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Breaking The Horizon

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Breaking the Horizon
A New Architectural Frontier

This community would consist of several devices that would harness water for energy generation, hydroponics, water purification and desalination. This community would be an urban environment along with architectural designs to fit the needs of the community and will also help introduce new technologies to an alternative way of living. The community would be located in the lower portion of the Gulf of Mexico; this is a low wave, low storm area as well as abundant amount of sun.
Thesis Collaborative 2016 – 2017

Request for Approval of Project Book

Chelseay Frith

Breaking the Horizon

Thesis Summary:

We are consuming more resources than the planet can sustain and at the current rate of usage these resources will be exhausted. By creating this community, it will allow the exploration of different methods of living, regenerative cities, and research wave energy technology. The combination of elements from architecture, engineering, and technology can create a community that is an experiment in how we can design an environment that can exist above and below the surface of the ocean. The challenge is to break the horizon and explore a new architectural frontier.

Student Signature ________________________________Date___________

Approved by:

Internal Advisor 1 __________________________________Date__________

Internal Advisor 2 __________________________________ Date___________

Chelseay Paige Frith 5/4/2017

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SECTION 1: THESIS PROPOSAL

Section 1:
Thesis Proposal
1.1 THESIS STATEMENT

SECTION 1: THESIS PROPOSAL

The seastead city is designed to be the next level in the advancement of the human race. The seastead city is a community that is an experiment in how we can design an environment that can create a community that is an experiment in how we can design an environment. We are consuming more resources than the planet can sustain and at the current rate of usage these resources will be exhausted. By creating this community, it will allow the planet to replenish-able Resources. This will help with the elimination of our fossil fuel consumption.

1.2 PROPOSED PROJECT

With this design, I propose a structure that could float on top of the water as well as penetrating the water's surface. This Structure will be used for collection of energy from the plants replenish-able Resources. Global warming is when air pollutants, such as carbon dioxide, collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the planet's surface. Normally this radiation would go back to space, but the rising concentration of greenhouse gas, especially carbon dioxide, has changed this. This has lead to an increase in the Earth's surface temperature. In 1800s, United States, fossil fuels are burnt to make electricity and this is the largest source of heat trapping pollution. The United States produces about two billion tons of Carbon Dioxide every year! The power plants that burn coal are the biggest polluters. Then the pollutants from cars come in second place, this generates about 1.7 billion tons of Carbon Dioxide a year.

The Seasteading Institute creates floating cities, they believe the "first key step is for Seasteading to become not just possible, but sustainable." Technologically and legally feasibility. This firm focus on 5 things when dealing with floating cities. The first one is that it is designed for protected waters, which means it will be floating off shore in protected waters of a host nation. The second one is that the host nation will trade political autonomy for economic, social and environmental benefits, which means that they will help govern it and to help the floating city to get started. The third one is that Seasteading Institute is partnered with DeltaSync for the design concept, DeltaSync is one of the best aquatic engineering firms in the world. The fourth concern is the cost per building this city, it has been estimated to be built for $500 per square foot or less. The final thing is locating and asking people how they would feel about the city, they would move to it or it is a bad idea. One of the questions the they ask themselves "how do you build a seastead that is comfortable and safe in all sea conditions, yet is economical to build? They are not going to try to re-engineer water distribution or sanitation services, they are using the systems that are already on the cruise ships. Their main focus is going to be on the structural design, will it hold up during a storm, it will be comfortable for an average family in sea conditions, and can it be expanded so that the city grows. They are really concerned with the cost. How are they going to make it easy for middle class people to live in, at the moment they are just doing the testing to see if engineering is causing major concern. They have been working on design and development of the seastead city they started testing in 2014 on a secluded location with a few architects to get started off. The third one is that Seasteading Institute is partnered with DeltaSync for the design concept, DeltaSync is one of the best aquatic engineering firms in the world.
Section 2:

Case Study #1:
FLOODING CITIES
Miami, Florida

Case Study #2:
SUSTAINABLE COLONIES
Arcosanti, 70 miles north of Phoenix, Arizona
Masdar City, Abu Dhabi

Case Study #3:
AQUATIC STRUCTURES
The City of Meriens, Oceans of the World
Eco-Island, China
Miami, Florida has had a problem for the past several years. When high tide comes in, the streets started flooding and made the roads unusable. They have linked this to global warming. With the ice caps melting it has made the sea levels rise, which makes the coastal water line to rise. The streets are unaccessible to residents.

The mayor has devised a plan after several city meetings and engineering features. The plan is to rebuild the roads and elevate them 3 feet. Then install several pumps and pipelines to divert the water back to the ocean. This will allow the water to stay off the streets and allow the roads to be clear.

