALL 2015

THESIS POSTER

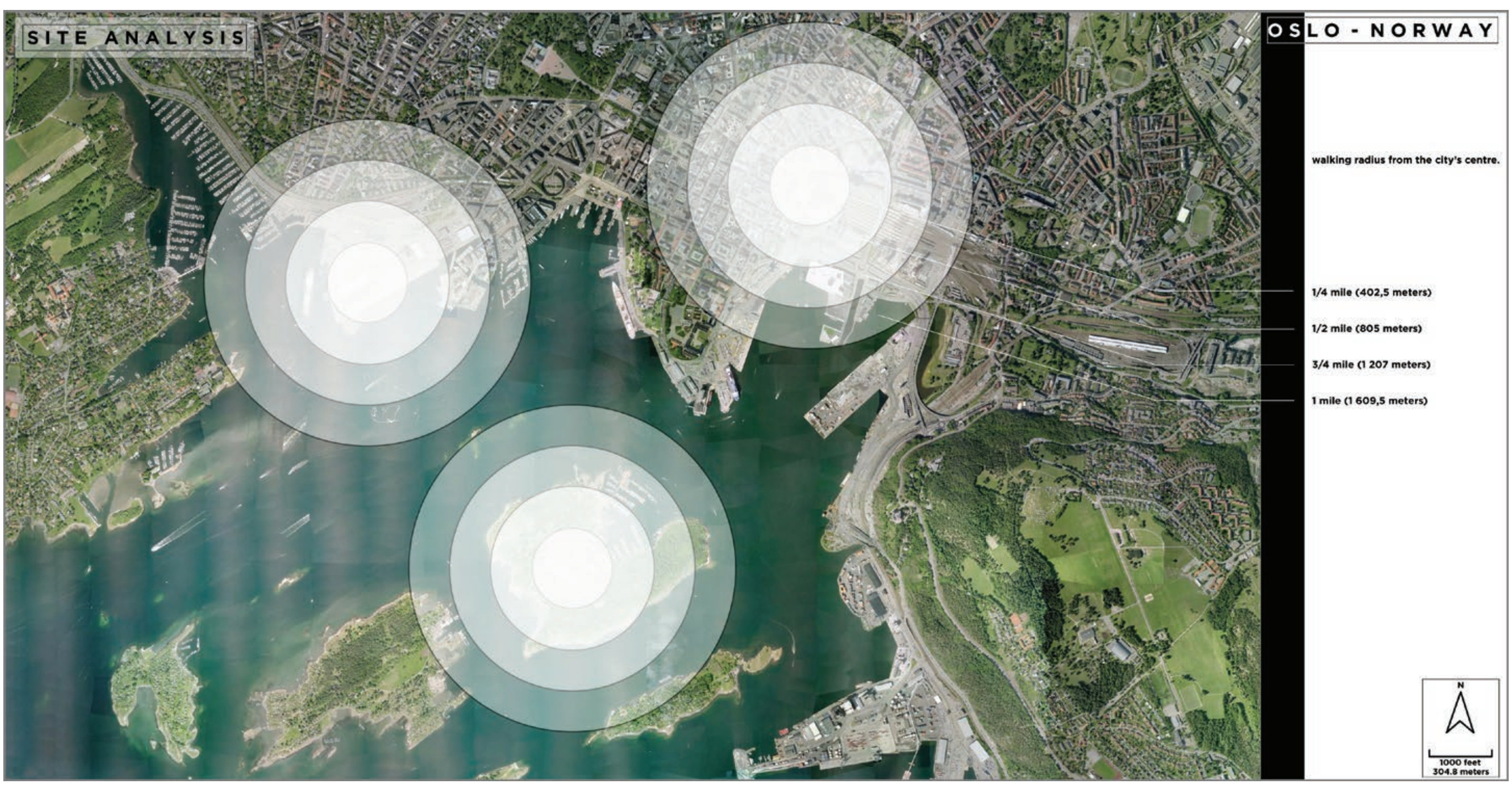
BASIC INFORMATION



DISTRICTS

LANDMARKS

WALKING RADIUS



TRANSPORTATION

DEMOGRAPHICS

SITE ANALYSIS

OSLO - NORWAY

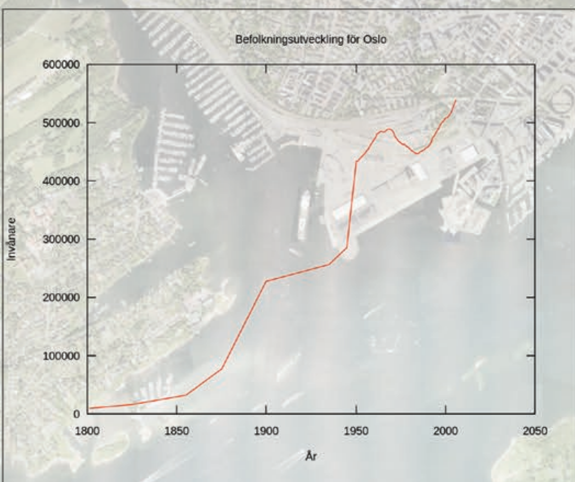
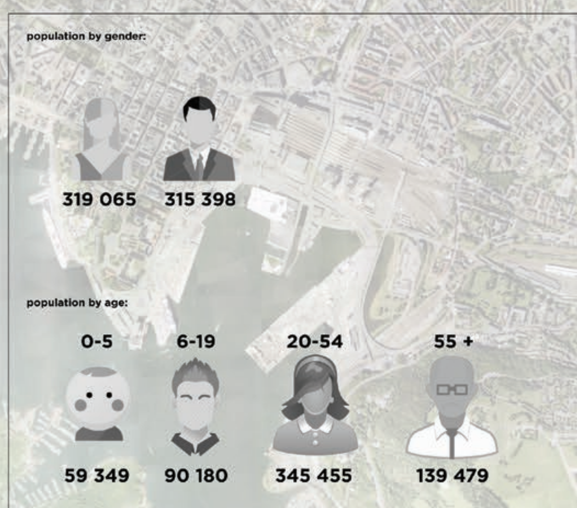


figure 1. Population of Oslo from 1801-2006, with yearly data from 1950-2006.



According to the most recent census 432,000 Oslo residents (70.4% of the population) were ethnically Norwegian, an increase of 6% since 2002 (409,000).
Oslo has the largest population of immigrants and Norwegian-born to immigrant parents in Norway, both in relative and absolute figures.
Of Oslo's 624,000 inhabitants, 189,400 were immigrants or born to immigrant parents, representing 30.4 percent of the capital's population. All suburbs in Oslo were above the national average of 14.1 percent. The suburbs with the highest proportions of people of immigrant origin were Søndre Nordstrand, Stovner og Alna, where they formed around 50 percent of the population. Pakistanis make up the single largest ethnic minority, followed by Swedes, Somalis, and Poles.
Other large immigrant groups are people from Sri Lanka, Vietnam, Turkey, Morocco, Iraq and Iran.

In 2013, 40% of Oslo's primary school pupils were registered as having a first language other than Norwegian or Sami.
The western part of the city is predominantly ethnic Norwegian, with several schools having less than 5% pupils with an immigrant background.
The eastern part of Oslo is more mixed, with some schools up to 97% immigrant share. Schools are also increasingly divided by ethnicity, with white flight being present in some of the northeastern suburbs of the city. In the borough Groruddalen in 2008 for instance, the ethnic Norwegian population decreased by 1,500, while the immigrant population increased by 1,600.

