

[kyle a. lacek]

maui aquatic research center

mauí, hawaii

MAUI AQUATIC RESEARCH CENTER

MAUI, HAWAII

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
of North Dakota State University

By:

[Kyle A. Lacek]

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STEVE C. MARTENS; ARCHITECT, ASSOCIATE PROFESSOR

Primary Thesis Advisor [Steve Martens]


Mark W. Bamhouse May 8th, 2013
Thesis Committee Chair

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thesis abstract

This thesis project is meant to explore, in architectural terms, the question of “what will happen if water levels continue to rise, and population levels continue to grow at an alarming rate?” This issue will impact all continents of the world and about 65 percent of the world population, located along water’s edge. Rather than forcing the relocation of billions of people inland, to an even more condense area of dry land, our new technologies make it possible to utilize the 71% of the earth covered by water, where no one is currently living.

The project itself would need to focus on efficiency and due to the isolated location it will need to be relatively self sustaining. The new oceanic facility would also need to have a huge connection to its surrounding aquatic environment, as well this project will integrate innovative design to find a habitual solution to link today’s infrastructure with the aquatic facilities of tomorrow.

The project will focus on development of sub-aquatic communities along coastal regions for those who lose their homes due to the rising sea levels, which have consumed 2,000 miles of coast since 1900 (Willem Post, 2012). Natural disasters such as hurricanes also contribute to people losing their home in coastal communities around the globe. However, these individuals still are inclined to be geographically connected to the ocean. The community itself will act as a model on a global scale for the expansion into aquatic living, and will demonstrate the cutting-edge technology mankind currently has to offer.

Such a building would drastically change our perception of current communities. Thus it will be critical to maintain connection between the communities, using infrastructure that has been set up over the last century, while at the same time expanding that infrastructure. This will need to be a permanent, self sustaining building, strong enough to withstand natural disasters but diverse enough to extract energy and other beneficial resources from the sea. The structure must also have a variety of spaces that incorporate living, working, research, and tourism.

[keywords]

- [aquatic living]**
- [research center]**
- [sustainability]**
- [exploration]**
- [nature]**
- [ocean]**
- [water]**
- [changing environment]**
- [culture]**
- [maui]**

problem statement

With 70% of the world being covered by water should we consider aquatic infrastructure ?

statement of intent

Statement of intent

[typology]

A small sub-aquatic mixed use facility for people to explore oceanic science. This community will provide the residence a place to work and live well promoting oceanic living and exploration.

[claim]

With population density and water levels both rising at alarming rates, sub-aquatic living would be a more efficient use of our planet.

Actor Rising Population/Sea Levels
Action Move Under Water
Object Acted Upon Current Living Situation
Manner of Action Relocation

[premises]

A common theme in architecture and society today is the need to address changing environmental conditions. Integrating sustainable design with today's architecture, while also reducing carbon foot print has been an issue at hand within the past couple of decades. However, land has been another resource that continues to disappear. With sea levels rising, as well as the increasing population we should dive into the issues rather than retreat from high waters.

New, viable locations will need to be sought at due to the depletion of dry land being consumed by the population and rising sea levels. With 65% of the world's population on water's edge, there is an apparent, desire to be closely connected with the ocean for both resources as well as an unexplained emotional connection. This connection can be strengthened through aquatic living. Such communities and facilities would not only help with population control on dry land, but it would also prevent devastation concerns caused by rising sea levels due to global warming. Not only will it provide a place to thrive, this structure would also protect communities devastated, natural disasters.

NOAA states that, "today's oceans cover 71 percent of the earth's surfaces and that, 95 percent of these waters are unexplored." These numbers will continue to grow as "sea levels are expected to rise by three feet before 2100, due to global warming." (James Gerken, 2012) It is time consider reversing evolutionary history, and explore the possibilities of aquatic living as a practical option. Humans can once again adapt to their ever changing environment.

Statement of intent

[theoretical premises/unifying idea]

With climate change causing sea levels to rise and population growth causing the 65% of the population on water's edge to condense and relocate, we need to use modern technology to explore what has yet to be discovered; the ocean. This leaves much hope for advancements as well as a possible living environment protected from natural disasters that occur on land.

[project justification]

With 71% of the Earth's surface being covered by water, why have we only been occupying the 29% not covered by water? Populations continue to rise along with sea levels. We are losing land, but still need to support more inhabitants. New technologies are currently changing our transportation efficiency and its effect on the environment. These new technologies can also help us increase efficiency in our living locations on a planetary scale.

the proposal

narrative

Global climate change reminds us that it's up to us to make environmental changes today, that will impact the generations' of tomorrow. This stressful impact on the environment can also be seen in stronger storm systems, droughts, as well as increased precipitation. Perhaps the most talked about impact is the rising sea level caused by polar ice caps melting, an impact that could effect up to 65% of the world's population living along costal regions. (National Geographic)

"Until recent years much more was known about the surface of the moon than about the vast areas that lie beneath three-fourths of the surface of our own planet" (Submarine Geology) Today's technologies make it possible to investigate uncharted territories on the earth that are able to sustain life; the ocean being one of them.

Now with global warming causing polar ice shelf's depletion rates to drastically increase and sea levels to increase with them, waterfront cities could potentially be consumed by water on which they sit. This would force the evacuation and relocation of populations and economic infrastructures and coastal communities the connection to water is a way of life both economically and emotionally. The question would then be, "where would these inhabitants and companies relocate to?"

This thesis will explore architectural responses to a growing question that many ponder. Is it possible for humans to efficiently work, live and more importantly survive on the ocean floor? Or is this notion purely a speculation much like the lost city of Atlantis? One might also ask how will this sub-aquatic structure impact the aquatic ecosystem that surrounds it? Like the intent of their studies, this research community will be completely submerged by the aquatic environment in which they study. As well, the facility will maintain a minimal impact on the environment through using the smallest footprint possible.

This multifunctional research facility will house a small community of aquatic-researchers who will live and work on site, while opening their doors to the outside community through an interactive, educational, observatory. The hope being to expand knowledge of the aquatic environment, and promote the exploration into aquatic living and ocean harvesting.

user/client description

[client/owner]

The proposed project will be a joint venture between NOAA (National Oceanic & Atmospheric Administration) and GE (General Electric) with additional funding through private investment firms. The project will be inhabited by researchers from the NOAA and GE to conduct studies in the areas of aquatic energy conduction, biology and aquatic infrastructure.

[residents/users]

A state of the art facility will bring together the brightest minds from across the world, ranging from biologists to engineers. All collaborating under one roof to study and create solutions which will enable society to live sustainably under the ocean.

[visitors]

Communal and civic interaction will be a key aspect of this push to aquatic exploration, therefore this facility will house a public, oceanic observatory. Observatory visitors will enter the submerged structure through a tunnel, accessible from a security booth on the mainland. This booth will distribute clearance passes to each visitor as a means to monitor information theft and prevent terrorist attacks.

[peak usage]

The building will have highest activity throughout the daytime hours, due to local visitors using the observatory spaces as well as scientists and engineers testing new forms of technology in the labs.

[parking]

There will be no on site parking available for this facility. Instead parking will be located off site in the neighboring town. From there both scientist and tourists alike must take a shuttle system that runs every fifteen minutes to the facility's tunnel entrance located 500 feet away from the structure on the main land.

[health issues]

Although there are no immediate health risks associated with this building, visitors and residence might at times be overcome with claustrophobia. These enclosed quarters may also be susceptible to outbreaks such as flu.

major project elements

The typology for this project is not completely defined. The major project elements will be developed from the research and data analysis.

[labs/offices]

Labs will be used by resident researchers. [biologists, engineers] The size of labs will vary depending on team or individual research work being conducted.

[auditorium]

A large auditorium will be used for research lectures to the communities, media and investors. This will also be used as an in house movie theater for residence during after hours.

[living quarters]

Apartment style living quarters will house researchers and their families for months at a time.

[tunnel]

A transportation system will reach from the structure to the main land and will allow people to enter and exit the facility.

[observatory]

A public observatory will allow members of the outside community to observe both research taking place, as well as the surrounding oceanic ecosystem.

[rest rooms]

[mechanical]

[circulation]

[storage]

[gift shop]

[reception]

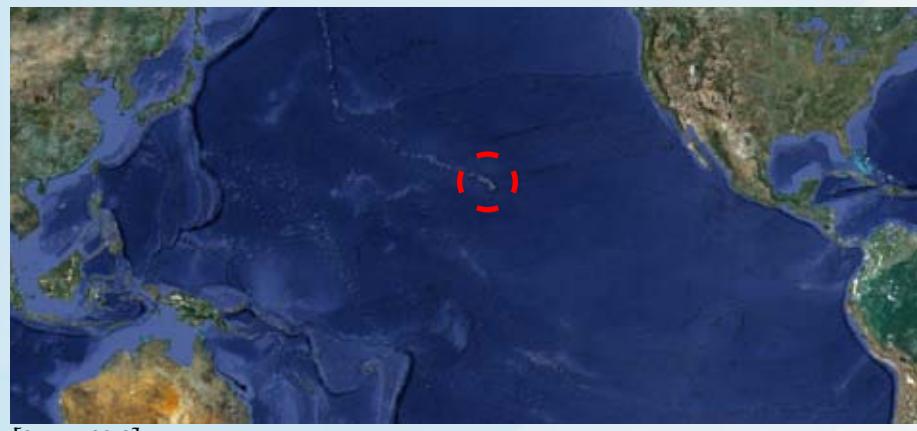
site information

[region] Site information

[REGION]

The site is located just off the island of Maui, Hawai'i. Maui has a population of 131,531 and one of eight islands located in the Pacific Ocean that together make up the Hawaiian Islands. With its warm and gentle trade winds, mild temperatures and sunny skies, Hawai'i has but two seasons, summer and winter. The summer months tend to be dryer and have air temperatures averaging about 85 degrees fahrenheit, with ocean temperatures of about 80 degrees. The winter months tend to be a slightly wetter with air temperatures averaging about 80 degrees fahrenheit and ocean temperatures of about 73 degrees.

[to-hawaii.com]



[Google, 2012]



[Google, 2012]

[city] Site information



[Google, 2012]



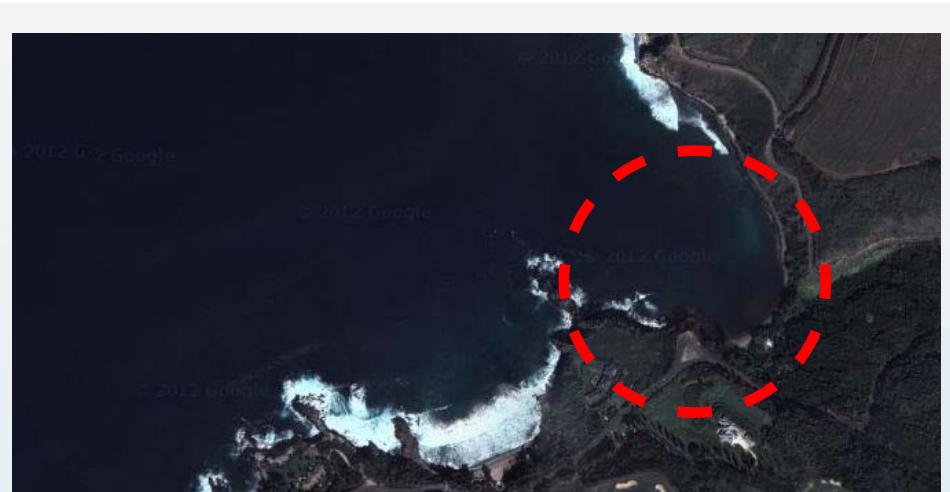
[Google, 2012]

[city]

The site sits in a bay just north of Kapalua, one of Maui's largest resort communities. With a 2010 census reporting 353 permanent residence this 23,000 acre, resort community is actually much larger then the reports indicate, due to the approximately 2.2 million visitors per year.

[citydata.com]

[site] Site information



[Google, 2012]



[Google, 2012]

[site]

The site is located in Honolua Bay, just south of Maui's Highway 30 and is apart of the Honolua-Mokule'La Bay Marine Life Conservation District. This site is important to the project because not only is the location protected by the bay, more importantly it is not diluted from previous, human interaction. This pure and untamed environment will not only make researchers data more accurate, it will also be optimal for visitors of the observatory to view the untouched environment.

project emphasis

[project emphasis]

This thesis will examine how modern technologies have the ability to transform one's perception of environmental surroundings.

plan for proceeding

plan for proceeding

[definition of research direction]

Research for this project will be conducted throughout the thesis process and will focus on the theoretical premise and unifying idea. Related fields of investigation will include typological studies, historical context, site analysis, project typologies and programmatic requirements.

[design methodology]

This thesis research will use mix method, quantitative and qualitative approaches.

Quantitative and qualitative research will be conducted using concurrent transformative strategy, to meet theoretical premises and achieve better design quality. This will include but is not limited to, graphic analysis, digital analysis, interviews and observations.

Quantitative will include scientific data and statistical information

Qualitative will be gathered through interviews, observations, surveys and archival research.

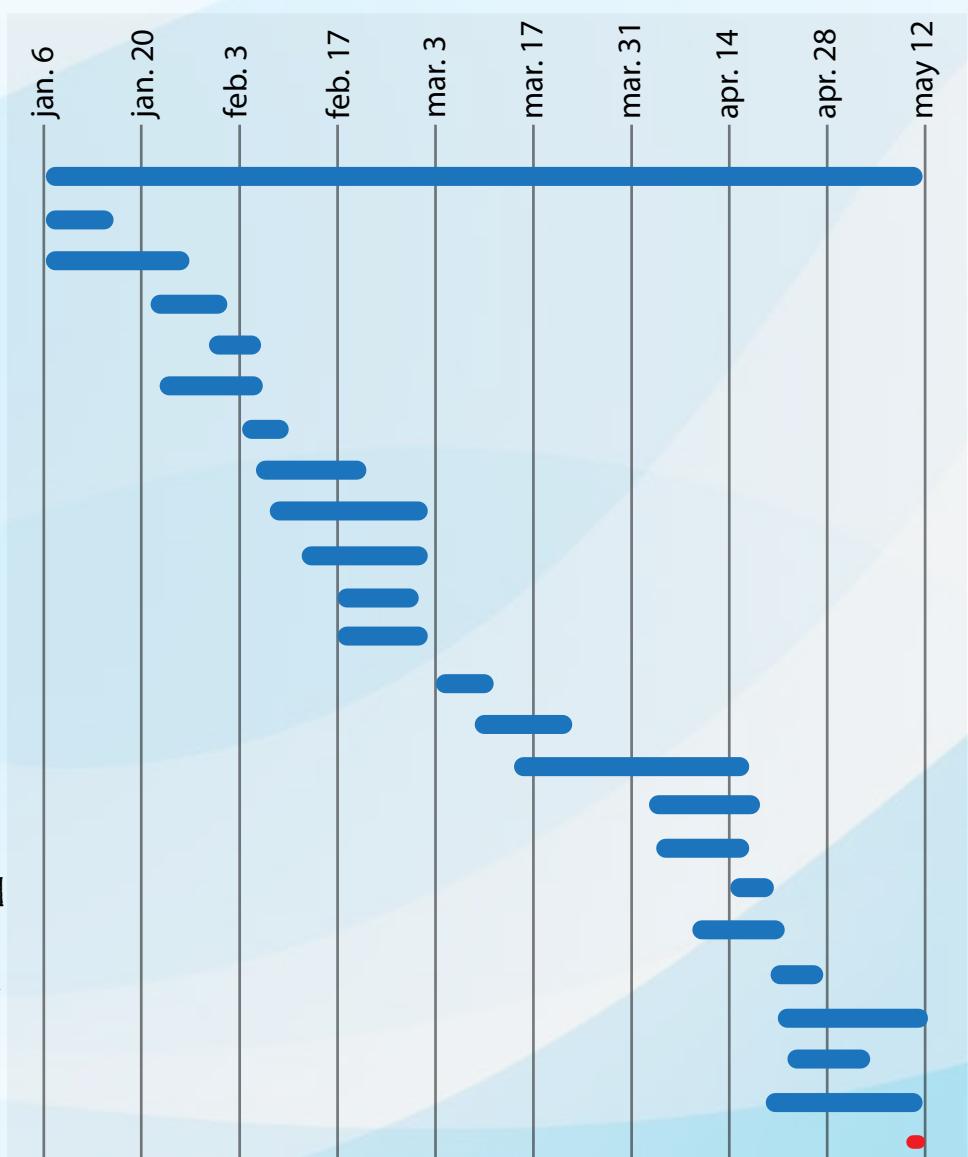
Documentation of the design process will be done on a consistent basis and will be illustrated through digital means, including photography, scanned images, and digital drawings. It will also be done thorough hand drawn sketches.

plan for proceeding

[project documentation]	89 days	01.07.13 – 05.10.13
[context analysis]	5 days	01.07.13 – 01.11.13
[conceptual analysis]	11 days	01.07.13 – 01.24.13
[ECS passive analysis]	7 days	01.22.13 – 01.30.13
[ECS active analysis]	4 days	01.30.13 – 02.04.13
[structural development]	8 days	01.23.13 – 02.04.13
[context redevelopment]	5 days	02.04.13 – 02.08.13
[floor plan development]	11 days	02.06.13 – 02.20.13
[envelope development]	15 days	02.08.13 – 03.01.13
[materials development]	11 day	02.15.13 – 03.01.13
[structural redevelopment]	9 days	02.18.13 – 02.27.13
[section development]	10 days	02.18.13 – 03.01.13
[midterm reviews]	5 days	03.04.13 – 03.08.13
[project revisions]	11 days	03.08.13 – 03.22.13
[rendering/artistic]	24 days	03.15.13 – 04.15.13
[presentation preparation]	15 days	04.05.13 – 04.16.13
[presentation layout]	6 days	04.06.13 – 04.15.13
[CD of boards to thesis advisor]	3 days	04.15.13 – 04.17.13
[plotting and model building]	8 days	04.10.13 – 04.19.13
[exhibits installed on 5th floor]	5 days	04.22.13 – 04.26.13
[thesis exhibit]	13 days	04.23.13 – 05.11.13
[final thesis reviews]	6 days	04.25.13 – 05.2.13
[final thesis document due]	8 days	04.22.13 – 05.10.13
[commencement]	0 days	05.15.13 – 05.15.13

plan for proceeding

- [project documentation]
- [context analysis]
- [conceptual analysis]
- [ECS passive analysis]
- [ECS active analysis]
- [structural development]
- [context redevelopment]
- [floor plan development]
- [envelope development]
- [materials development]
- [structural redevelopment]
- [section development]
- [midterm reviews]
- [project revisions]
- [rendering/artistic]
- [presentation preparation]
- [presentation layout]
- [CD of boards to thesis advisor]
- [plotting and model building]
- [exhibits installed on 5th floor]
- [thesis exhibit]
- [final thesis reviews]
- [final thesis document due]
- [commencement]



previous studio experience

[Fall 2009] Stephen Wischer

“Tea House”
[Fargo, ND]

“Boat House”
[Minneapolis, MN]

[Spring 2010] Phil Stahl

“Montisorri School”
[Fargo, ND]

“Hemmah House”
[Fargo, ND]

[Fall 2010] Milt Vergens

“Masonic Guild Hall”
[Mankato, MN]

“Healdsburg Guitar Festival”
[Healdsburg, CA]

[Spring 2011] Regin Schwaen

“ACSA Steel Competition”
[San Francisco, CA]

“National Geographic Cafe”
[Fargo, ND]

[Fall 2011] Don Faulkner

“High Rise”
[San Francisco, CA]

[Spring 2012] Ron Ramsay

“Adelaide University”
[Agincourt, IA]

[Fall 2012] Regin Schwaen

“North Dakota Museum of Art Addition”
[Grand Forks, ND]

program document

**theoretical
research**

Coastal population growth

In 2008, the United Nations Fund For Population Activities (UNFPA) officially announced that “for the first time in history, more than half of the world’s population lives within towns and cities... and by 2030 this number will swell by 5 billion” (UNFPA, 2007). This new found growth has already began to transform once large cities into “mega-cities,” cities that are made of converging metropolitan cities, much like New York, Boston and Washington D.C. As a result of these convergences, these new “mega cities” are eating up valuable agricultural land, that is needed to sustain these same cities.