Oslo's demographics:

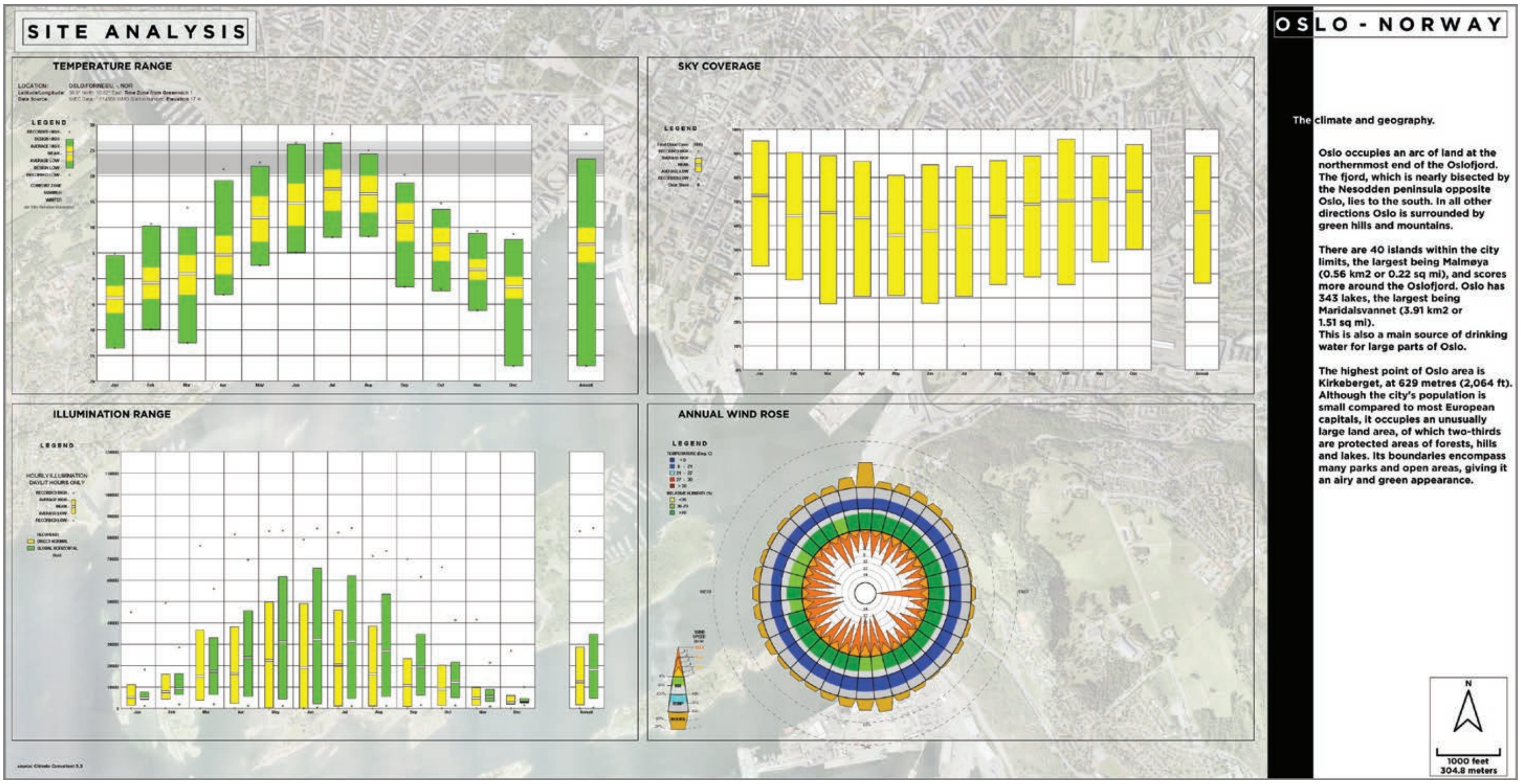
Historical population:

Year	Population	+/- %
1500	2,500	–
1951	434,365	+17274.6%
1961	475,663	+9.5%
1971	481,548	+1.2%
1981	452,023	–6.1%
1991	461,644	+2.1%
2001	508,726	+10.2%
2011	599,230	+17.8%
2014	634,463	+5.9%

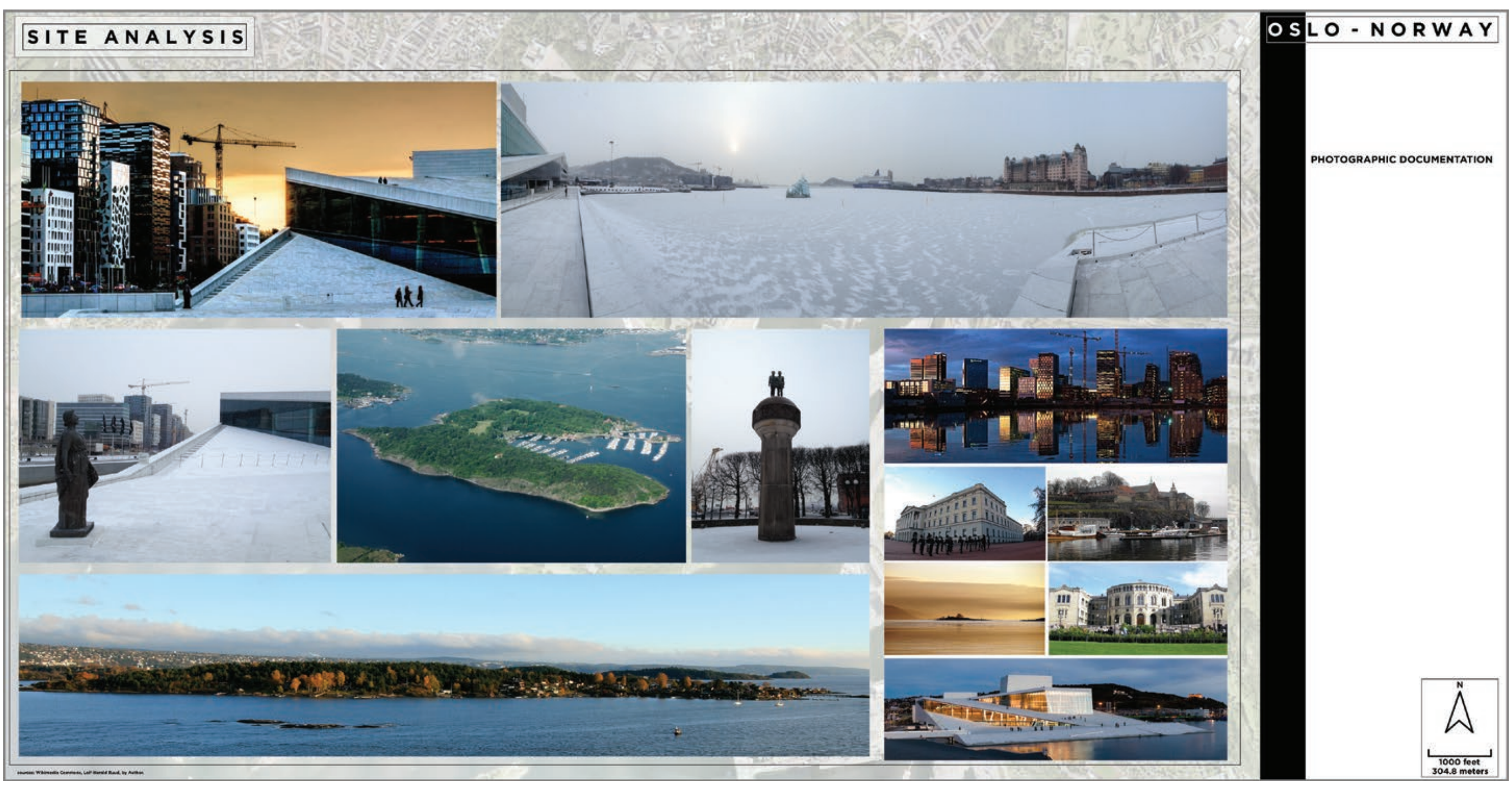
N

1000 feet
304.8 meters

CLIMATE DATA



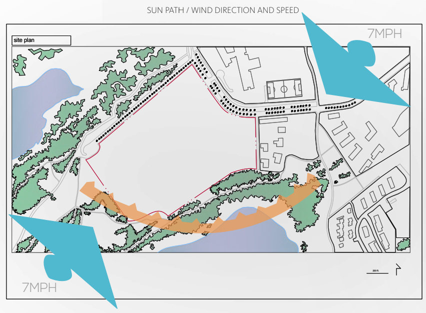
PHOTOS

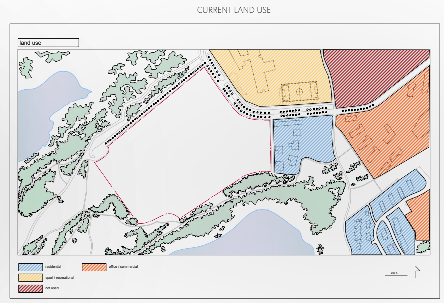


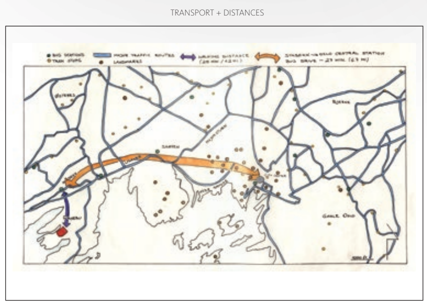
INITIAL DESIGN PROCESS

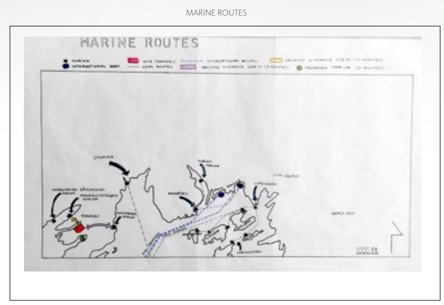
FORNEBU - BIOMIMIC RESEARCH CENTER

SITE ANALYSIS + CONCEPT SITE PLAN



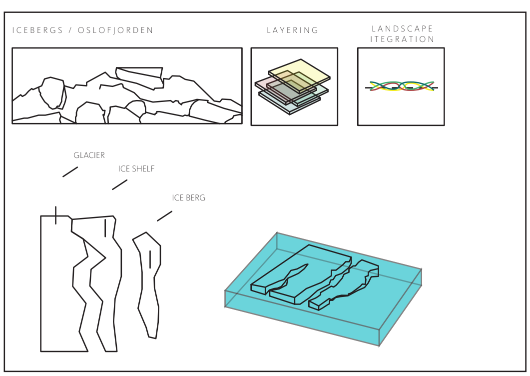


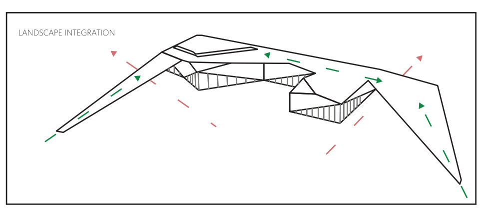


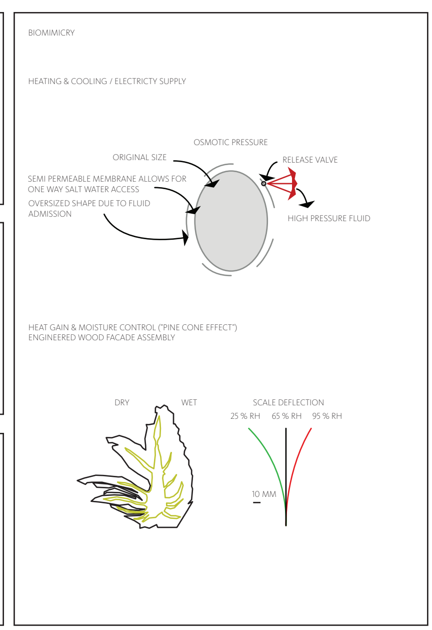


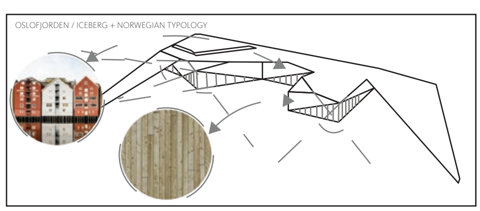
FORNEBU - BIOMIMIC RESEARCH CENTER

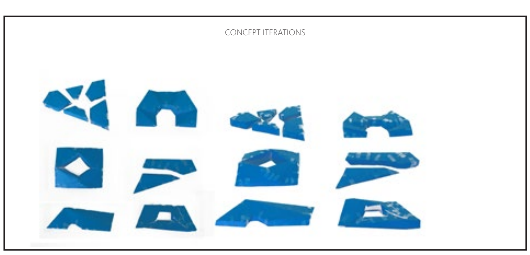
DESIGN PARTI + CONCEPT DEVELOPMENT + BIOMIMICRY