Today, 14 of the world’s 17 mega-cities are located along coastlines, whether that be saltwater; oceans and seas or freshwater; lakes and rivers, (Thorne-Miller, 1999). The presence of water is crucial for sustaining life, and for mega-cities water plays an integral role for commerce. In fact, roughly 1,000 people arrive each day in large coastal cities, throughout China, Vietnam and the Philippines. Most of which are farmers whom are moving to the cities because of land depletion, (Creel, 2003). One possible solution to this problem of “invasive cities” and their effect agriculture and land occupancy would be to inhabit unusable agricultural land, for instance aquatic subfloors.

Coastal population estimates tend to vary because of the fact that there is no defined definition for what constitutes a coastal region. However coastal regions are most generally described as an area within 60 to 200 kilometers of shore, which includes floodplains, coastal forests, marshes, tide-flats, dunes, beaches as well as coral reefs (Creel, 2003). Because of the economic benefits associated with this region through ocean navigation, coastal fisheries, tourism and recreation, human settlements are more often located near coastal regions than anywhere else, (CIESIN, 2012). In fact, coastline settlements account for over half the world’s total population, and have an average population density of about 80 persons per square kilometer, twice the world’s average density. These figures are projected to double by 2025, (Creel, 2003). With both population numbers growing and storm intensities increasing, it makes you wonder what would happen if a “mega-city” on the water like Tokyo with 33,200,000 people was struck with devastation?

water level predictions

The rising sea levels are cycle. Rising air temperatures causes increase in water temperatures and in return water expands and melts ice caps and snow. This then exposes ground making for less reflective surfaces for sun rays to bounce off of. Even if glacier melting was not considered the average global, sea level, increase prediction over the next century would be between seven to 23 inches. However if glacier melting is accounted for NOAA predicts that by the year 2100 sea levels will have seen roughly a 3.5 meter (11.5 ft) increase. (NOAA, 2012) That would be roughly 5,000-6,000 square miles of coastal land be consumed by 2100. Since 1900 we the planet has lost roughly 2,000 square miles. (Post, 2012)

Some experts say that these numbers tend to show best case scenario. According to Richard Z. Poore, Richard S. Williams, Jr., and Christopher Tracey of the U.S. Geological Survey stated that, "Reduction of the West Antarctic and Greenland ice sheets similar to the past reduction could cause the sea levels to rise more than 10 meters." This number is roughly three times what the NOAA has stated and if correct this water would flood approximately 25% of the United States population. With the most significant damage coming to the heavily populated, Gulf and East coasts. (Poore, Williams & Tracey, 2011)

This foreseen rise in sea level has put coastal communities at higher risk for floods, storm surges and continuous erosion. A recent report conducted in the Gulf of Mexico showed that within the next 50-100 years, 27 percent of the regions major infrastructure will be below the regions project sea levels. This would greatly increase effects of regional storms and their aftermath.

This foreseen rise in sea level has put coastal communities at higher risk for floods, storm surges and continuous erosion. A recent report conducted in the Gulf of Mexico showed that within the next 50-100 years, 27 percent of the regions major infrastructure will be below the regions project sea levels. This would greatly increase effects of regional storms and their aftermath. (NOAA, 2012)

Ocean Current energy

In 2005 the Energy Policy Act was created thus giving the Department of Interior and the Mineral Management Service (MMS) the right to oversee the renewable energy programs. This Act charges the MMS with the responsibility of overseeing and reporting all forms of renewable energy, from wind, wave, ocean current, solar, hydrogen, and other alternatives aside from fossil fuels. (MMS, 2006)

Flowing in one direction at a constant rate, Ocean currents are generated by wind and solar heating of water near the earth's equator. Examples of some usable, ocean currents would be the Florida Straits which is known for generating very powerful hurricanes and it is said that collecting 1/1000 of its energy could power 35 percent of Florida. Though the most promising gathering station will be located along the Hawaiian Islands, its combined jet stream and geothermal activity make it one of the strongest currents in the world. The speeds of the currents are generally slower than that of wind speeds, though due to the kinetic energy contained in the water it carries more velocity, due to the fact that water is 800 times denser than air. For example if a 12 mph water current would have the equivalent energy of a 110 mph wind gust. (BOEM, 2012)

At this time current energy is in its early stages of development for commercial use. Though the submerged turbines are currently being installed in Europe and will operate much like wind turbines you would find on land. There have been and are being an array of prototypes developed and tested in the field. However the basic elements for harnessing ocean current energy are the same, lift or drag include rotor blades, a generator for converting rotational energy into electricity, and a means for transporting the electrical current produced.

(MMS, 2006)

Ocean current energy

There are a few potential problems that are currently being worked out, avoidance of drag from cavitations, air bubbles creating turbulence, prevention of marine growth on machines and splices protection. It is important to address these issues before installation because performance reliability is crucial due to the high costs associated with repairs in the marine environment. (BOEM, 2012)

Before implementing ocean current conductors it will be important to consider the circulation paths of both shipping routes and commercial fishing so as to avoid any possible interference. It will be equally as important to take into consideration the protection of fish and marine animals in relation to the turbines. If not carefully calculated prior to installation the disturbance of aquatic wildlife could cause both political and environmental implications. There are many systems currently being tested at to help safeguard the aquatic species and their co-existence with ocean current conductors. Such items include but are not limited to slow moving turbine blades that would safely allow fish to maneuver through without being harmed. As well as large protection fences with built in sonar that would allow breaks to be activated when large aquatic animals are in the vicinity.

Currently conduction turbines are generating electricity with velocities as low 1 m/s. However to become economically efficient within the current energy market, they will have to be able to generate a consistent flow rate of 2 m/s. (MMS, 2006)

Ocean, a biological resource

Many people take for granted all the things that are made possible to us by marine ecosystems. Such things include the air we breathe, food, transportation, recreation, tourism and developments.

To fully understand the importance of the marine ecosystem and its effect on living organisms, one must first look at the ecological connection between land and sea.

The marine ecosystems play a vital role in the earth's cycle, as it contains: oxygen, carbon, nitrogen, phosphorus and sulfur. The ocean in particular has been widely recognized for its important role in the carbon cycle and its ability to adjust the carbon concentration in the atmosphere. Microscopic plant species, known as microalgae or phytoplankton, grow on the oceans surface in what is referred to as the zone of light, (Thorne-Miller, 1999). This surface water, plankton is uniquely important due to its ability to balance out carbon dioxide levels.

"Carbon dioxide is added to the surface waters by three processes: absorption of carbon dioxide from the atmosphere, release of carbon dioxide from the respiration of bacteria and animals in the water, and upwelling of carbon dioxide from dissolved calcium carbonate in deposits of shells and other materials on ocean floor, (Thorne-Miller, 1999)."

The process in which these methods balance out is dependent on its time and location in the sea. Scientist have believe that due to the phytoplankton and their role in carbon dioxide, these species could regulate atmospheric carbon dioxide and subside global warming. "It is not known just how climate change and change in the ocean carbon cycles are related, but scientist have speculated that the increased productivity of oceans has cause global cooling by reducing atmospheric carbon dioxide in the past," (Thorne-Miller, 1999).

ocean, a biological resource

"Numerous marine species can be considered "good" for human use, consumption and commerce," (Thorne-Miller, 1999). By maintaining healthy marine ecosystems one can have a healthy supply of food and food supplements to be used for drugs, cosmetics, and animal feed. "Fishers, aqua-culturists and those supplying services and goods to them assure the livelihoods and well-being of a total of about 520 million people, 7.9 percent of the world population," (FAO, 2012). With that being said, fishing it is crucial for nations around the world. In some countries, fish are the primary source of protein. But with population increase, fishery yields decline, (Thorne-Miller, 1999). Today there are roughly 9,000 fish species currently being exploited, of which 22 are harvested at global quantities, (exceeding 100,000 metric ton) nine of these are on the decline. If measures are not put in place to protect the vital resources of which the ocean embodies, then it repercussions will have lasting effects on the environment and subsequently mankind.

tourism, a change in scenery

“The travel and tourism contributes US.\$6 trillion to the global economy, 9% of the global GDP, and supports 260 million jobs worldwide,” (WTTC, 2011). These numbers put the travel and tourism industry as the highest grossing industry in the world. Research gathered by the United States Department of Commerce indicates that the United States recorded the second highest number of international tourist arrivals with 73.1 billion per year, however Germany held the record with an astonishing 80.1 billion international tourist arrivals, (WTTC, 2011). Such findings also illustrated that the top tourist destinations of the world were commonly linked through their geographical proximity to water. Though one could argue the reason for this is because of populous cities being already positioned there. Although this is arguable, what is not arguable is the growth rate of tourism and its commerce has undergone within the last couple years. This year alone tourism is up 28 percent, putting it on track to surpass 2010’s record growth of 32 billion dollars. Successful tourism is key to most countries survival, the United States being to exception as it is one of the leading sources of export, and supports millions of jobs in the service sector. It is important to note that extensive growth is forecasted with tourism. “All but two of the top-40 visitor origin countries are forecasted to grow from 2010 through 2016.” (USDC 2011) With the largest expected growths coming from China, South Korea, Brazil, Russia and India. (USDC 2011)

With a new push towards aquatic tourism our perception of travel destinations have changed drastically. Hotels such as the Atlantis, located in both Dubai and the Bahamas now allow families to enjoy sub-aquatic adventures like the sea, without leaving the comfort of their hotels. Amenities include shark tank water slides that allow you to pass through shark aquariums, as well as ocean exposed rooms (living spaces that separate the ocean with nothing but a pain of glass.)

coral reef impacts

Although coral reefs cover less than one percent of the earth's surface, they house twenty five percent of all aquatic species. In fact, there are over a billion coral polyps that make up the world's largest living structure, the Great Barrier Reef. The Great Barrier Reef, is so large that it "covers an area of about 348,000 km² and can be seen and stretches along 2,300 km of eastern Australia coastline and is visible from space," (Klappenbach, 2012). These ecosystems are not only crucial to the aquatic environment as well as the human culture as it produces roughly \$375 billion a year worldwide through things such as tourism, food and medicine, (R2 Coral Reefs, 2007). Over the last decade these very actives have decreased the coral reefs around the world by twenty percent through things as coral trampling, unsanctioned fishing, and worst of all anchor dragging; caused by cruise ships as they come ashore to port. Beside human activities the ocean has climate related threats, associated with the oceans carbon dioxide fluctuations have began to cause coral bleaching (whitening or de-coloration of coral). Though thus far, "corals have shown remarkable resilience through major climate events and sea level changes, giving hope for their continued survival," (R2 Coral Reefs, 2007). However these hopes of continued survival are contingent on our care for the environment.

theoretical research summary

To create a well-developed thesis, it was critical to examine the co-existence between man and nature, on planetary scale. After having done such research into aquatic environments and their surrounding communities, I feel as though I have gained substantial knowledge in the realm of aquatic developments and their interaction with nature. Having said that, I believe that protecting and forming to the needs of nature is key to the protection of mankind.

Research has led me to believe that for continued co-existents between nature and man, man must be willing to sacrifice things. In most recent years, climate change has caused for the reduction of polar ice caps and as result there have been rising sea levels consuming, valuable space in heavily populated, coastal cities. The land in which these cities occupy will need to be given back to nature, if not human devastation will occur.

From very early on in my research I was interested in a buildings ability to adapt to its environment, an environment in which is changing drastically every day. Unaware or perhaps naive, I did not realize the severity of the scientific data associated with such changes. This led a great deal of interest in not only results of environmental effects but causes for such effects.

Having already known that there was tremendous amount of water front cities, I was amazed by these “mega-cities” and their geographical size, as well as their immense populations. Now knowing these unprecedeted statistical numbers, my belief in successfully using aquatics explorations as a means for expansion is ever greater.

theoretical research summary

The findings of this research have provided useful information in regards to the ocean's ability to produce multiple forms of renewable energy and in return directly serve societal needs. In order to produce enough sufficient energy for a facility much like this one in which this thesis is proposing, several sources will need to be used, ranging from solar, and hydropower. The evidence of the research indicates that the hydropower from ocean currents will be the optimal power supply. These devices although very new, and in-fact still being tested, could be installed at the waters surface, and have minimal visual, or environmental.

Perhaps the biggest commonality throughout these research findings was the emphasis on "invasive species," and their ability to overpower and inability to co-exist. When I use the term "evasive species," I am referring to man in correlation to the sea. If nothing else this research has provided me with a set up open eyes. Its clear that the man's need for the ocean has grown greater in recent years through in-heighten uses of food, medicine, and leisure. It is also clear that the sea's need for real estate has grown in recent years due to rising sea level. With this newly gained knowledge I strongly believe that I have the ability to create a strong thesis design, in which both man and sea can live in unison.

topological research

Lily pad: a floating ecopolis

title: Lily Pad: A Floating Ecopolis

architect: Vincent Callebaut

location: Any body of water

completion: N/A

square footage: N/A (50,000 Inhabitants)

description word: ecological-linkage

Like many, the Belgian architect Vincent Callebaut is concerned with global warming's effect on nature, more importantly the ocean and rising sea levels. However the difference between Callebaut and others is that he decided create design solutions to combat global warming. The result is a floating structure that could take in refugees from any distressed location of the world, its name; "Lily Pad: A Floating Ecopolis." This was not something Callebaut just threw together, this is a well thought out floating city that could house 50,000 people at one time, and many people believe it will revolutionize the future.

The goal of this structure is to create a harmonious co-existence between humans and nature. The structure brings elements of land living to the ocean, much like a cruise-liner, with some area being submerged under the water. This multi-dimensional, symmetrical structure is comprised of three evenly balanced marinas and artificial mountains covered by stratum plant life. Inhabitants would diversely live in all three mountains, however each mountain would perform different communal functions; for example work, commerce and entertainment.