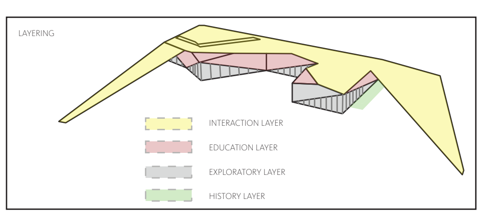






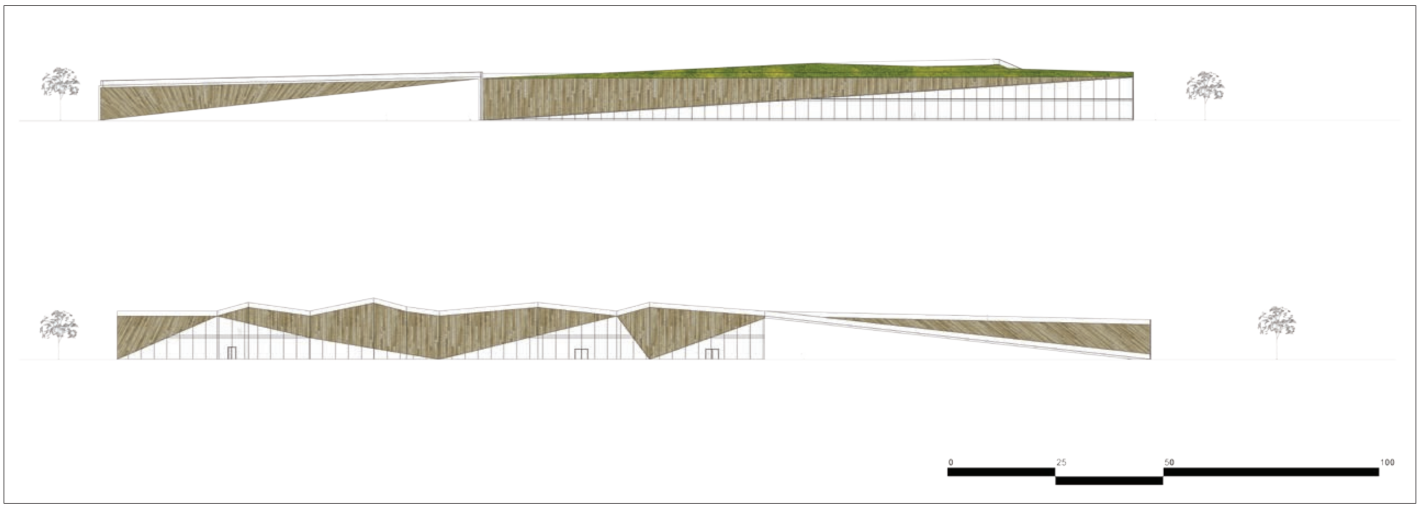






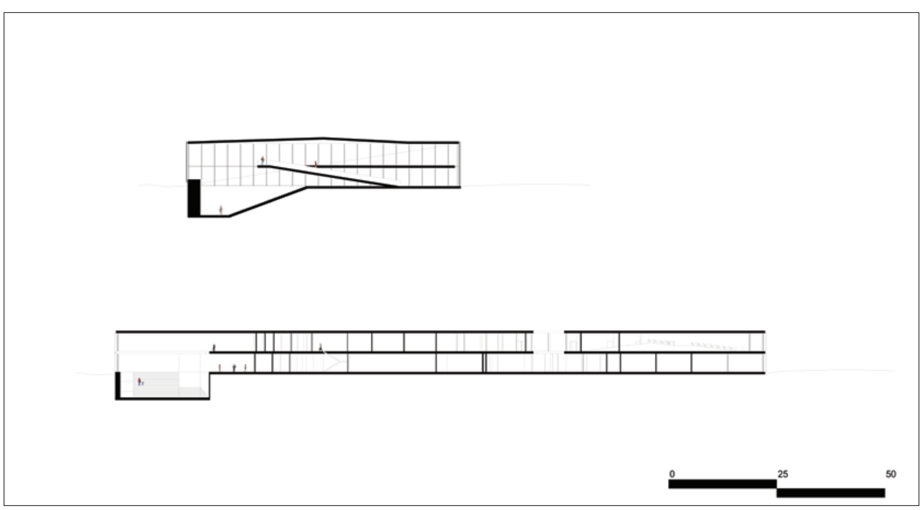
FORNEBU - BIOMIMIC RESEARCH CENTER

ELEVATIONS

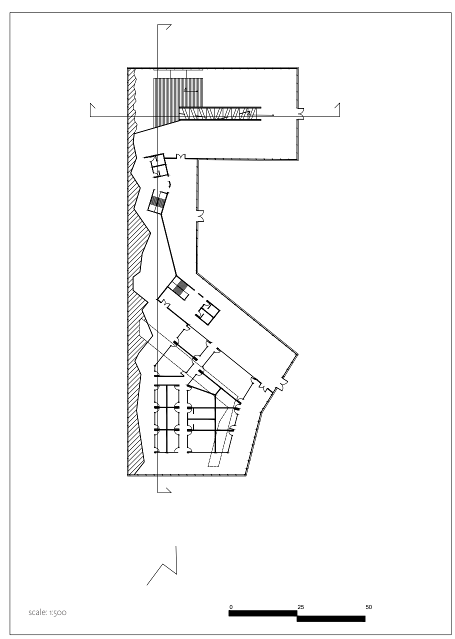


FORNEBU - BIOMIMIC RESEARCH CENTER

SECTIONS

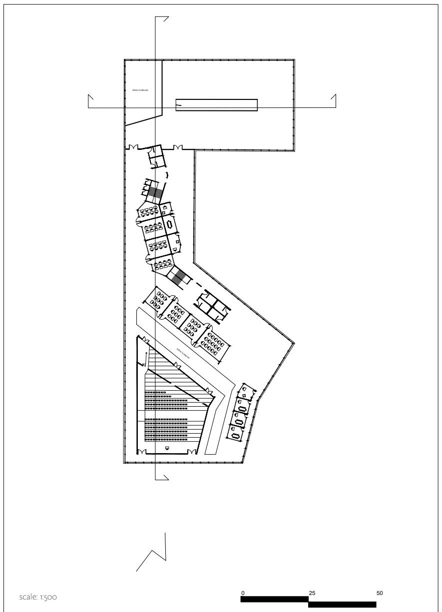


FIRST FLOOR PLAN

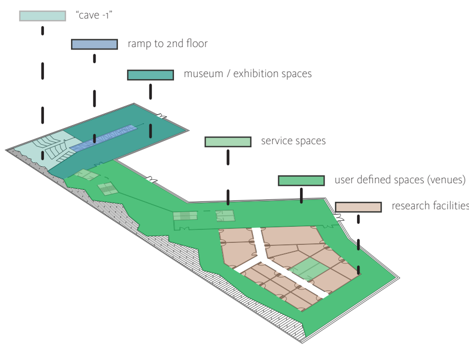


FORNEBU - BIOMIMIC RESEARCH CENTER

SECOND FLOOR PLAN



FIRST FLOOR PROGRAM



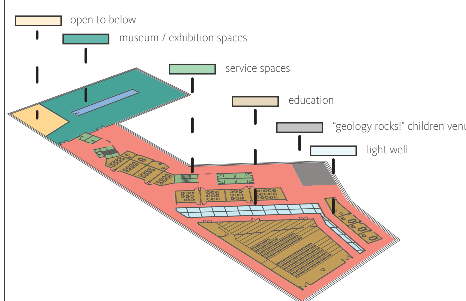
AREAS

"cave -1" - 543.5m2 (5 753 sq. ft.)
museum / exhibition spaces - 1 330m2 (14 316 sq. ft.)
service spaces - 192.7m2 (2 074 sq. ft.)
user defined spaces / venues - 1 336m2 (14 381 sq. ft.)
research facilities - 1 239m2 (13 336.5 sq. ft.)

TOTAL AREA

4 641m2 (49 955 sq. ft.)