[case study I] lily pad: a floating ecolonolis



[Arch2o, 2012]

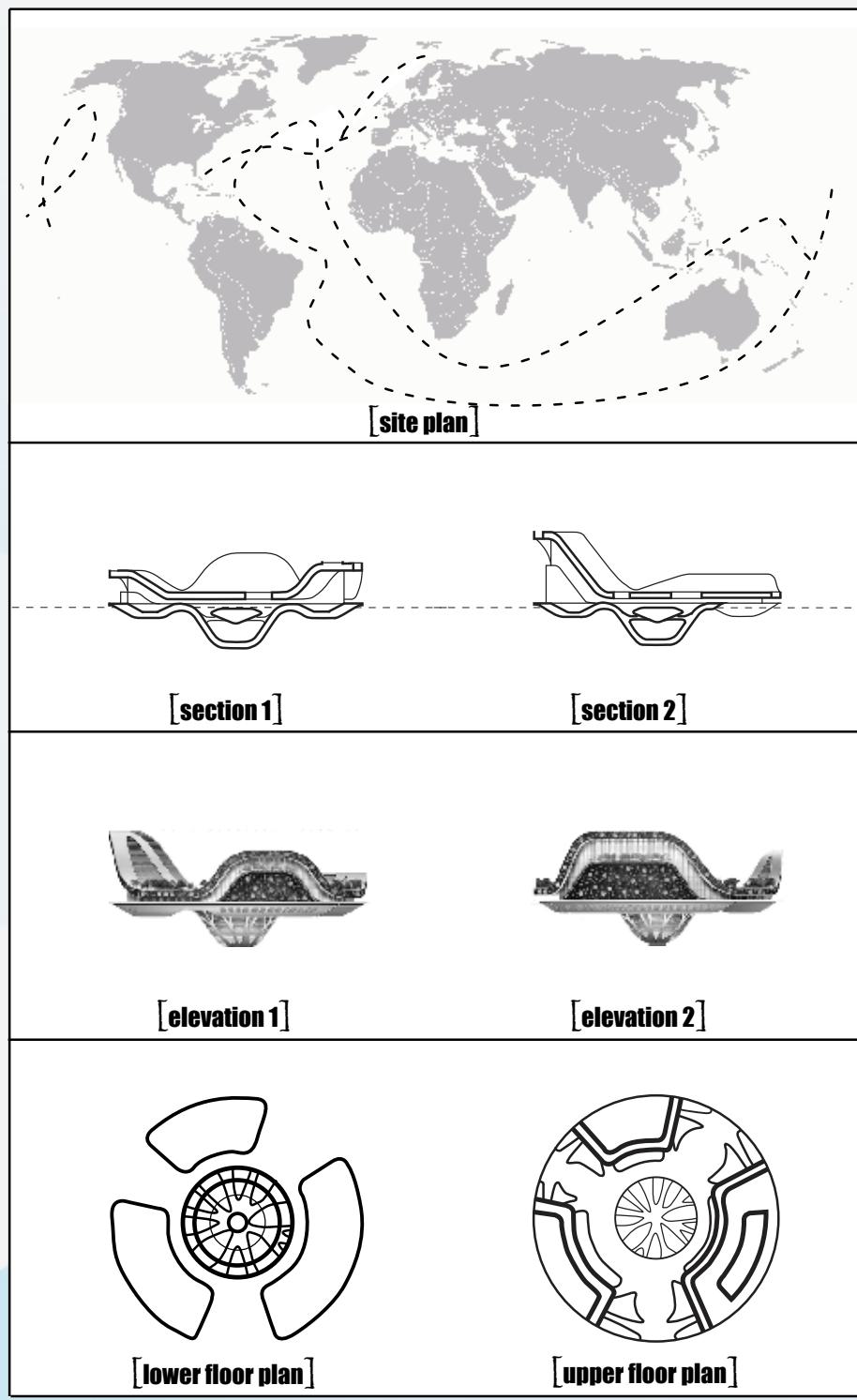


[Freshome Design & Architecture, 2012]

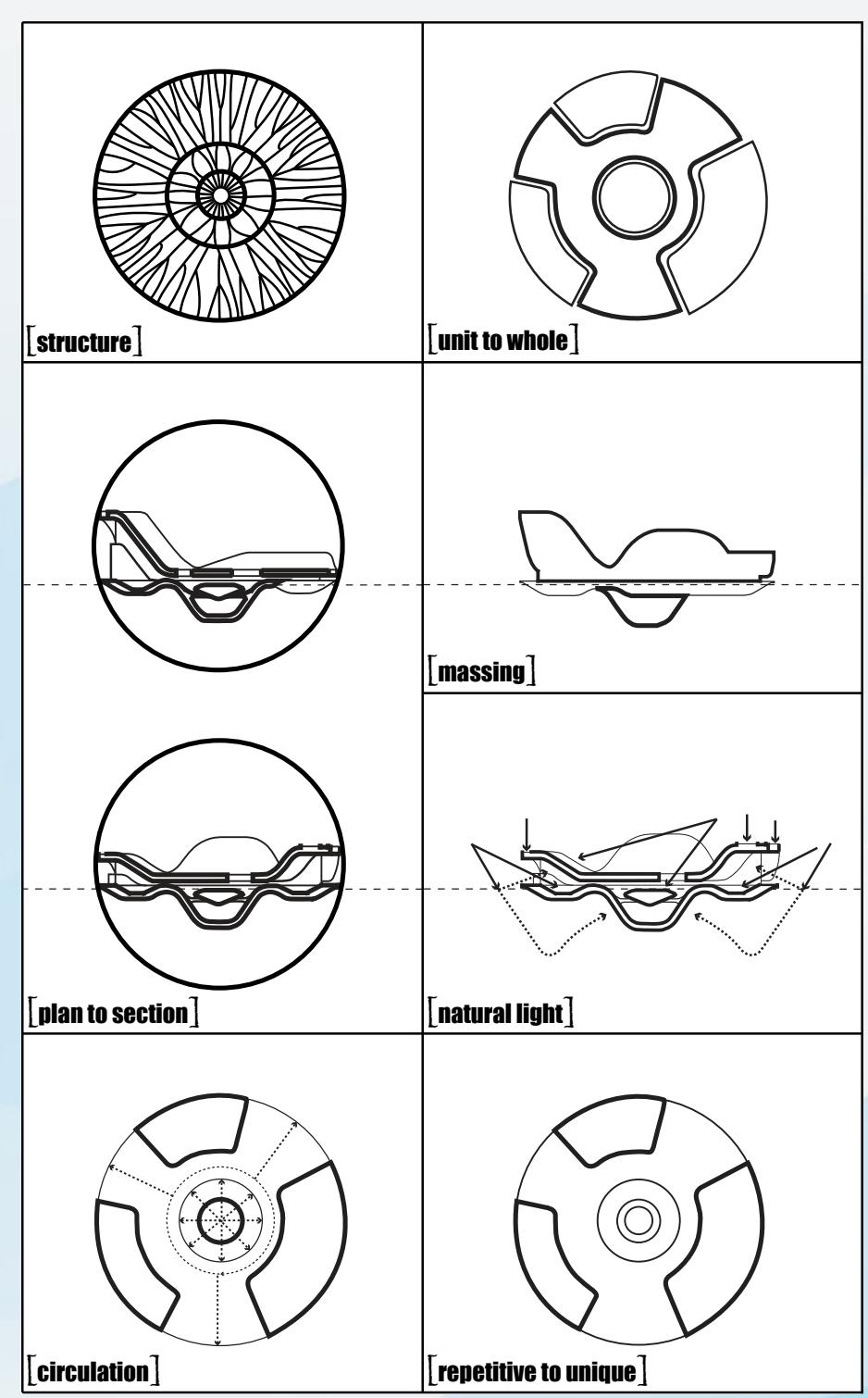
It is clear that when designing this project the environment was crucial aspect of Callebauts design. This project was developed for disasters that many say were caused by human's impact on the environment. It is for that reason Callebaut created a net producer of energy with zero carbon emission, to help balance emission levels. All energy is produced using renewable systems like photovoltaics, tidal power stations, biomass, osmotic energies, hydraulics, wind energy, and phytopurification, (Callebaut, 2008).

Callebaut's design was a great case study for examining a successful, cutting-edge solutions in regards oceanic living. With that being said, this case study was the most programmatically relevant building I have looked at thus far. It is for that very same reason that I believe I now have the necessary knowledge to move forward with this thesis proposal.

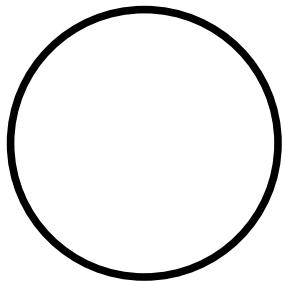
[case study I] **Illy pad: a floating ecopolis**



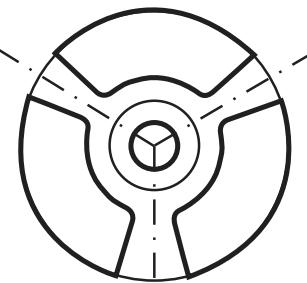
[case study I] lily pad: a floating ecopolis



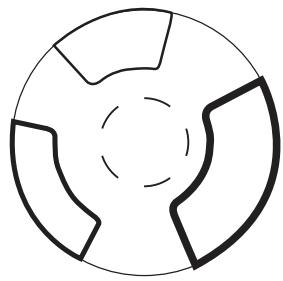
[case study] lily pad: a floating ecopolis



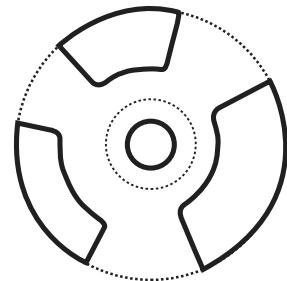
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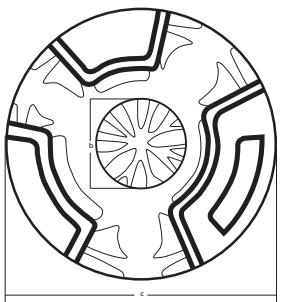
[symmetry and balance]



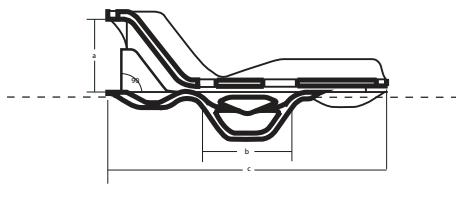
[hierarchy]



[additive and subtractive]



[geometry]



VanDusen botanical garden visitor centre

title: VanDusen Botanical Gardens Visitor Center

architect: Perkins+Will

location: Vancouver, British Columbia

completion: 2011

square footage: 19,000 square feet

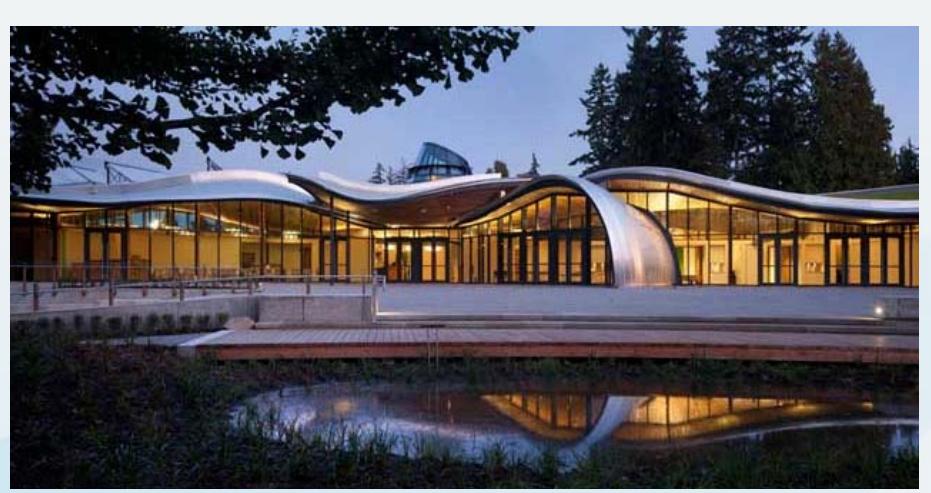
description word: transformation

Inspired by a native orchid, Perkins+Will's VanDusen Botanical Garden Visitor Center in Vancouver, British Columbia is 19,000 square feet, and one of the most sustainable structures ever created. This was no accident. The building was "designed to meet the Living Building Challenge, the most rigorous set of requirements of sustainability." (Vinnitskaya, 2012) This structure formally and functionally meets these goals by its unique and intelligent design decisions. Perhaps the most impact-full of these decisions is the building's green roof system, which emerges from the ground taking with it the very earth and vegetation from which it sits. (Vinnitskaya, 2012)

It is obvious that form did not follow function with this particular design, but it is possible that they were created simultaneously. This building's sprawling form and ability to have co-exist with the environment were made possible by numerous passive and active systems that reuse the site's resources and the building's own waste. On site, renewable sources include but are not limited to: solar photovoltaics, rain water collection, solar chimney, aluminum heat sink, geothermal boreholes and solar hot water tubes. When combined these sources help achieve an annual net zero energy reading. (Vinnitskaya, 2012)

[case study II]

VanDusen botanical garden visitor centre



[Damir, 2012]

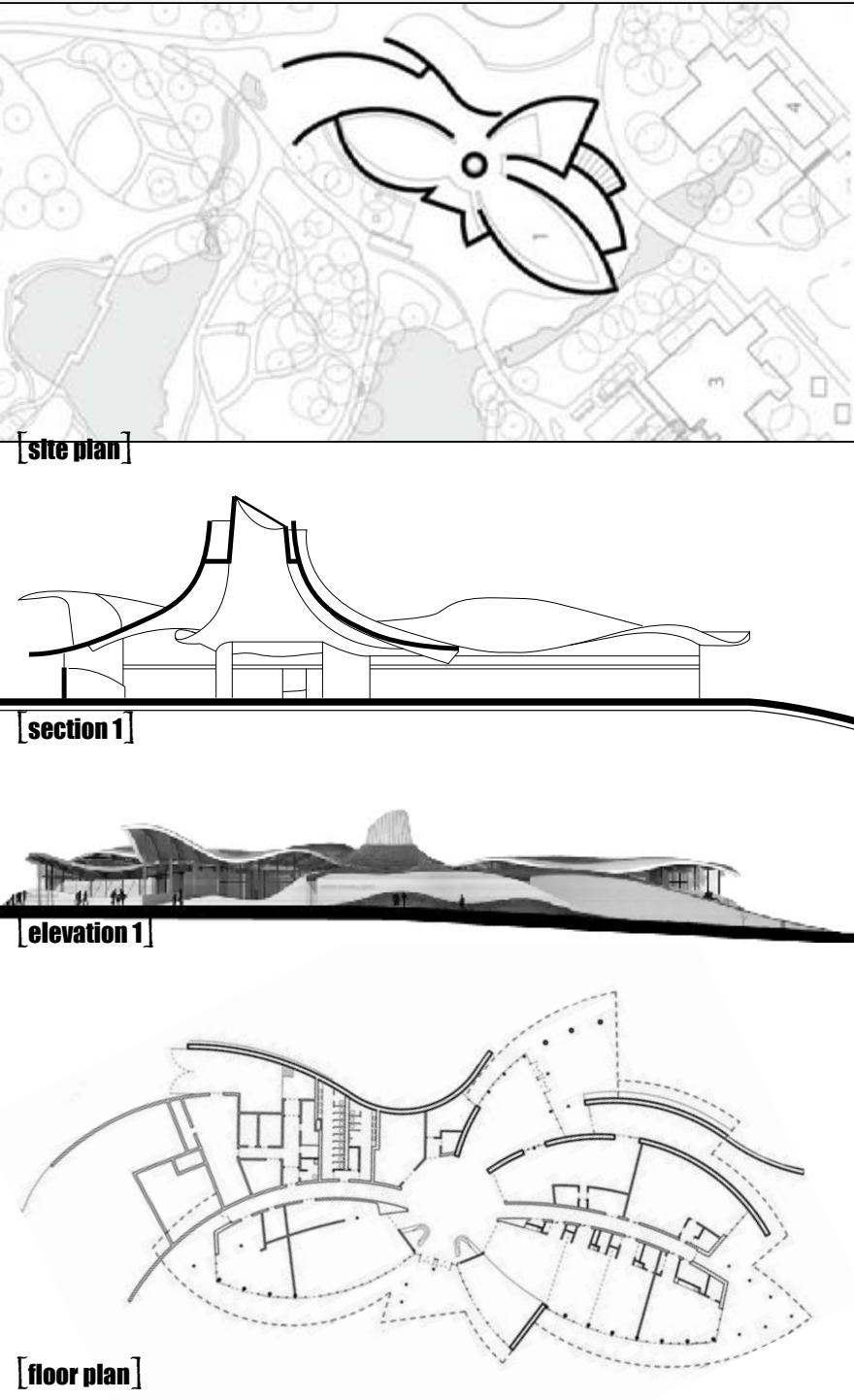


[Konkol, 2011]

Aside from the structures outstanding sustainability resume, it is aesthetically pleasing on both the inside and out. The lack of sharp edges on the buildings facade make it very calming and welcoming for visitors to not only explore the gardens, but the structure as well. Once inside is the building the ornate structure continues as you slide and squeeze through the buildings undulating passageways.

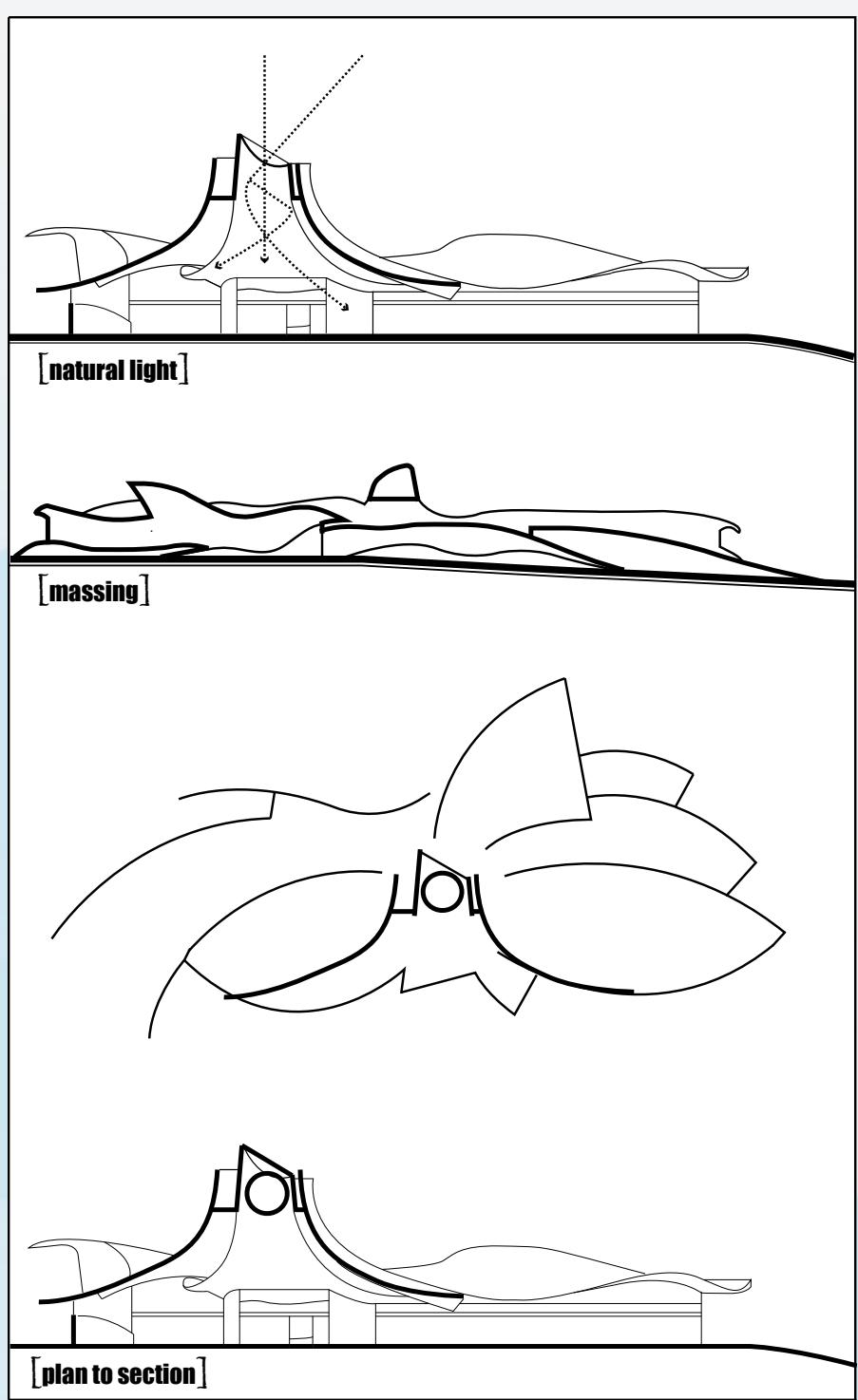
The VanDusen Botanical Garden Visitor Center has shown me the importance of structure's connection to the site, and their ability to co-exist. I see this knowledge playing vital role in many aspects of this project, from site selection and orientation, to materiality selection and system's selection.

[case study II] VanDusen botanical garden visitor centre

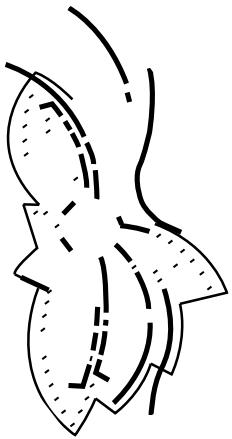


VanDusen botanical garden visitor centre

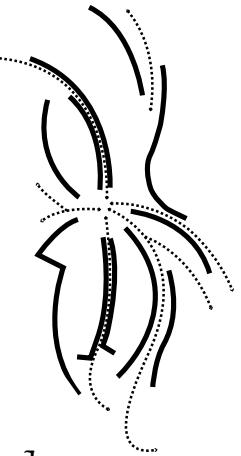
[case study II]



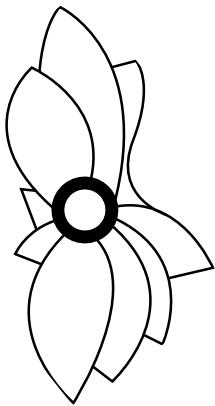
[case study II] **VanDusen botanical garden visitor centre**



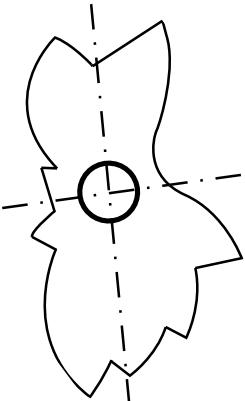
[structure]



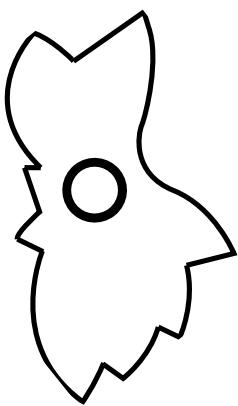
[circulation]



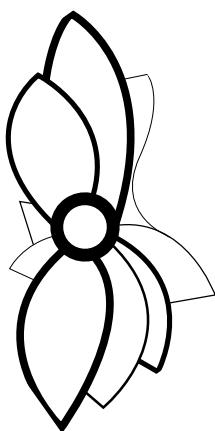
[repetitive to unique]



[symmetry and balance]



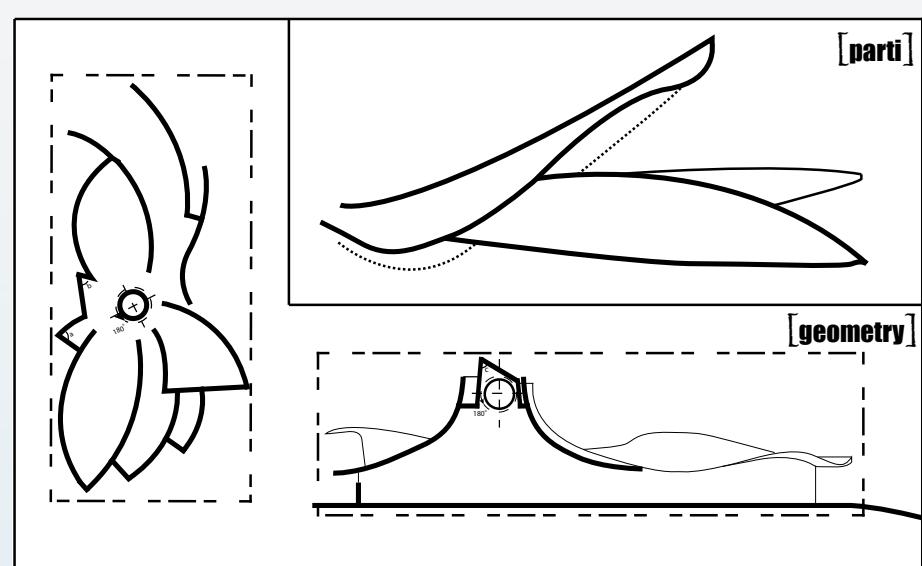
[additive and subtractive]



[hierarchy]

[case study II]

VanDusen botanical garden visitor centre



beaty biodiversity museum/research center

title: Beaty Biodiversity & Aquatic Ecosystem Research Centers

architect: Patkau Architects

location: Vancouver, British Columbia

completion: 2010

square footage: 16,650 square meters

description word: circulation

In 2010 the University of British Columbia added a new precinct to their campus. The new complex is located on the campus's main mall, and is comprised of two facilities; the Beaty Biodiversity Center and Aquatic Ecosystem Research Centers. Together they form an ideology of related environmental sciences. (ArchDaily, 2012) The primary intent of this design was to create a complex that would meet the needs of two different programmatic functions, a museum and research laboratories. Patkau Architects successfully achieved this by linking these different functions, with a common intent to explore and inform.

When looking at this project, I appreciated Patkau Architects ability to take two programmatic functions that are polar opposites (research facility & museum) and unified them through circulation, on both the interior and exterior. As you approach the 16,650 square meter facility it appears to be one mass. But upon arrival, it is clear the structure is two adjacent complexes that are intertwined around a beautiful exterior courtyard that is in return bisected by the campus's main pedestrian path.

The building's museum does a spectacular job showcasing its exhibitions from the inside out, by allowing its installations pieces to be seen through the glass facade and become the "public face for the complex." (ArchDaily, 2012) An example of this can be seen through the enormous Blue Whale skeleton hanging on display in that gallery.

[case study III]

beatty biodiversity museum/research center



[Dow, 2012]

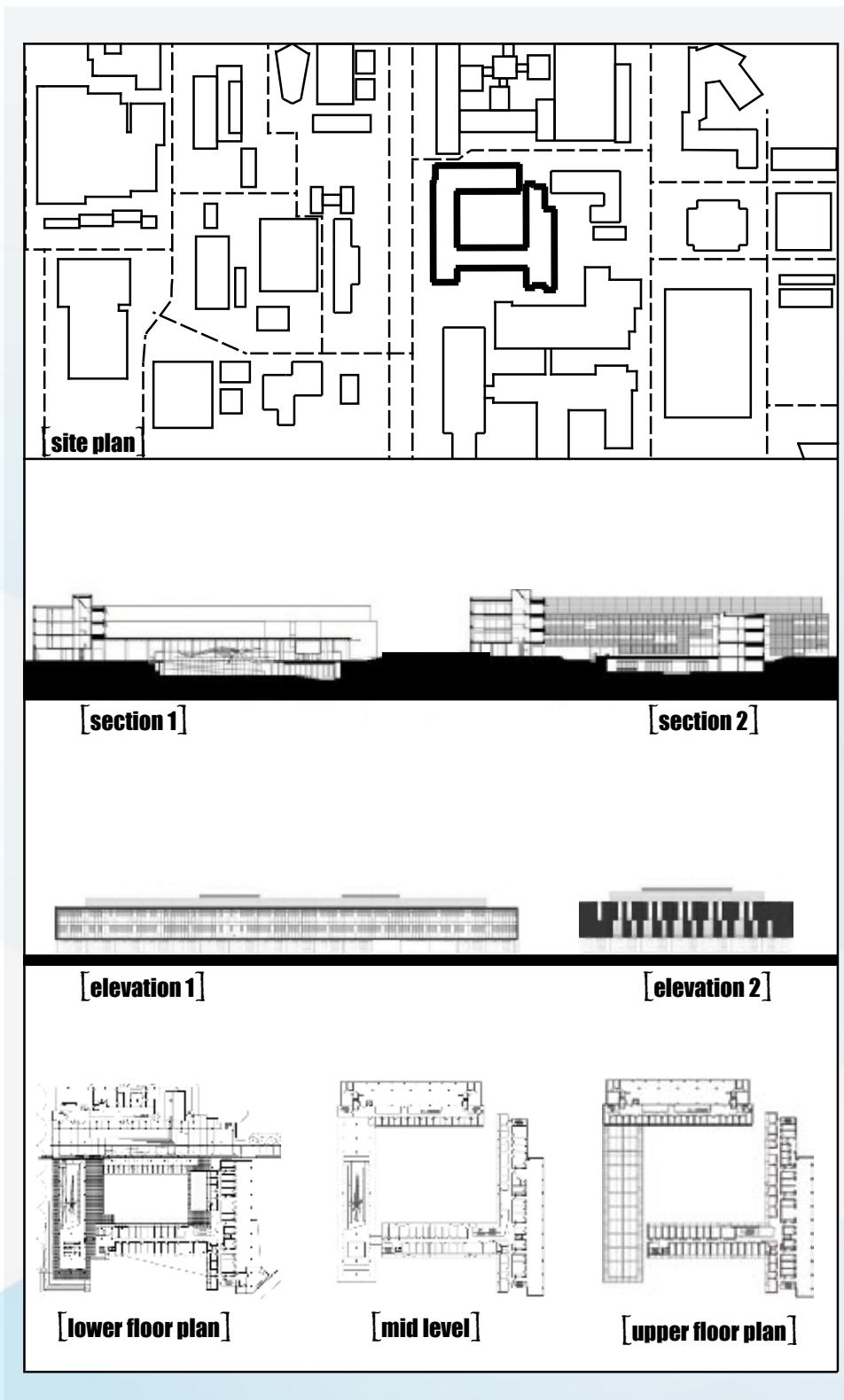


[UBC Public Affairs, 2010]

Located on the north side of the central courtyard is the most used space, a 5,150 square meter Aquatic Ecosystems Research Laboratory. The most unique feature in this space is the atrium, which is key for both circulation and sustainability. The space brings day-light deep into the interior of the building, and due to its positioning on the north side of the building photo sensors control allow for minimum dependency of artificial light. (Arch-Daily, 2012) This is but one component that helped the Aquatic Ecosystems Research Laboratory receive it's LEED Gold status, a certification that is becoming the new cultural norm for in regards to architecture.

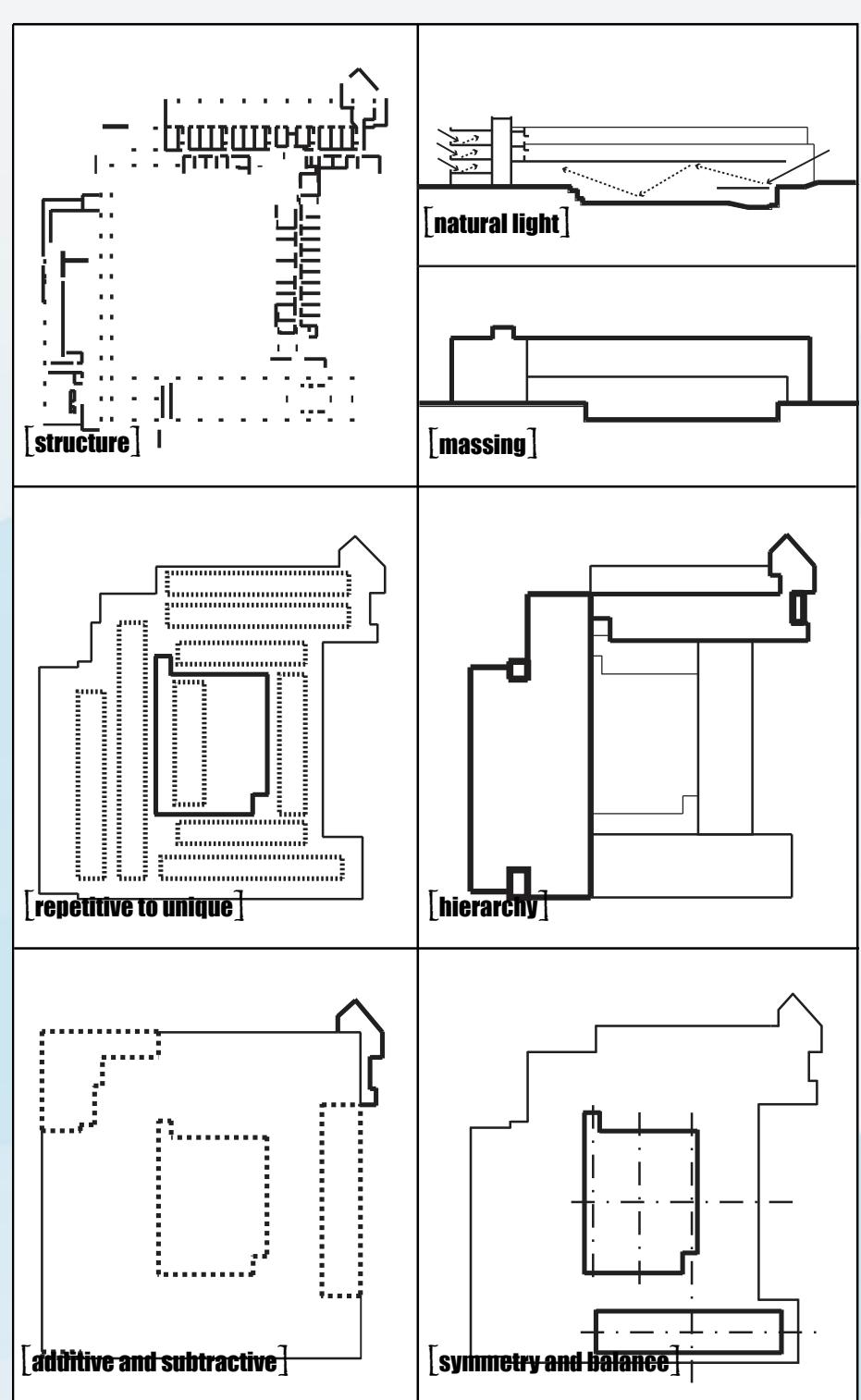
After closely examining Beatty Biodiversity Center and Aquatic Ecosystem Research Centers, I greatly admired how the structure was successfully able to house two different programmatic functions in one facility. I believe this newly gained insight will be valuable in the schematic design stages of this thesis proposal, due to the array of programmatic spaces in the facility.