SECOND FLOOR PROGRAM

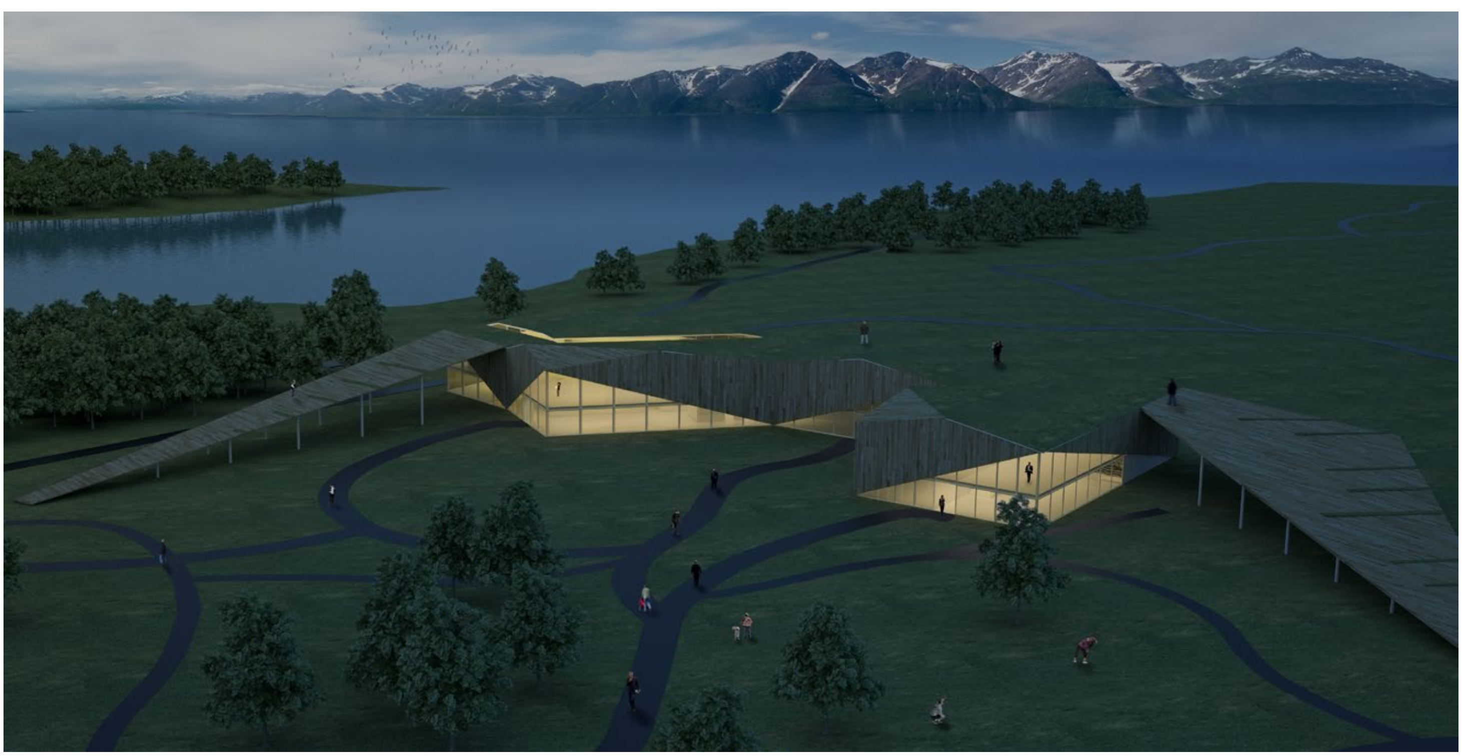


AREAS

museum / exhibition spaces - 1 602m2 (17 244 sq. ft.)
service spaces - 192.7m2 (2 074 sq. ft.)
education / administration - 1 400.5m2 (15 075 sq. ft.)
"geology rocks" children venue - 85m2 (915 sq. ft.)

TOTAL AREA

3 280m2 (35 306 sq. ft.)



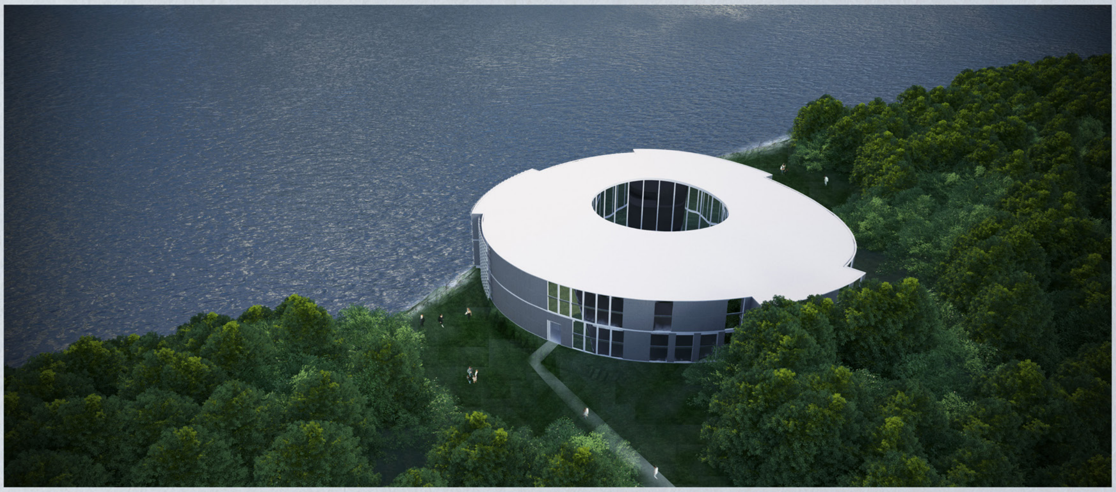
ARC 702 – DESIGN AND FINAL BOARDS - SPRING 2016

PRESENTATION BOARDS

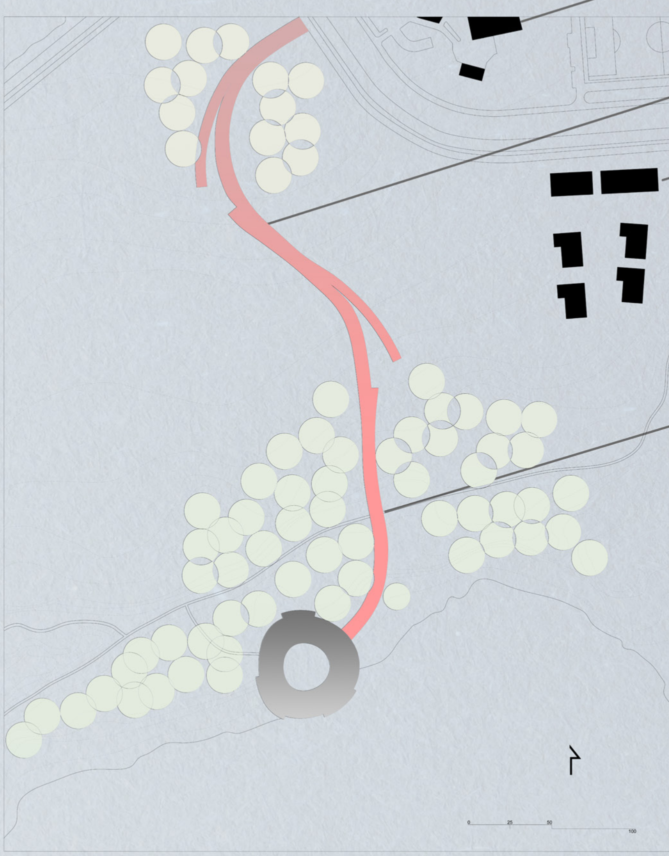
site perspective

site plan

SITE PERSPECTIVE - SOUTHWEST VIEW



SITE PLAN WITH KEY ELEMENTS



site plan / 1:750

FORNEBU SPORTS CENTER - PARKING AREA / STOPPING POINT

PEDESTRIAN AND BIKING ACCESS PATH

RECENT RESIDENTIAL DEVELOPMENT

ALTERNATE ACCESS AND SERVICE PATH

ON SITE VEGETATION

norwegian spruce picea abies

birch betula pubescent

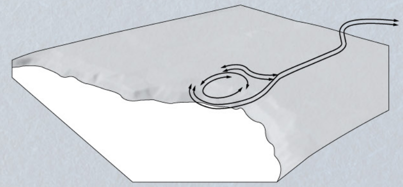
pinus sylvestris

design parti

concept development

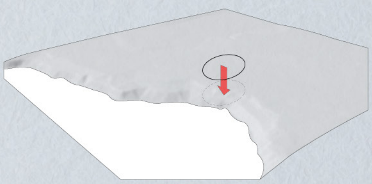
GLACIER GEOMORPHOLOGY

Various type of glaciers always form a fluid - lava like patterns, unstoppably moving towards the open water reservoirs. This journey, can take thousands of years, forming the land beneath, just to go in reverse again when finally reaching the seas or oceans.



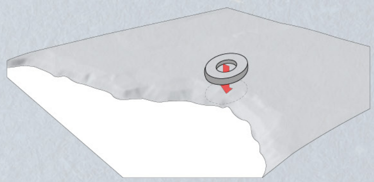
GLACIER FLUIDITY

Glacier fluidity is used as an abstract concept for landscape development and preservation of natural area as well as for research center concept development.



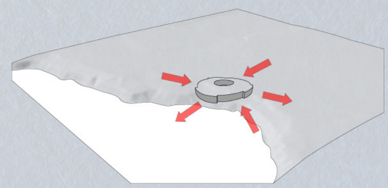
ABSTRACT GEOMETRY / DEFINED TOPOGRAPHY

The Research Center is concieved as a perfect circle projected on the existing natural topography.



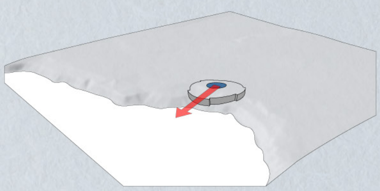
MASS

The Research Center is designed as a loop of exhibition spaces, research and education facilities allowing for great flexibility and different future possibilities.



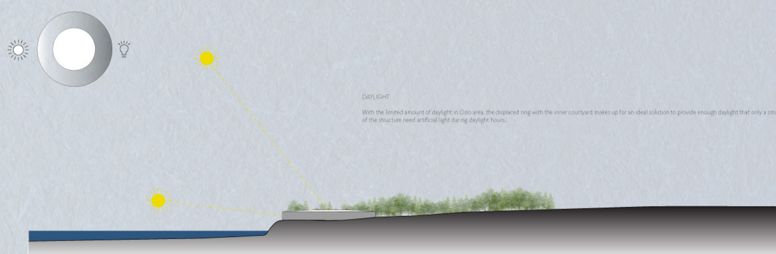
GLACIER

The loop is being subjected to unstopable forces of moving towards sea glacier and starts to shift and displace its geometry.



VIEW AND NATURAL LIGHT

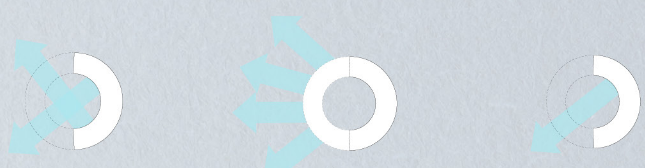
The pushed, pulled and displaced ring acts as a framework for an open space: a reminder of connection between humans and nature. The sloped topography opens up possibility of getting a poetically framed view of the majestic fjord, providing plenty of daylight into the space at the same time.



DAYLIGHT

With the limited amount of daylight in Oslo area, the displaced ring with the inner courtyard makes up for an ideal solution to provide enough daylight that only a small portions of the structure need artificial light during daylight hours.

VIEWS



OUTLOOK FROM RESEARCH

Reseach facilities get views in the direction of cityscape and Oslofjord. The daylight admission is is accomplished through windows facing the inner courtyard and sloped form of the center.

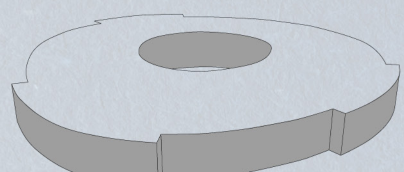
OUTLOOK FROM EXHIBITION AND USER DEFINED SPACES

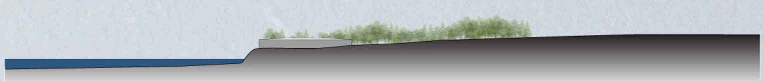
The most impresive 180 degree view can be enjoyed from the ehxibition space and user defined spaces. This is achieved by almost doubling the volume height and establishing the spaces at the farthest / northernmost end of the center. The visitors can enjoy views of Fornebu, city center, and the dramatic Oslofjord.

OUTLOOK FROM EDUCATION AND AUDITORIUM

Located on both levels, education facilities and auditorium space get daylight through windowed inner courtyard and views in the direction of Oslo city center.

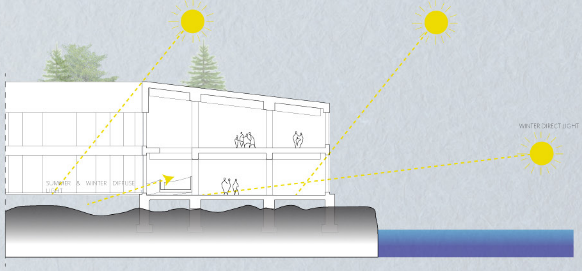
MASS



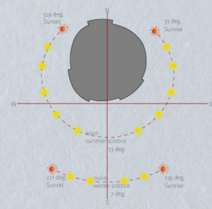


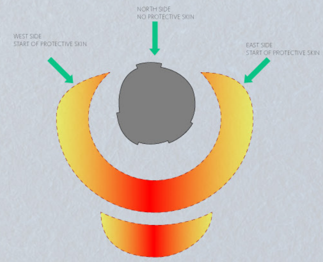
mass analysis

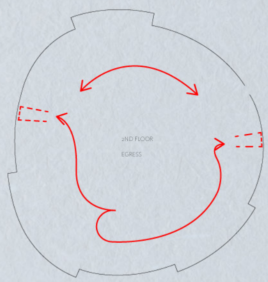
biomimic principles

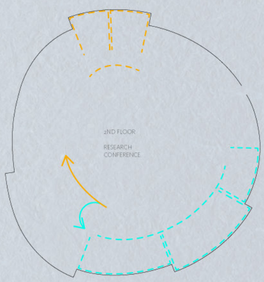


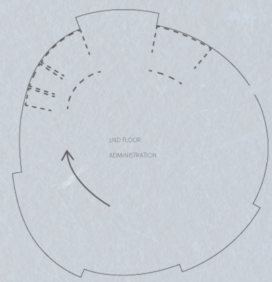
DAYLIGHT ON FACADE ANALYSIS

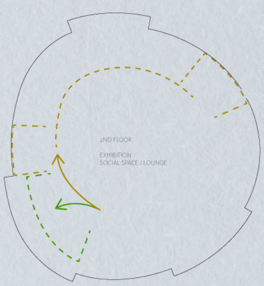


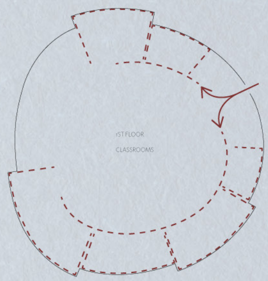


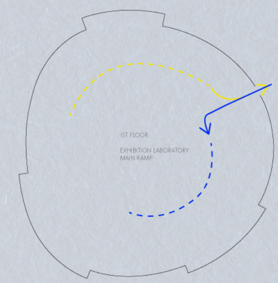








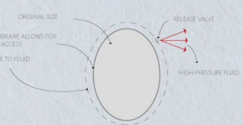




BIOMIMIC PRINCIPLES - INSPIRATION

OSMOTIC PRESSURE

HEATING & COOLING / ELECTRICTY SUPPLY

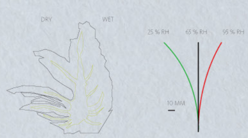


OSMOSIS CONVERTS THE PRESSURE DIFFERENTIAL BETWEEN WATER WITH HIGH SALINITY AND WATER WITH LOWER OR NO SALINITY INTO HYDRAULIC PRESSURE. THIS HYDRAULIC PRESSURE CAN BE USED TO DRIVE A TURBINE THAT PRODUCES ELECTRICAL ENERGY OR PUMP WATER THROUGH HVAC SYSTEM IN THE BUILDING.

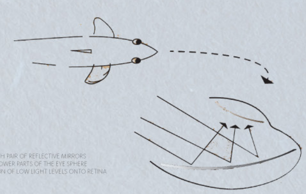
OSMOSIS IN NATURE OCCURS IN PLANT LIFE, HUMAN BODY AS WELL AS IN ANIMAL LIFE (MOVEMENT OF LIQUIDS). THE NORWEGIAN ECOSYSTEM AND CLIMATE SUSTAINS PERFECT CONDITIONS FOR OSMOSIS TO OCCUR.