[case study III] beauty biodiversity museum/research center

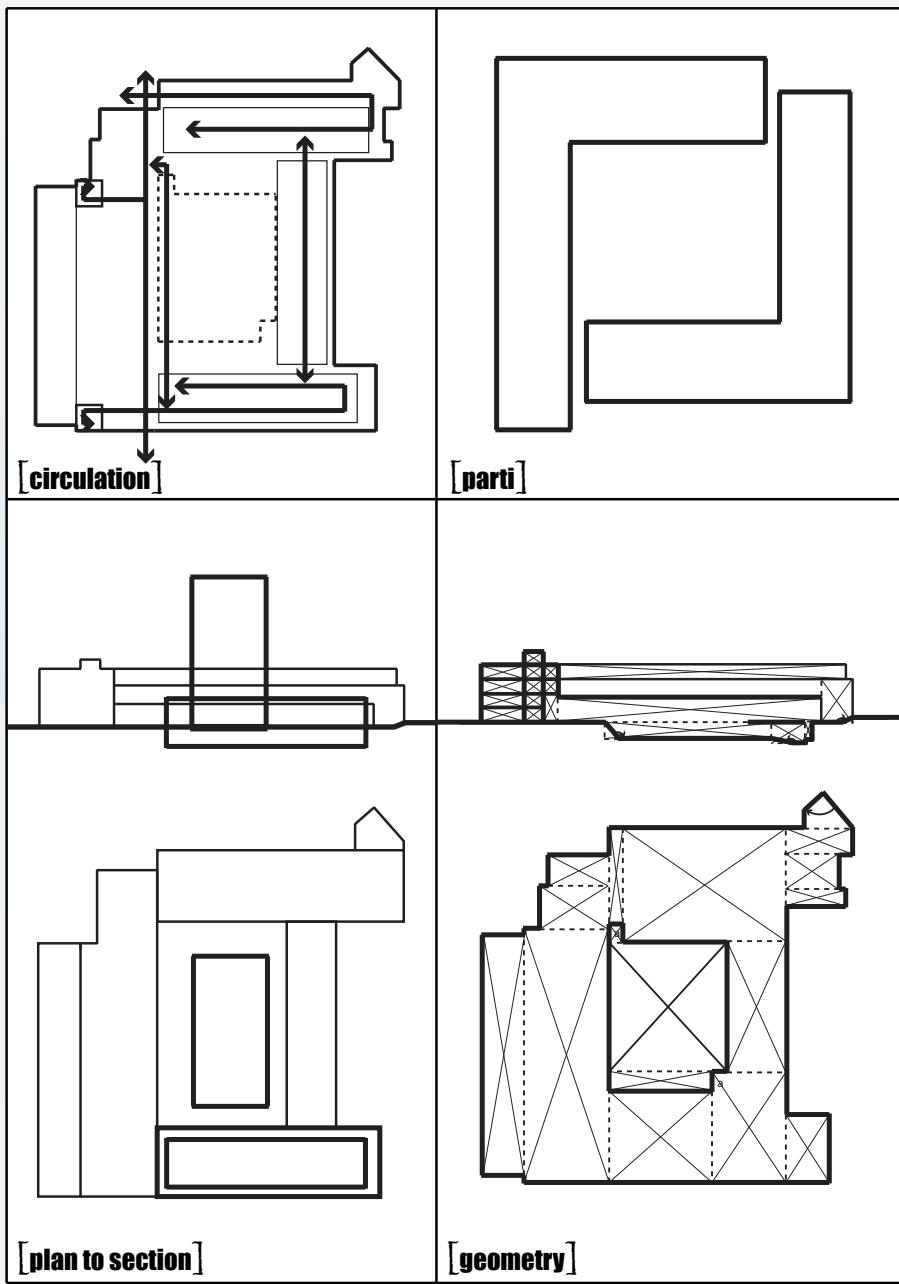


[case study III]

beatty biodiversity museum/research center



[case study III] **beaty biodiversity museum/research center**



case studies summary

When searching for case studies I attempted to find projects that had matching typologies, as well as a clear connection to the nature and more importantly the ocean. This however was more difficult than originally thought. After weeks of searching I was unable to find any truly comparable case studies so I began looking for common aspects which include, research facilities, observation centers, aquariums, space stations, Biosphere2, as well as the “channel tunnel” that runs from London to Paris with direct ties to the ocean. The diversity of such searches ended up being beneficial, and resulted in a broader knowledge of spaces and typologies which this project proposed to create.

One tying element between the projects, was their views regarding a building’s impacts on the environment, or that rather lack there of. With Sustainability having political implications such as government funding, and tax deductions, it is also becoming the cultural norm, with a lot of new construction pursing LEED certifications. Everyday you hear the words “sustainability” and “green,” however what you don’t hear are buildings that giving back to the environment more than they consume. Both the VanDusen Botanical Garden Visitor Center and Lily-Pad: Floating Ecopolis do just that.

People should draw an emotional connection and sense of intrigue throughout every space of a building, starting from the moment they see the building. This is another shared characteristic between all three structures examined. Callebaut accomplished this with the “Lily Pad” by just breaking the norm and creating a structure that sparks the interest of people the world over; a movable city literally on the water. People are intrigued by new things that they haven’t seen before, this building is just that and more. These stimulations are drawn at the Beaty Biodiversity Center and Aquatic Ecosystem Research Centers through a suspended, pre-historic whale skeleton that attracts the imaginations of the passing people, inviting them in to explore. At the VanDusen Botanical Garden Visitor Center a visual expression of a building transforming into the earth causes similar emotions.

case studies Summary

These case studies have taught me that a building should not be restricted by its site. Each of the three case studies were successfully able to transform to coexist with their landscape. The “Lily Pad” is able to transport itself across the Earth’s oceans, depending on things such as natural disasters and weather. The Beaty Biodiversity Center and Aquatic Ecosystem Research Centers was able to be built around its campus primary circulation path without disruption. At the VanDusen Botanical Garden Visitor Center they were successfully able to replace the land the structure occupies by means of a green roof. This lesson will be useful when aligning the proposed thesis structure on its site.

These case studies have provided valuable insights for creating a successful aquatic research facility. Site selection, connection to the natural environment, spacial organization and overall experience are all important aspects for the creation of a sub-aquatic research facility.

historical context

historical context

[history of hawaii/maui]

Nicknamed The Valley Isle because of its two adjacent volcanic mountains peaks, the island of Maui is rich with history, and is second largest of the eight islands that make up the Hawaiian Islands. The islands are a result of both tectonic and volcanic activity. This activity is still taking place today and as a result, causing the Hawaiian Islands to continue to grow as well the emergence of new islands. The islands genetic make up are that of petrified magma, better known as igneous rock.

The island of Maui is positioned as the second, easternmost island of the Hawaiian Islands. Native Hawaiian traditions state that the name Maui was given to the island by the Polynesian navigator Hawai'i'loa, the man credited for the discovery the Hawaiian Islands, (Hawaii History, 2012). According to legend Maui was the mans son, whom he had named after the demigod 'Ihikapalaumaewa, when translated means Maui. Maui has been the home to civilization for over 1,700 years.

Polynesians from Marquesas were the first to settle on the island between 300-500 AD., followed several hundred years by other South Pacific islanders from Bora Bora and Tahiti around the 11th century, (Waimea, 2009). It took near 1,000 years for this tropic oasis to be discovered by Europeans. On November 26, 1778 the Hawaiian Islands would change forever because of the British explorer James Cook. Cook published tales of his exploration adventurers to these undiscovered islands, and soon everyone wanted to see this paradise for themselves.

historical context

[history of hawaii/maui]

The Hawaiian islands became host to settlers, missionaries, whalers and traders from all over the world after Cook's publications, and soon began to exploit the areas resources. Like native Hawaiians before them, the new settlers found the abundance of oceanic resources, and untouched, fertile soils to be unprecedented, and worth fighting for.

Europeans began exploiting and destroying Hawaiian resources which in return upset Native Hawaiian, who wanted to live harmoniously with nature and protect their land. Needless to say turmoil broke out and ensued for many years, causing the formation of the Kingdom of Hawaii. The Kingdom of Hawaii was the governing monarch from 1795 until its overthrowing in 1893, at which time troops from the United States were sent in to oversee control. (Malama Honoluia, 2008.) In 1898 Hawaii officially became a territory of the Untied States of America. On August 21, 1959 congress voted Hawaii in as the 50th state of the union.

As a way to make amends for the two centuries of turmoil between pineapple farmers and Native Hawaiians, 1979 Maui Land & Pineapple Co. (ML&P) donated 11,600 acres of conservation land through its malama 'aina (caring for the land) program (Malama Honoluia, 2008). The reserve stretches from my site at Honoluia Bay, all the way up Pu'u Kukui (Hawaiian for "Hill of Light") and encompasses all of Mauna Kahalawai, Maui's western mountains.

historical context

[History of boats]

By learning the history of aquatic exploration, we can begin to understand application uses in the 21st century. These explorations are attributed to the creation of boats and submarines. Without these, the world as we know it would cease to exist. Columbus would never have found the Americas. There would be no water spanning bridges, and the Channel Tunnel connecting Paris to England would never have been built, in fact there would be no England.

Aquatic structures such as boats have been around for thousands of years. Circumstantial evidence shows that boats were used in Australia's early settlements over 40,000 years ago, suggesting that boats have been around since ancient times (Thomas & Sydenham, 2012). Scientists predict the first boat ever created was a log-boat, where logs have been tied together. Recent excavations findings have suggested that these boats were first used between 7,000-10,000 years old. However the world's oldest, intact boat is a mesolithic canoe from the Pesse, suggested to be 10,000 years old and made from a hollowed *pinus sylvestris* tree trunk (Thomas & Sydenham, 2012).

Boats have gone through significant development since then. By the year 2500 B.C., Egyptians created large wooden boats that were able to sail across the sea (Thomas & Sydenham, 2012). In 1000 A.D. Vikings were able to sail with ships of 60 oarsmen up rivers and across open ocean. 100 years later in 1100 A.D. the Chinese had figured out a rudder systems that allowed for added speed and maneuvering. In the year 1450, three and four masted sailing ships were created. These ships were used as battle ships, trading and exploring, and are possibly the most iconic boats ever created.

historical context

By 1819 The Industrial Revolution had completely changed the construction of boats. Man no longer had to rely on the wind and sea currents, boats were now able to be powered by steam. Innovation took over and in 1845; propellers were implanted which allowed for boats to be operated by machine. (Thomas & Sydenham, 2012). In 1980 these two were combined to form the steam powered paddleboat. Twenty years later in 1910 the use of steam became less popular, as ships converted coal to bio-diesel. Perhaps the most unique advancement came in 1955 with the invention of the hovercraft, which is a hover craft that allowed you to hover across water on pillow of air (Thomas & Sydenham, 2012). Soon after, in 1959 nuclear power was used to power boats, making refueling no longer an issue. The 1980's produced boats like hydrofoils, which were used as ferries allowing people to "ski" across waters with relative ease and quickness. The 1980's introduced us to shipping containers. A ship that allows for unprecedented amounts of trading goods to be shipped from various geographical locations. The most recent boat development came in the 1990's with the introduction of the cruise liner. This boat's sole purpose is to carry hundreds of people on a floating holiday and cater to clientele's every need.

historical context

[History of submarines]

The earliest depiction of a submarine came in 1580 by a named William Bourne, a scientist and innkeeper from England, (Capt. Harris, 2011). Bourne was the first to offer intelligible insight as to how boats float. Bourne stated, “It is possible to make a Ship or Boate that may goe under the water unto the bottome, and so to come up again at your pleasure. [If] Any magnitude of body that is in the water . . . having alwaies but one weight, may be made bigger or lesser, then it Shall swimme when you would, and sinke when you list . . .” (Capt. Harris, 2011). In layman’s terms, if you decrease a boat’s volume by making it heavier, the boat will sink because the weight of the water is displaced. However, by increasing the volume and making the boat lighter, the boat will be more buoyant and in turn will rise. Although Bourne did not create or illustrate this design, he did in fact describe the principle upon which a submarine functions.

The first built submarine came in 1623 by Dutchman, Cornelius Drebbel, an inventor for James I of England, (Capt. Harris, 2011). This design was extremely complex and was influenced by the writings of William Bourne. The design was similar to that of an enclosed rowboat, and with twelve oarsmen powering it, it made its first submerged trip down the Thames river, roughly 15 feet under the water’s surface. Much like today’s modern submarines, this submarine was forced under the water’s surface by forward movement, rowers stopped rowing, the boat would begin to rise. The development of submarines continued, however it was not until eleven years later in 1634 before a breakthrough in submarines arose. A French priest name Marin Mersenne suggested submarines should be cylindrical and made of copper so as to better withstand pressures associated with deeper dives. (Water pressure increase 1/2 lb PSI for every foot of depth.)

historical context

[History of submarines]

By 1654; a Frenchman by the name of DeSon has created the first naval submarine to be used in war, (Capt. Harris, 2011). However the first Naval ship to attack a vessel was created over a hundred years later, in 1776 by David Bushnell. Dubbed the "Turtle," Bushnells submarine was able to advance into enemy lines without being detected, and sink enemy ships by drilling holes in the boat's hull. Perhaps the biggest break through in submarines came in 1864 when Narcus i Estarriol built "The Lctineo," the first combustible engine for a submarine. Narcus i Estarriol did this by taking the very pressure applied to the ship and transferring it to an engine. This energy converter only lasted a short time due to the creation of the steam engine, and because of rapid technological advancements at that time by 1910 diesel engine had taken over. By the WWII submarines were able to house over a hundred men, and able to be submerged for months at a time, strategically helping naval forces. Submarine technology increased drastically after WWII. In 1952 a United States submarine named "Thang" could reach depths of 713 feet, (Capt. Harris, 2011). Though it was Russia who changed submarine history with the invention of "Nautilus," a 323 foot nuclear submarine that could reach speeds of 23 knots (26.5 mph). From this point on nuclear submarines became the standard, allowing for ships like the "Thresher" to submerge to depths of 5,000 feet in 1963, (Capt. Harris, 2011). Since 1963, there has been much advancement in submarine technology especially in forms of single man submarines, most of which have been used to explore undocumented catacombs lining the sea floor. Perhaps the most historical event in the history of submarines can this year on March, 26 2012 when the billionaire, movie producer, James Cameron took his single manned submarine to the deepest, darkest part of the world; the 35,765 foot deep, Mariana Trench, (Potter, 2012).

summary of historical context

The site for this thesis project is located on the north western side of Maui in Honolua Bay a Marine Life Conservation District. This marine life district is protected from has an abundance of wildlife and very picturesque views and vistas, no matter what direction you look. At a macro scale, there are views into the Pacific ocean that allow you see the Hawaiian Island's of Moloka'i to the northwest and Lana'i to the southwest. At a micro scale views to the east/northeast allow witness to lush, tropical rainforest that slowly transform into Mt. Puu Kukui (Hawaiian for "Hill of Light"), one of two volcanos on Maui. If not for the south/southeast views of Honolua Marine Life Conservation District Center, one would truly feel cut off from civilization. However, even with the sites obvious beauty, there are still glimpses of disturbing damages caused by man. The forest and vegetation on the eastern part of the site have been trampled by visitor looking to access the bay, while in the bay itself coral bleaching has began to shrink and dull, these once vibrantly colored reefs.

Shear, rock face cliffs on the north and south side of the site help keep waters calm by blocking trade winds, while also limiting the accessibility of the site, allowing access only from the east and west. To the east one can follow the winding highway 30, five miles from Kapalua until they reach Honolua Marine Life Conservation District Center's main entrance. At that point one must walk a tenth of a mile through tropical rainforest, before reaching this gorgeous bay. Speaking from my personal experience, I can say this form of entry is perhaps the most powerful entry point, it truly gives you the feeling as though your in a "Robinson Cruso" novel. However, because of the roughly 1,500 snorkelers a day that visit this site the most used form of entry is from the west, by way of boat. (Tropical Snorkeling, 2012)

summary of historical context

Depending on the season, one can take full advantage of the bay's north point, which is known by the world to be one of the best swells to surf in winter months. Whether you surf or not, these waves are truly a sight to see. Luckily even in the winter months these waves do not reach the inner most portion of the bay, allowing for great snorkeling.

By entering the bay's water from the east, one can truly appreciate the beauty of the ocean as the white sand from the beach starts to transform into spectacular coral reef all around you. In continuing to the middle of the bay one comes upon an opening of flat, white sand. In this void one is fully able to peer out in every direction, and see the abundance of diverse species around them. Some of these species include sea turtles, dolphins, eels, sharks, chubs, butterfly fish, box fish, flag tails, trigger fish and even the state fish of Hawaii, the Humuhumunukunukuapuaa. (Tropical Snorkeling, 2012) This is truly a remarkable site to behold.

project goals

goals of this thesis

[Academic]

It is my belief that one should know their surroundings. When hypothesizing a thesis proposal I began to ask myself, if much of the world is covered by water, why do we know so little about it? And why do we not live there? At the time I drew the conclusion that, although we live so close, our feet are barely begun to get wet in regards to either question. The west may not have been the last frontier, but instead aquatic exploration may be.

Academically, I hope to explore such questions through successfully completion of a comprehensive, sub-aquatic thesis design, and become a creditable resource for aquatic infrastructure, thus providing valuable knowledge to others that follow. Sub-goals for accomplishing this would be to create a well-developed schedule, a thoroughly designed project. And lastly, demonstrate superior graphical and verbal presentations.

[Professional]

I once heard the phrase, “a man is judged by the company he keeps.” If this is true I believe that a company is also “judge” by the men they hire. With that being said, I would love to be a valuable asset to a “well judged company.”

Professionally, I hope this project will show the design community that not only do I have the design and presentation skills to be successful in this industry. I also bring unique insights and knowledge to this growing exploration into aquatic infrastructure. This is not to say I wish to design aquatic infrastructures, but rather that I have the ability to design spaces that most have not even fathomed, thus making me an asset.

goals of this thesis

[Personal]

CoCo Chanel once said, “In order to be irreplaceable one must truly be different.” As a designer I believe it is the personal goal of every designer to create unique projects that are “different” from our peers, and thus making us “irreplaceable” in the design community.

Personally, I hope this thesis project will give me recognition as a cutting edge and impact-full designer. This could come through awards such as the McKenzie award or through publications such as ArchDaily.com. Though the ultimate goal for this thesis project is to intrigue people, to sparking their imaginations, through realistic opportunities such as aquatic design.

site analysis



[north]



[south]



[east]



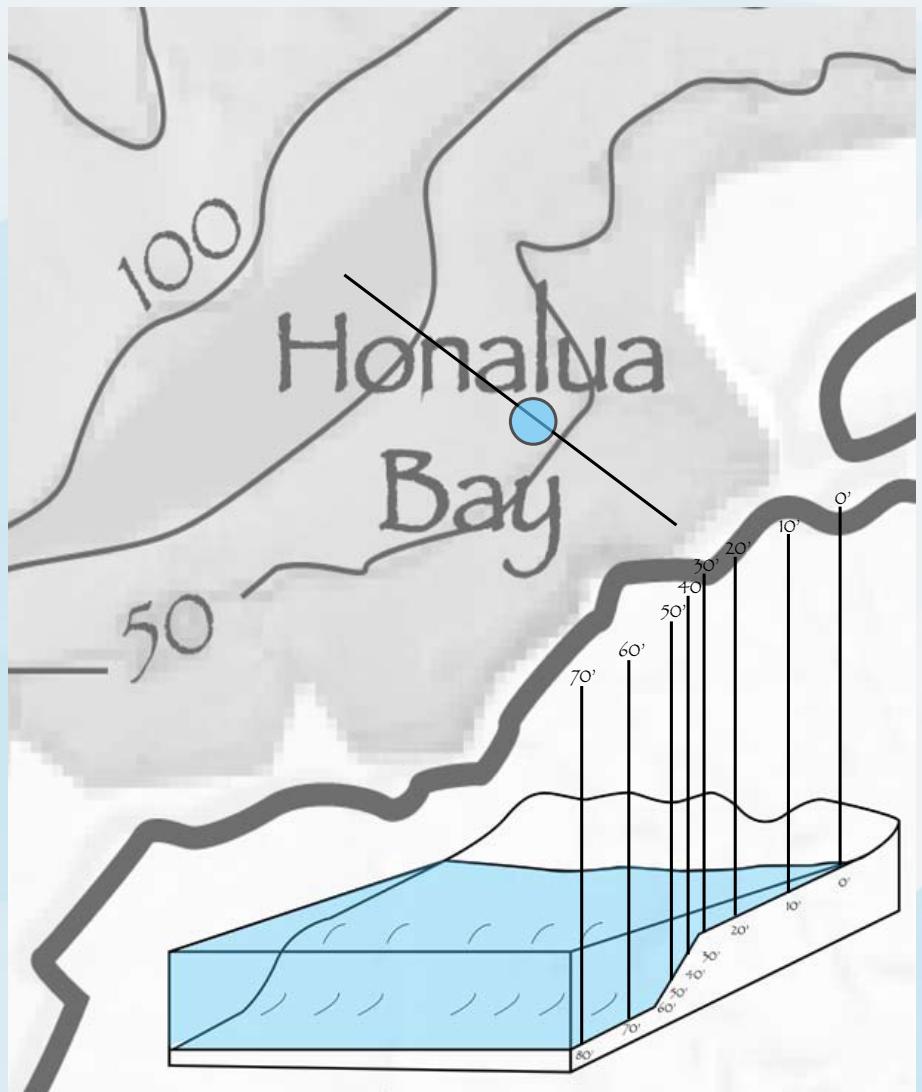
[west]

site analysis [views]

site analysis

[Site Section]

This diagram represents a east to west, section cut through the earth and into the ocean, showing elevation changes and sea depths.



Site analysis

[Grids]

The site has a dense forest that flows into the ocean, rather than having a distinct grid system nature makes its own ordering system. However, a case could be made that the park reservation's boundaries act like a grid system.

[Textures]

Since the site is located near the equator, textures in and around the site do not go through drastic seasonal changes. Sub-aquatic textures of sessile (coral reef) however change quite drastically from soft and smooth, to sharp and ridged, depending on species. East of the site, above sea level are textures of dense, tropical rainforest foliage to the north and south; also above sea level are textures lush prairie grasses to the west; you will find only the textures of sea waves.

[Geometries]

This site has no geometric relations, unless you count the organic forms come from natures landforms such as the coral reefs and tropical rainforests.

[Shade and Shadow]

The shade and shadows will constantly change depending on the time of day and year, however the reflection and refraction of the ocean will help to balance the sites natural daylight.



Site analysis

[Built features]

One would think being on relatively small, highly populated island it would be virtually impossible to feel secluded, that is not the case with this location. The fact that the site is located in a park reserve, roughly five miles from town which means that the only built feature in the site's vicinity is the park reserve's visitor center. The visitor center is located to the southeast of the bay atop the bluff and is the only glimpse of man you will see, even the roads leading to the trail head are hidden by the dense rainforest.

[Lighting Quality]

Being located near the earth's equator, lighting quality does not differ very much in regards to seasonal changes. However the lighting quality and clarity in the bay its self differs depending on the amount of sediment in the water, which changes due to heavy rainfall and ocean currents.

[Vegetation]

Because this site is submerged into the ocean, coral although it is a sessile animal would resemble vegetation. The nearest actual vegetation to the site is located on the bank of the bay and is a dense rainforest.

[Water]

Obviously the site has a direct connection to water, and is located on Maui's Honolua Bay. Depending on your location, the bay itself varies in depths ranging from 15 to 70 feet deep, and its tremendous clarity allows you to see every inch from the waters surface.

site analysis

[Wind]

There is a tremendous amount of trade-winds that flow throughout the Hawaiian Islands. However, this site is fortunate to have much of the winds blocked by the mountains and bluffs that surround it on three of its four sides.

[Human characteristics]

Even though the island of Maui is one of the most visited islands in the world, the site itself has been minimal effected by human activity. Much of this can be attributed site's dense rainforest and coral reef, which together form Honolua Bay Park Reserve. The park reserve's offices and observatory, located on the bay's bluff is truly the only apparent effect of human activity near the site. To find all other human interaction, one would have to travel five miles to the resort town of Kapalua.

[Distress]

A great deal of distress is occurring at coral reefs around the world and the island of Maui is no exception. Many years of rising temperatures have began to cause coral bleaching, and as a result the worlds largest living organisms are starting to die, including the ones at this site.

[Soils]

The Hawaiian Islands were formed through volcanic activity, as a result the island's composition is made mostly of igneous rocks. This is also the case at the location site. However because the site is located in the ocean, there are layers of clean sand, shells and dead sessile (coral), that line the sea floor.

site analysis

[Water Table]

Positioned in the ocean, the site and building itself would be directly exposed to the “water table.”

[Traffic]

Located one of the most secluded parts of Maui, there is but one road to the park reserve (Highway 30), thus automobile and pedestrian traffic are not a major issue with this site. Boat traffic on the other hand is very present on this site, due in large part to the pristine coral reefs, that draw divers from around the world.

[Topography]

The site has a topography that gradually slopes from east (shoreline) to west (ocean) at a 2-10% slope. The slope on the north and south axis converge in the middle, with a slightly greater slope at a 8 – 15% grade, due to its proximity to the cliffs. These converging slopes allows for water run off to flow with ease into the ocean.

[Plant Cover]

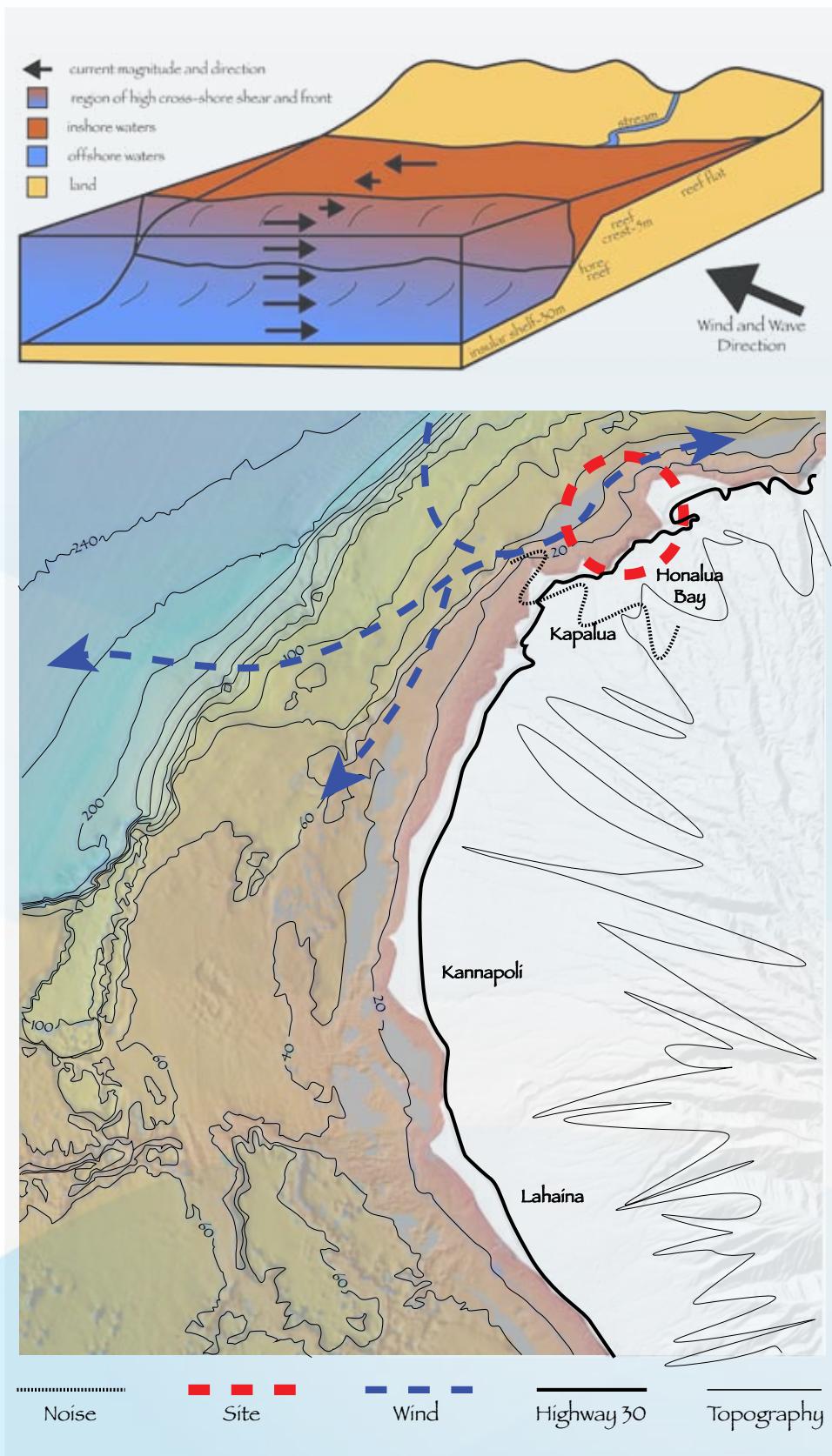
The site's aquatic boundaries are covered with “sessile;” better known as coral, however the sites surrounding dry land is covered with a dense, tropical rainforest, and foliage.

[Site Section]

This diagram represents a east to west, section cut through the earth and into the ocean, showing elevation changes and sea depths.



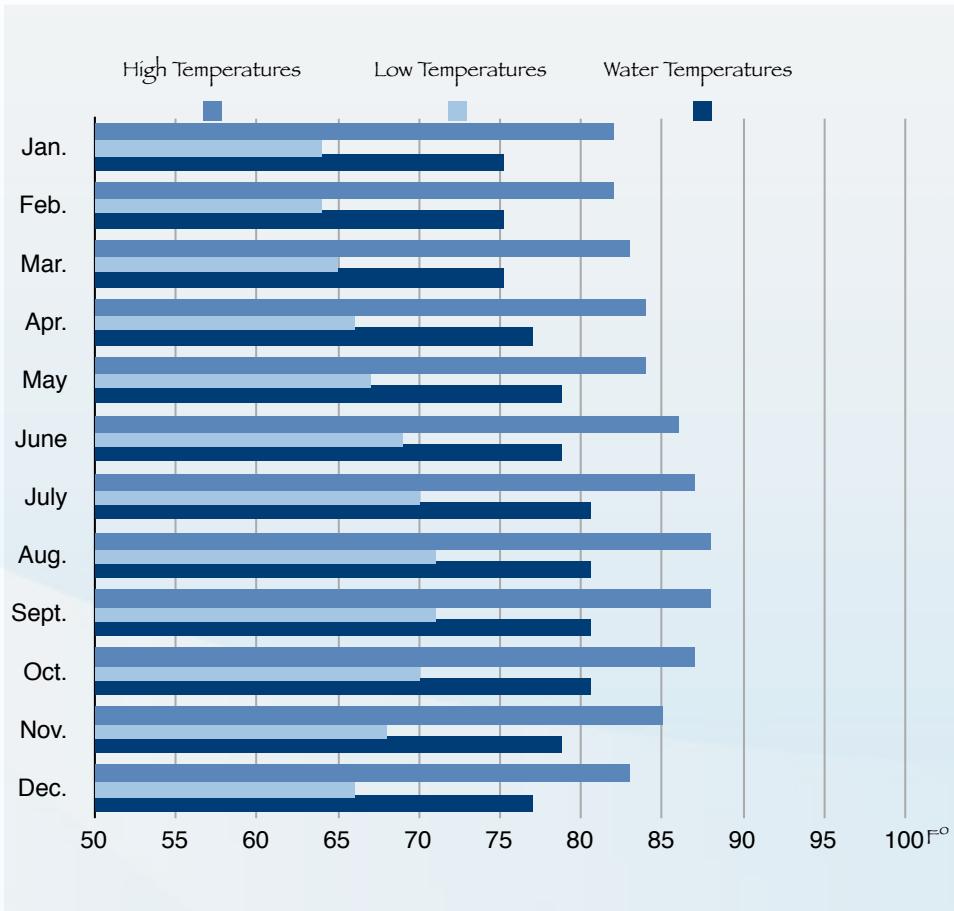
noise, topography and air movement diagram