SCALE DEFLECTION / SUN FOLLOWING - SHADING / SHUTTERS

HEAT GAIN & MOISTURE CONTROL ("PINE CONE EFFECT")
ENGINEERED WOOD FACADE ASSEMBLY



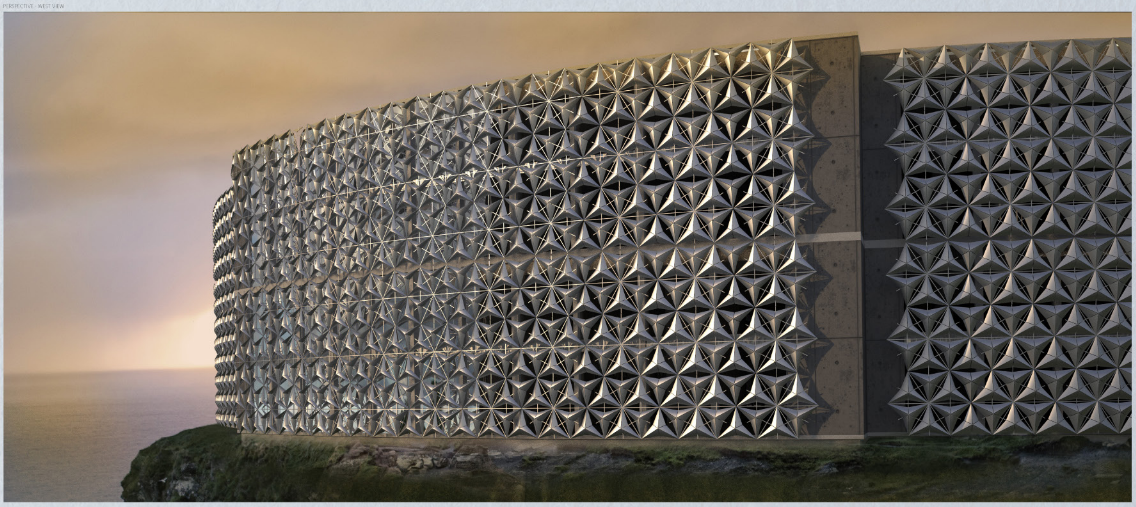
REFLECTIVE DAYLIGHT ADMISSION



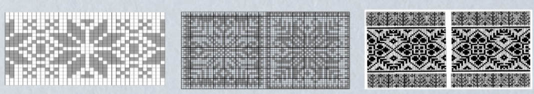
SPOOKFISH EQUIPPED WITH PAIR OF REFLECTIVE MIRRORS SITUATED IN UPPER AND LOWER PARTS OF THE EYE SPHERE ALLOWING FOR REFLECTION OF LOW LIGHT LEVELS ONTO RETINA

biomimic facade assembly

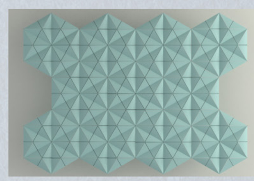
PERSPECTIVE - WEST VIEW



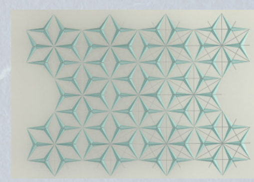
NORWEGIAN KNIT PATTERN INSPIRED BY SNOWFLAKE / FACADE ASSEMBLY INSPIRED BY THE KNIT PATTERN



FULLY CLOSED ASSEMBLY



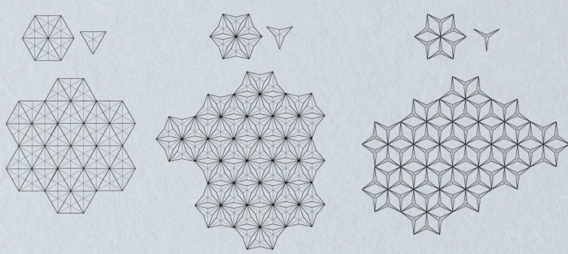
FULLY OPEN ASSEMBLY



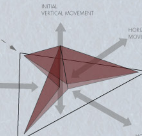
FULLY CLOSED ASSEMBLY

PARTIALLY OPEN ASSEMBLY

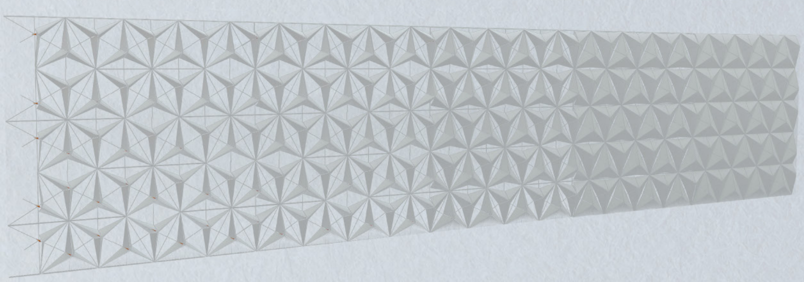
FULLY OPEN ASSEMBLY



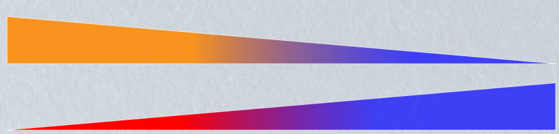
FACADE COMPONENT MOVEMENT



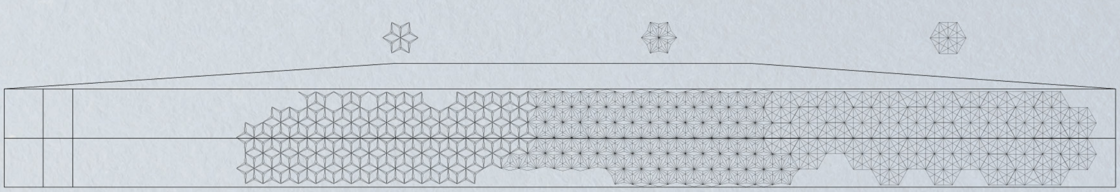
FACADE MOVEMENT IN PERSPECTIVE



RESPONSIVNESS ON THE ELEVATION



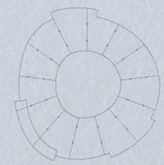
ELEVATION

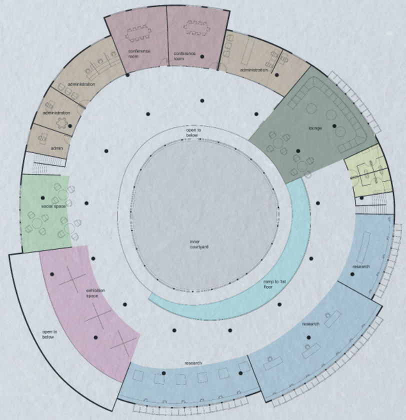


floor plans + section

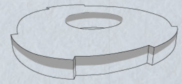
osmotic pressure

STRUCTURE SCHEME / N.T.S.