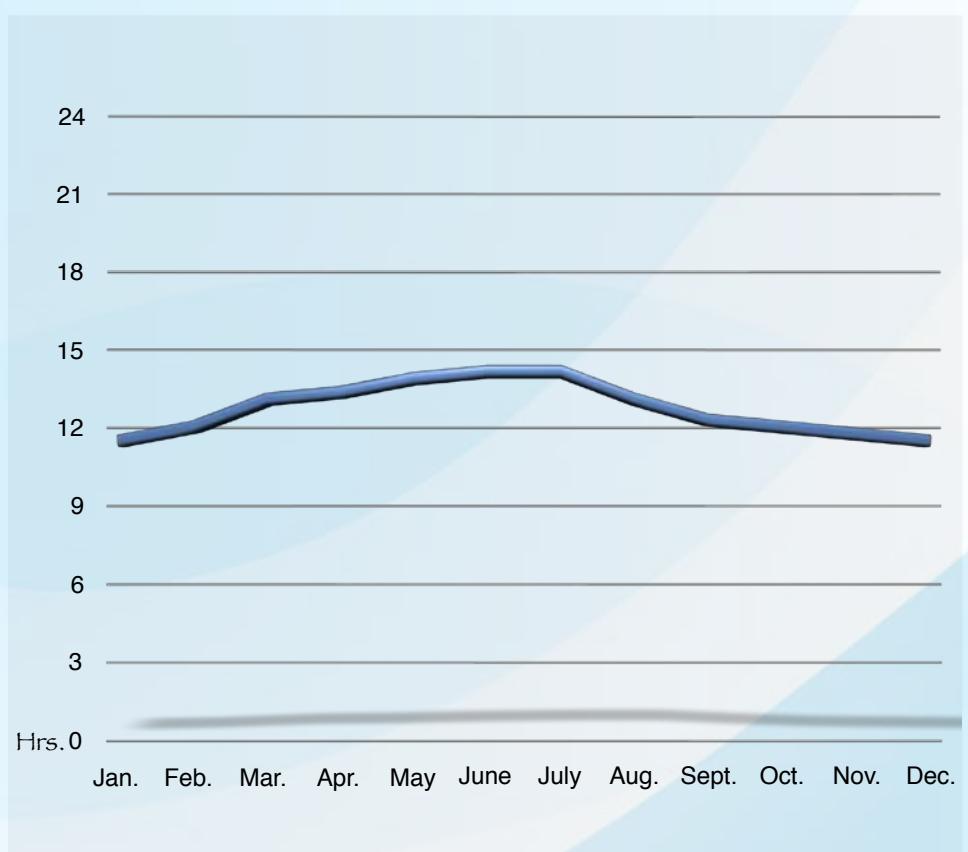
average swell heights



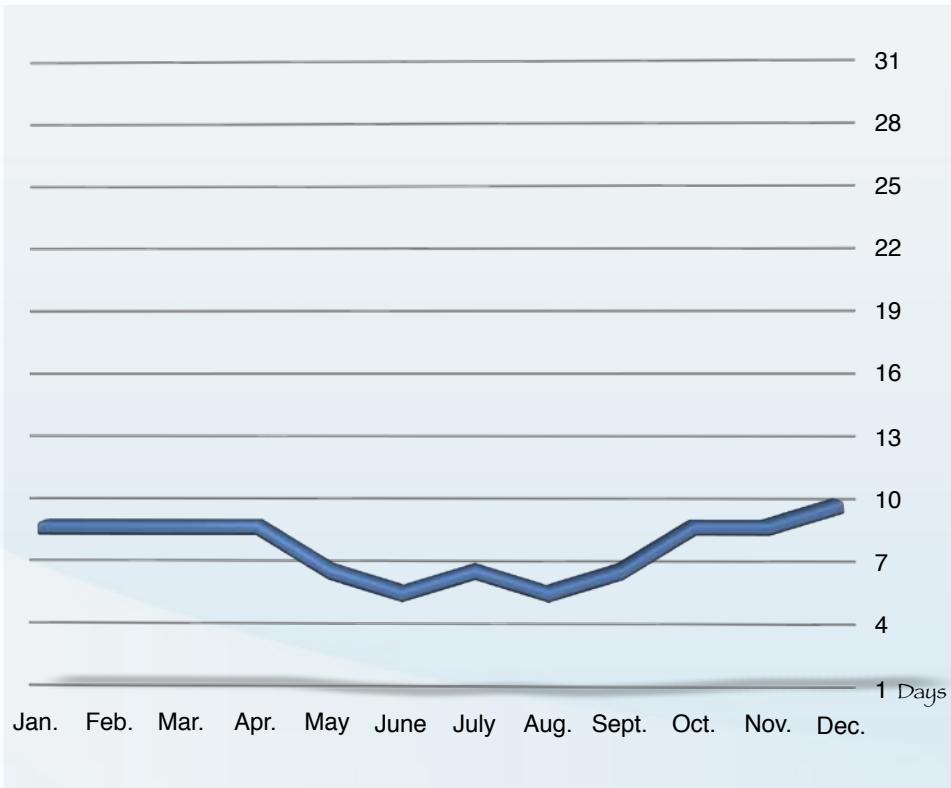
average temperatures



hours of Sunshine per day



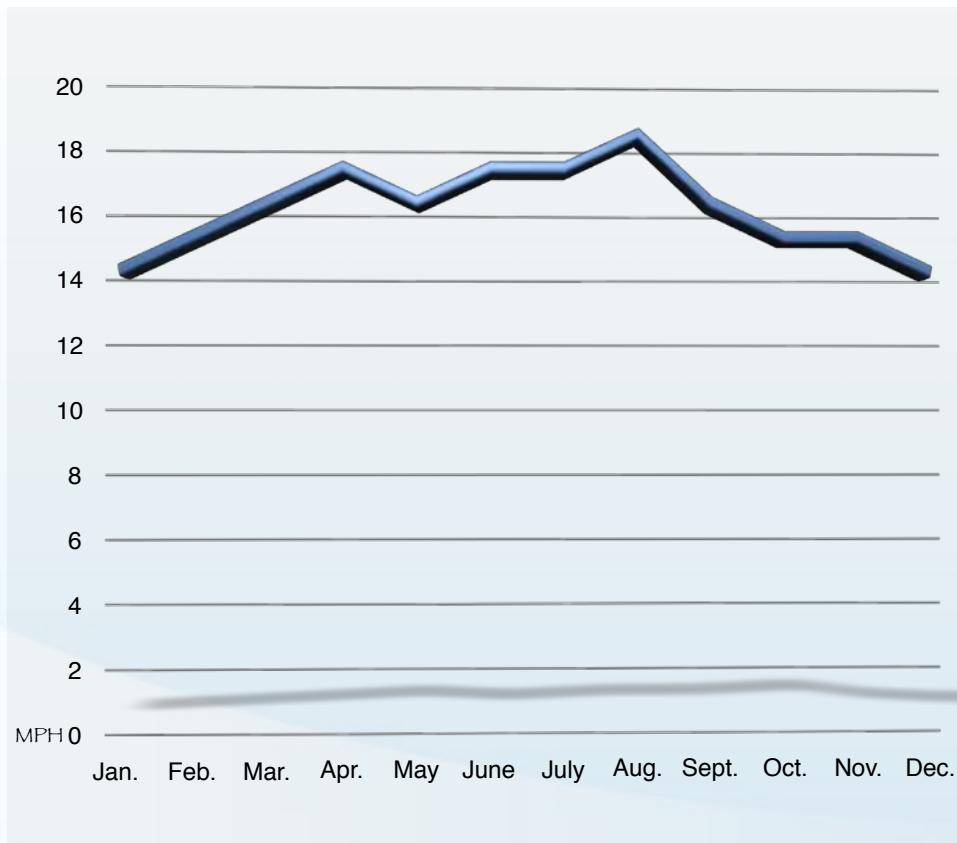
average rainy days per month



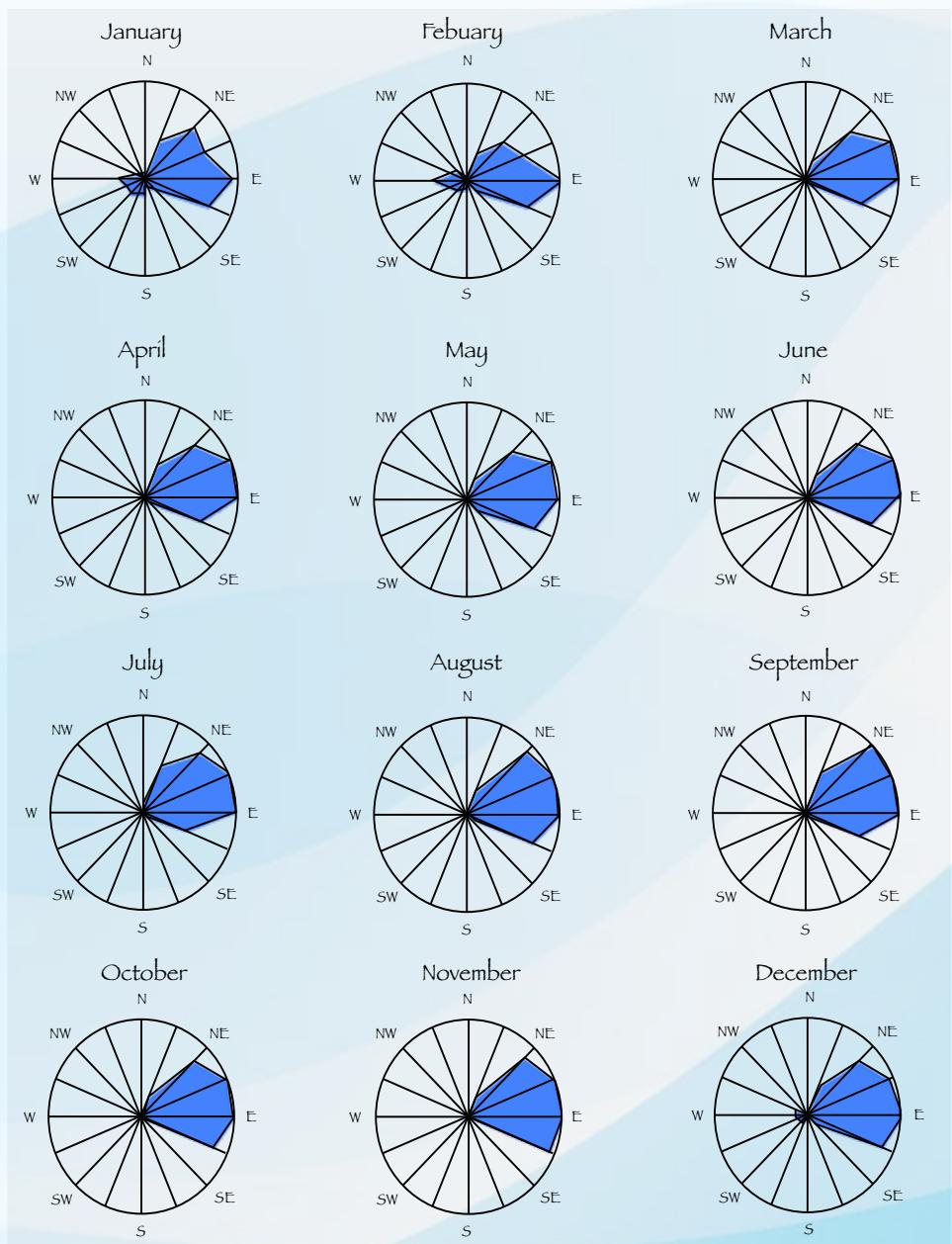
average relative humidity



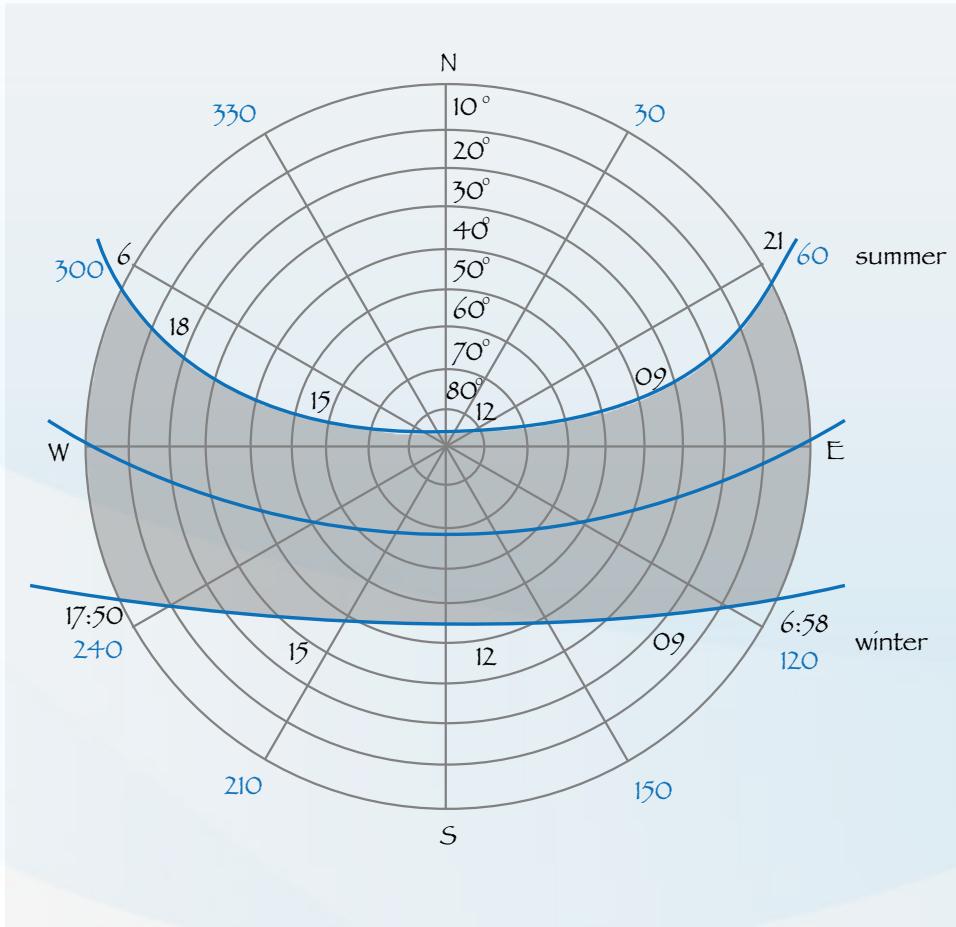
average wind speed



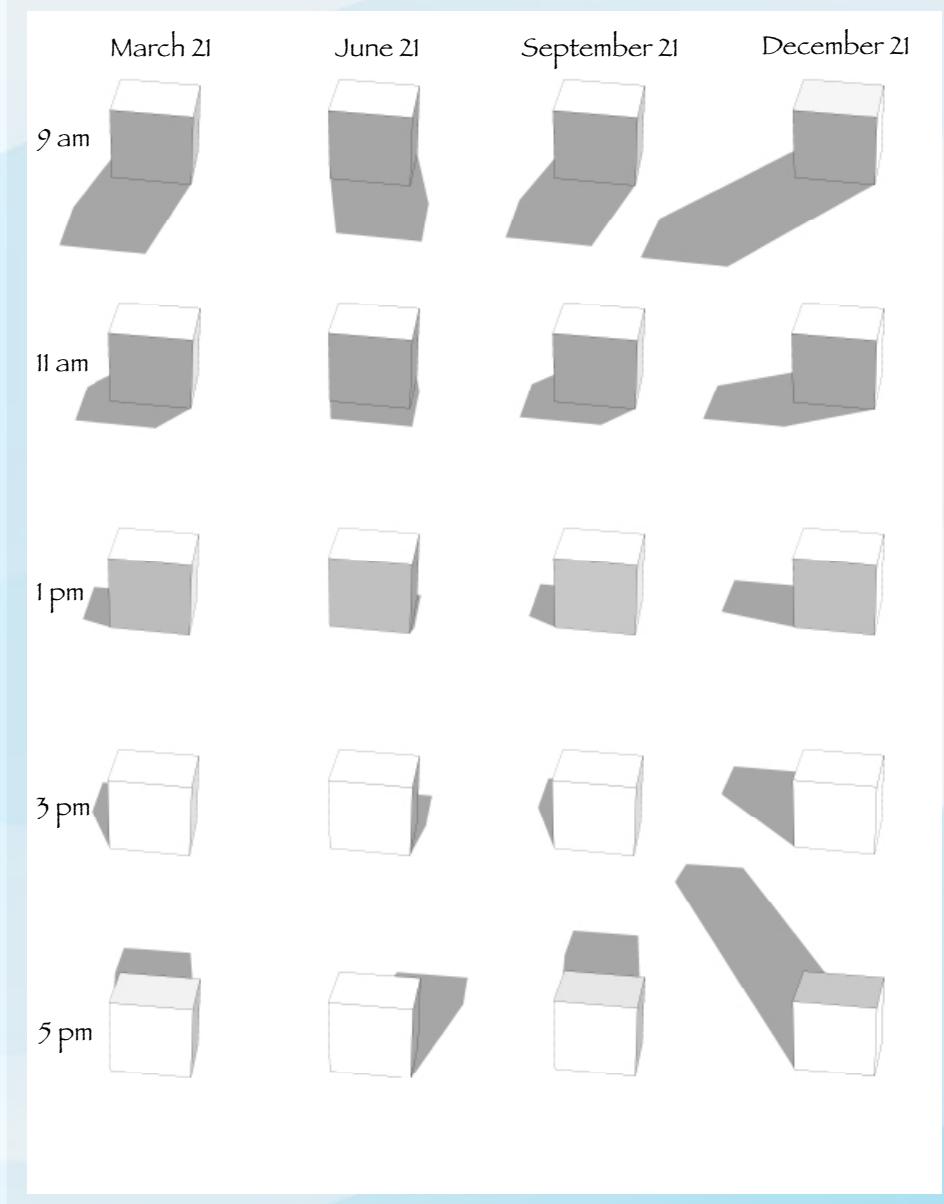
wind direction



sun path diagram



shading diagram

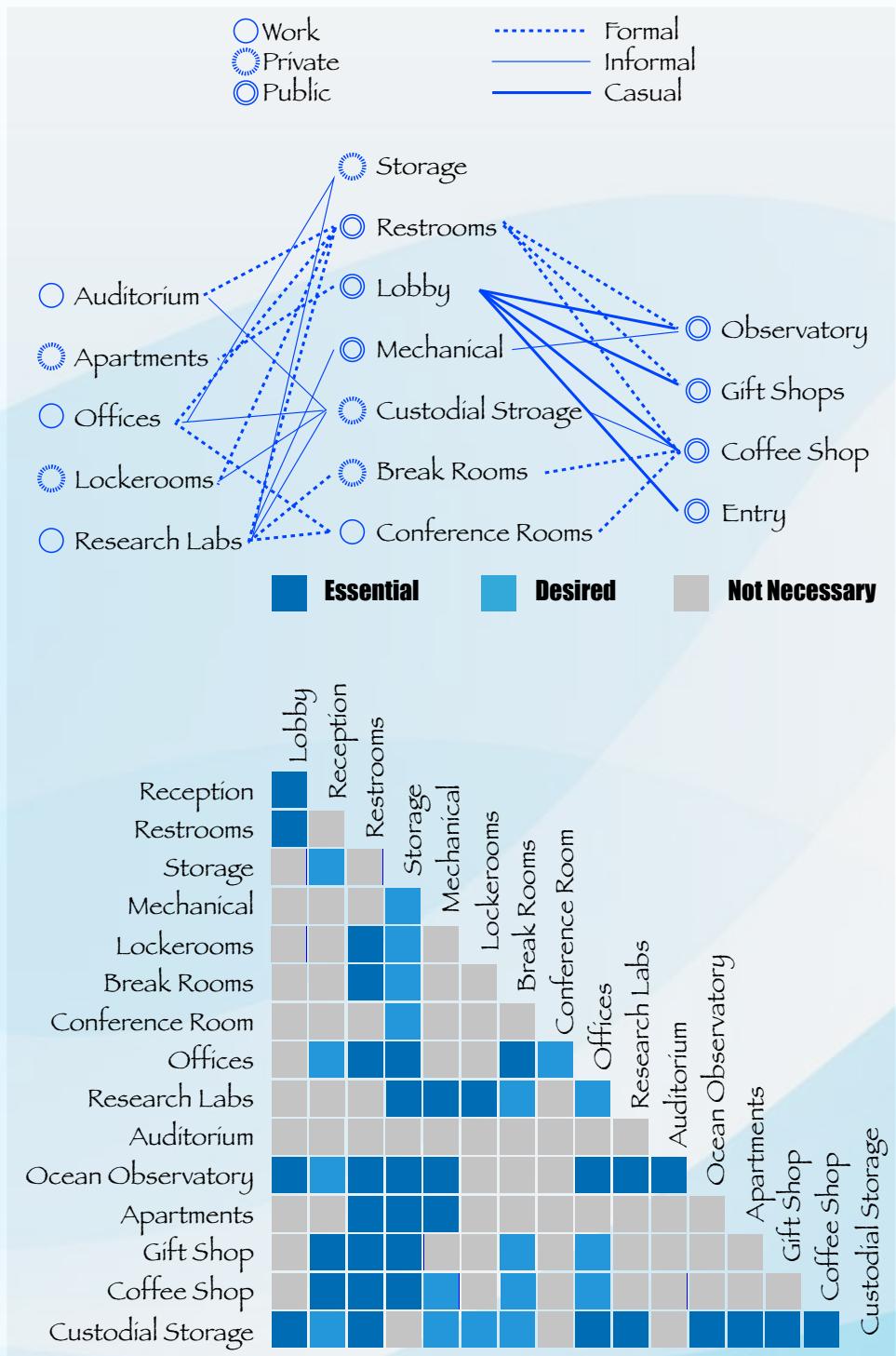


programmatic requirements

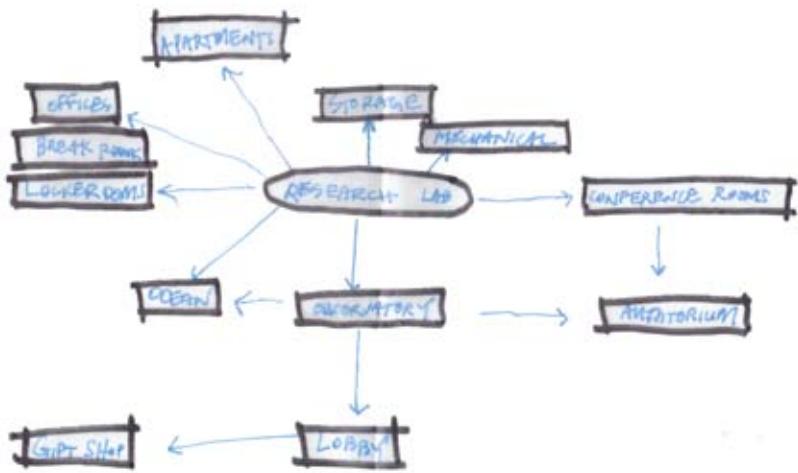
programmatic requirements [80,236 square feet]

offices	coffee shop	storage
[net area] 120 sf.	[net area] 500 sf.	[net area] 500 sf.
[number of spaces] 12	[number of spaces] 1	[number of spaces] 4
[gross sf.] 2,400 sf.	[gross sf.] 500 sf.	[gross sf.] 2,000 sf.
reception	auditorium	ocean observatory
[net area] 120 sf.	[net area] 4,000 sf.	[net area] 20,000 sf.
[number of spaces] 1	[number of spaces] 1	[number of spaces] 1
[gross sf.] 120 sf.	[gross sf.] 4,000 sf.	[gross sf.] 20,000 sf.
conference room	lockerooms	research labs
[net area] 300 sf.	[net area] 1,100 sf.	[net area] 2,500 sf.
[number of spaces] 2	[number of spaces] 2	[number of spaces] 4
[gross sf.] 600 sf.	[gross sf.] 2,200 sf.	[gross sf.] 10,000 sf.
break rooms	mechanical	apartments
[net area] 150 sf.	[net area] 5,000 sf.	[net area] 1,000 sf.
[number of spaces] 2	[number of spaces] 1	[number of spaces] 10
[gross sf.] 300 sf.	[gross sf.] 5,000 sf.	[gross sf.] 10,000 sf.
lobby	restrooms	Circulation
[net area] 3,000 sf.	[net area] 100 sf.	[gross sf.] 18,516 sf.
[number of spaces] 1	[number of spaces] 6	
[gross sf.] 3,000 sf.	[gross sf.] 600 sf.	
gift shop	custodial storage	total [80,236 square footage]
[net area] 900 sf.	[net area] 50 sf.	
[number of spaces] 1	[number of spaces] 2	
[gross sf.] 900 sf.	[gross sf.] 100 sf.	