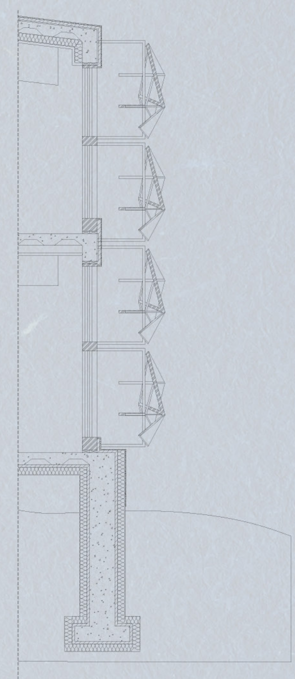
2nd floor plan / 1:200

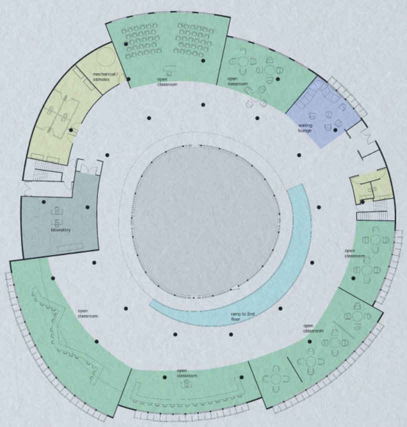


SECOND FLOOR SPACES

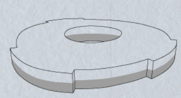
- COMMUNICATION AND SOCIAL SPACES
- SERVICE SPACES
- INNER COURTYARD
- RESEARCH FACILITIES
- RAMP
- LOUNGE
- SOCIAL SPACE
- EXHIBITION
- CONFERENCE
- ADMINISTRATION OFFICES

WALL SECTION - CONSTRUCTION METHOD / 1:25





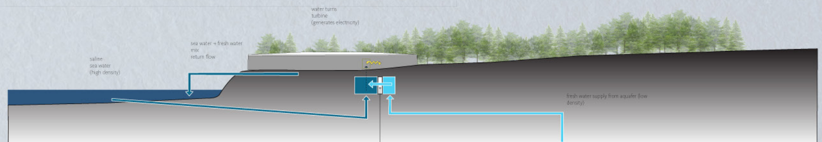
1st floor plan / 1:200



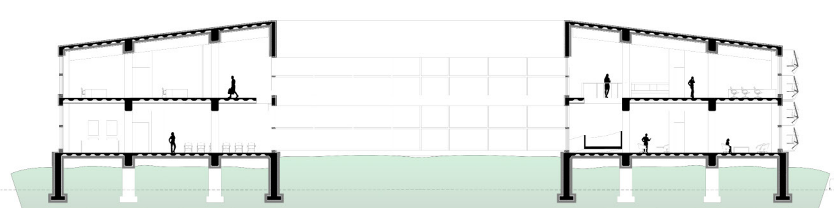
FIRST FLOOR SPACES

- OPEN CLASROOMS
- COMMUNICATION AND SOCIAL SPACES
- SERVICE SPACES
- INNER COURTYARD
- WAITING LOUNGE
- RAMP
- EXHIBITION LAB

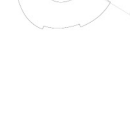
OSMOSIS HVAC SUPPLY DIAGRAM



BUILDING SECTION - 1:100



building section / 1:100



materials

perspectives

CO2 CALERA CONCRETE (BUILDING MATERIAL)
CAPTURING AND CONVERTING CO2 INTO CALCIUM CARBONATE CEMENT

The process for the capture and conversion of CO_2 takes its lead from nature. The earth's atmosphere has had higher concentrations of CO_2 in the past and nature dealt with these high levels of CO_2 by a mineralization process whereby marine organisms use CO_2 to form calcium carbonate structures that deposit on the ocean floor over time. It is estimated that up to 100 million billion tonnes of CO_2 is stored in the geological record in the form of calcium carbonate.

CO_2 from flue gas (industrial emitters)
Use raw flue gas – no concentration required
source: Calera (calera.com)

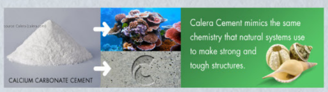
CO_2 captured and converted to a solid Calcium Carbonate novel cement

Used to make a range of building material products

BIOMIMICRY OF CO2 CONVERSION

The special form of calcium carbonate that Calera produces in its process mimics the form of calcium carbonate that marine organisms use to make their shells and other structures. The special form of calcium carbonate is a binder that creates structures with high strength and toughness.

Calcium carbonate exists in nature in different forms or polymorphs. The Calera process results in the production of the vaterite polymorph which is stable when stored in the absence of water. When water and other proprietary additives are added to the vaterite polymorph, a cement reaction occurs in which the vaterite transforms via a dissolution and reprecipitation reaction to form another polymorph of calcium carbonate known as aragonite. This conversion of vaterite to aragonite results in a material with high strength, just as natural systems like nacre (mother of pearl) are also constructed from the aragonite polymorph of calcium carbonate.



OUTSIDE GLAZING IS BUILT WITH QUADRUPLE GLAZING WITH ARGON INFILL TO ENSURE MAXIMUM POSSIBLE THERMAL PROTECTION

FIRST FLOOR - ENTRY AREA + SOCIAL SPACE

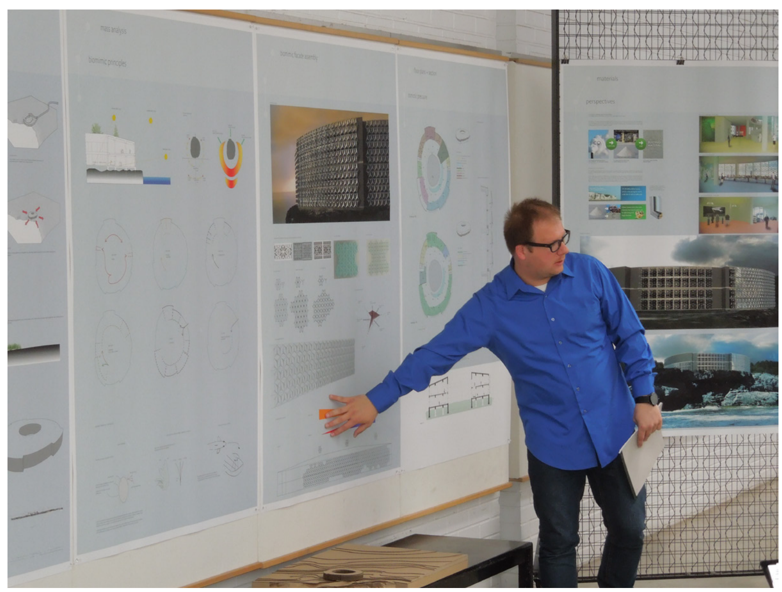
FIRST FLOOR - OPEN CLASSROOM

SECOND FLOOR - EXHIBITION + SOCIAL SPACE

PERSPECTIVE - NORTH

PERSPECTIVE - NORTHEAST

PRESENTATION PHOTOS



ADDENDUM

The Master of Architecture degree thesis process starts during the spring semester (in this case 2015). After initial brainstorm and searching for a suitable topic to explore, we come to a research methodologies, and start to write the conference ready papers – the one that is ultimately presented in the following fall semester. I have found out during this time, not only what actually interests me going deeper into the field of architecture, but also how to gather relevant information about it, conclude a thorough research and draw well informed decisions to push the topic as far as time allows.

After the symposium presentation in the fall of 2015, we dug deeper into the site analysis part of the process. I believe that this is a great time to make last minute changes in terms of site location. Fortunately for me, the site (in broader sense) was already fixed after summer semester. However, conducting more and more research and analysis, the chosen site presented some difficulties, especially in terms of designing the landscape part on a deserted plot with the area of 26 acres. At the beginning of the spring semester (ARC 702), following the advice of my committee (with which I have been in constant consults during the whole process in more or less 2 week intervals), I've modified the location of my project. This presented further challenges in terms of appropriate massing. I believe I have spent too much time on mass analysis and designing the shape itself (since the beginning of the process I went through 21 iterations of the design), because the final massing was agreed upon not until the beginning of March. This resulted in much difficult design process and eventually postponed the final presentation.

However, looking back at the whole thesis process, I can certainly see where the errors were made, and what could have been done to fix them. In general, in my opinion, if well managed in terms of proper communication between studio professors, committee members and student, the process itself broadens the knowledge of particular and very specific aspect of architecture tremendously, giving a sense of accomplishment and satisfaction.