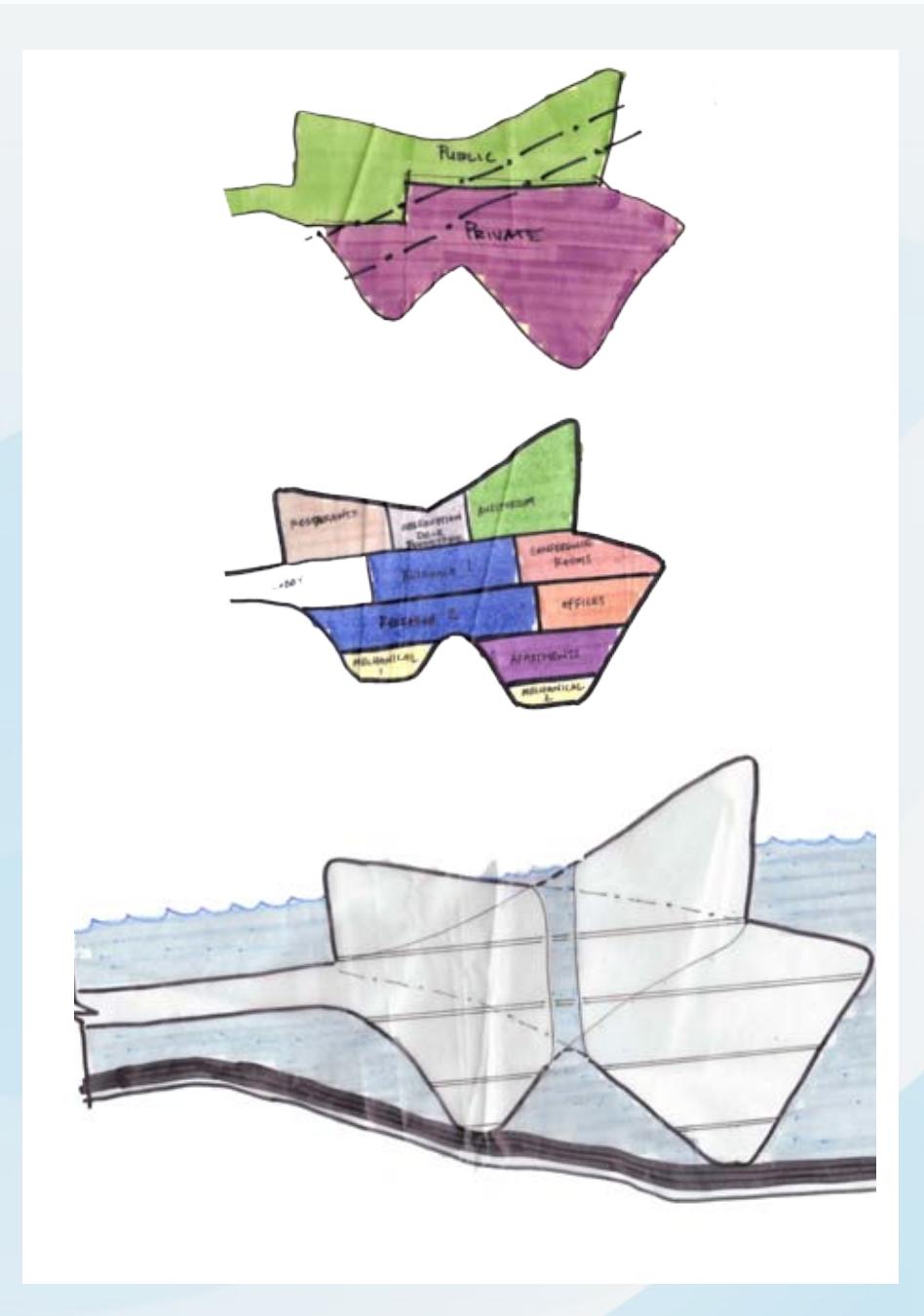
programmatic interacion matrix



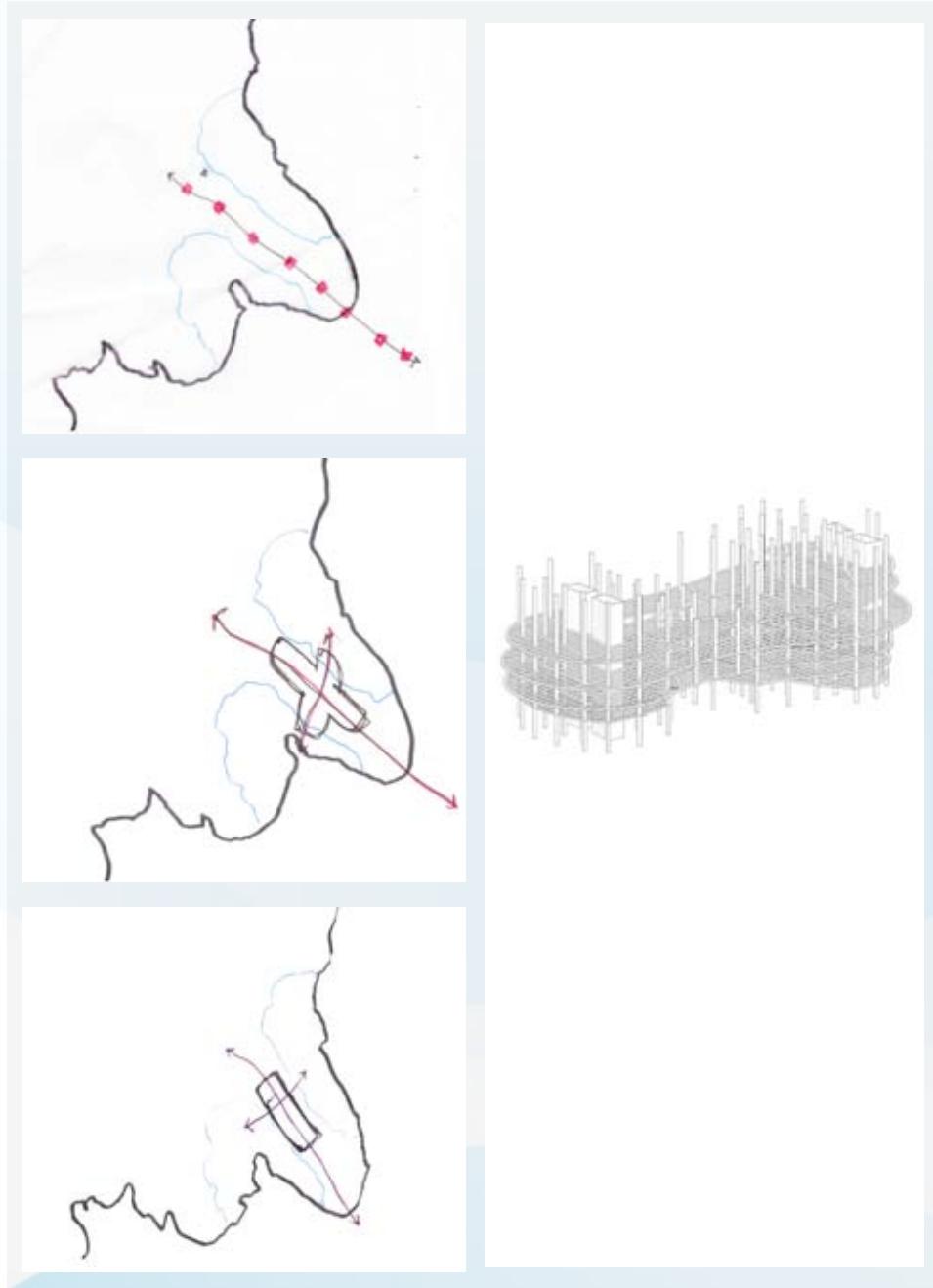
design process



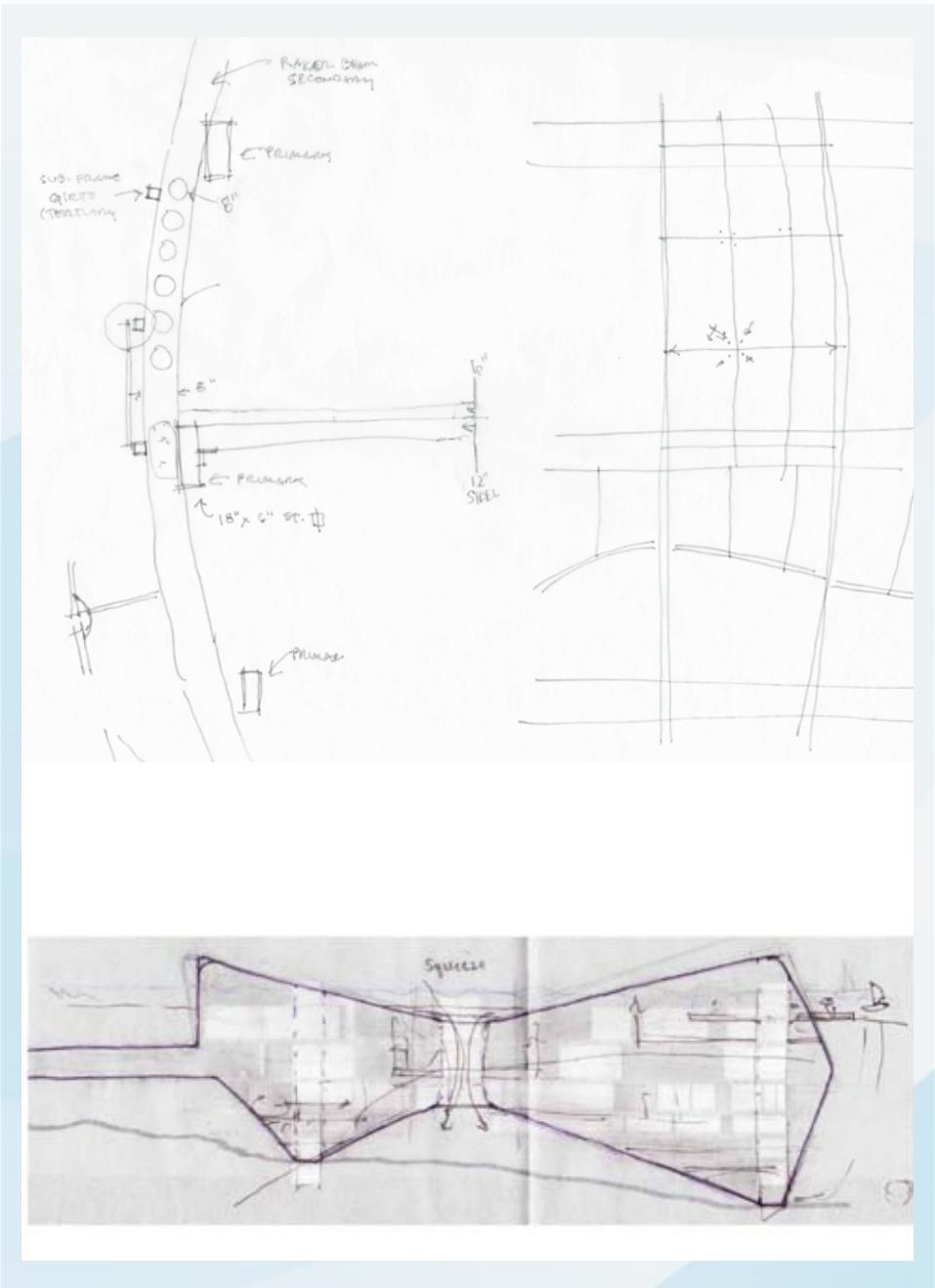
design process



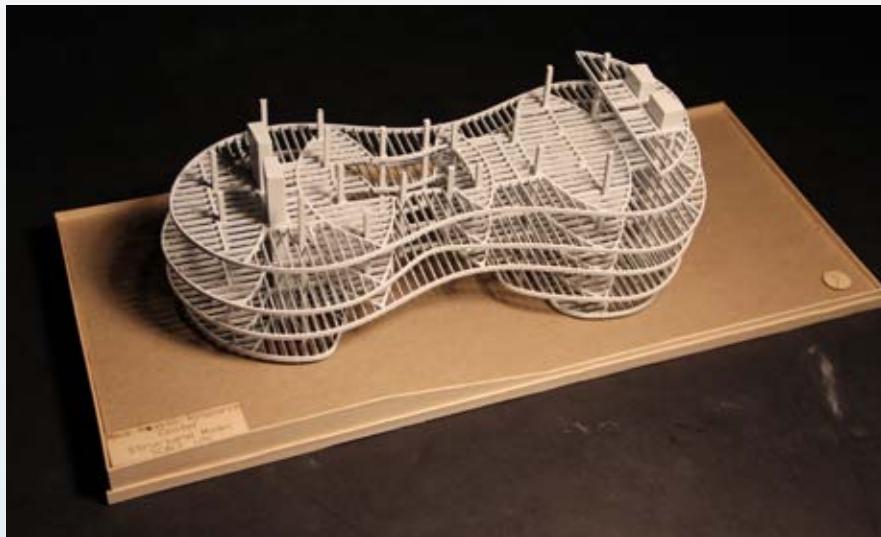
design process



design process



final models/boards



**Aquatic Research Center
Maui, Hawaii**

With 70% of the world being covered by water should we consider aquatic architecture? This thesis project is meant to explore, in architectural terms, the question of what will happen if water levels continue to rise, and population levels continue to grow at an alarming rate? This issue will impact all continents of the world and about 65 percent of the world's population. As land becomes scarce, people will be forced to migrate, the relocation of billions of people in land, to an even more condensed area, our new floating cities make it possible to live the 70% of the earth covered by water, where ever you want to go and stay. This is the Aquatic Research Center, a place where all people of all ages and handicaps to enjoy and explore the depths of the ocean while stimulating their excitement in the realm of aquatic architecture, therefore progressing future advancements.

final presentation



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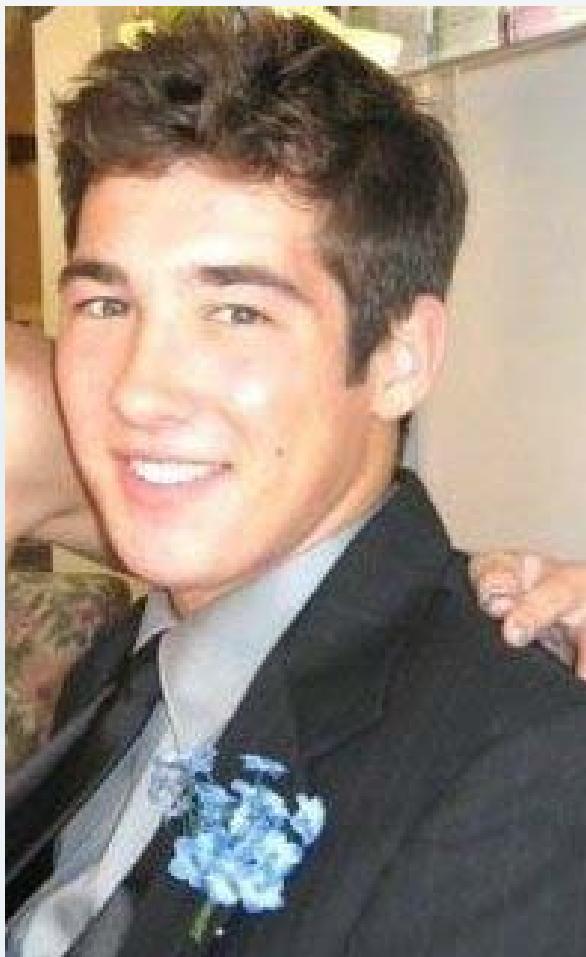
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personal identification



[Perminant Address]
25640 Hickory Blvd.
Belle Plaine, MN 56011

[Email Address]
kyle.lacek@gmail.com

[hometown]
Belle Plaine, MN, United States

"The Faculty at North Dakota State University do not treat you like a student, but rather an equal"