This project is to cost the city $206 million. They are currently trying to see if they will be needing more pumps or if their first initial pumps will work. If not then they will be redirecting the pumps to the neighborhoods. It is predicted that the sea levels will rise to 24 inches by 2060. They will have to rethink the pump systems by then.
Arcosanti is an experimental town in Arizona, it was designed by Paolo Soleri in 1970. This project was designed to demonstrate how urban conditions can survive without the damaging impact from the fossil fuels that are currently being used, that damage the earth. The project started in 1970 and the last completed building was in 1989. The population depends throughout the year, it ranges between 50 to 150 people, most of them are students.

There are several unique features with this design, such as the concrete panels, they are cast in a bed of silt which is from the surrounding earth, this gives the concrete a unique color and texture. This allows the building to feel like it has been with the landscape. The buildings are oriented to the south to capture the sun and heat, this is referring back to the vernacular architecture to capture the heat from the day into the concrete walls and allows the building to stay warm at night in the cold desert. The building layout is intricate and organic, unlike the modern day grid that we see today. There are several workshops that can help build up Arcosanti, students can enroll in these workshops and attend lectures about the design of arcology, learn about Paolo Soleri as well as getting hands-on learning experience by helping in construction.
Masdar City is the ultimate urban environment experiment, it is an $18-billion experiment and it will hold 40,000 residents in 2 square miles. Masdar will not allow cars, when you come to visit you have to leave your car in a designated area outside of the city. This city is the world's most sustainable city and it was designed for zero-carbon and zero waste.

This city is a test for innovations in fuel efficiency and renewable energy; this is very important now more than ever. There are several features to help with the constant heat in Dubai, one is narrower streets and more shading systems that is covered with solar panels. With the orientation of the city it allows the cool winds at night to cool the buildings down and helps with the heat throughout the day.

Transportation of this city is carts called PRT (personal rapid transit); they are pods that are driver-less and run on battery. This city is currently a living laboratory and people come here to conduct research on urban life and sustainable research as a whole. Some of the main technologies that they use are the solar panels, this place is one of the largest solar panel plant in the world right now. There is also a wind tower which they took from the traditional Arab technology; this makes the hot air rise and cooler winds to come in.
This is designed by a French architect named Jacques Rougerie. The shape of the vessel is that of a manta ray. It is designed to be roughly 3,000 ft long and 1,500 ft wide. It will hold up to 7,000 people. It was designed for researchers, professors, and students for long-term stays. It is also designed to be sustainable, zero-carbon and to run off renewable energy.

This shape took inspiration from the manta ray, because of how effortlessly it glides throughout the water with no resistance. It will rise up 200 feet above the ocean’s surface and 400 feet below the ocean’s surface. There is a lagoon in the middle of the ship that will host sea vessels and little bays where researchers can use them for research and observation of marine wildlife.

This design is supposed to be 100 percent sustainable, autonomous, zero waste and runs on renewable marine energy. No details on exactly how this will be obtained but would more than likely it will be using some wave energy technology. As of right now it is predicted to be completed by 2050.
2.3. Case Study # 3.2: Eco-Island

Eco-Island started off as a competition. Diller Scadillo + Renfro won the competition and beat out Foster + Partners and Morphosis. The reason Diller won was because of the beautiful design of it rising out from the ocean that it will provide to the landscape. The project will cost about $1.26 billion to build, it will have a cruise port, yacht harbor and several other amenities.

The Crescent design of the island was to recreate the yin-yang, which is a Chinese symbol that means harmony and balance. One of the other aspects of the island is to make it look as natural as possible. The building will start in 2017 and is supposed to be finished in 2027.

This island will be more of a tourist attraction and will give the area a recreational landscape area to explore. This is for a Biophilic living which involves the high urban life style and incorporating the tourism initiatives. It will give you the retreat that you need from the urbanism lifestyle.
Section 3: Types of Technology
3.1 Tidal Turbines

Tidal turbines are just like windmills on the earth’s surface but they are under water. The windmills that are on land are driven by the wind and the tidal turbines are driven by fast moving underwater currents. The rotors use the marine currents to harness power in generators, this produces electricity.

With water being 832 times denser than air, this will allow the rotors to be smaller than the windmills on land. This will allow the tidal turbines to be placed together closer rather than its counter partner. With the grouping of the turbines, it will be able to produce an abundant amount of energy.

These devices will have unique engineering challenges though, you have to consider design, installation and maintenance. The equivalent of wind to water would roughly be 345 mph and it will be about 320,442 tonnes of thrust on the rotors.

3.2 WaveStar

The WaveStar is a machine that harnesses energy from the water by floats placed along a platform which is secured to the sea floor. The floats move up and down with the movement of the ocean and will rise and fall with the ocean waves. The motion that the floats move in will be transferred by hydraulics to a generator which will produce energy.

Waves are more predictable than wind, which makes this type of energy more reliable. The waves can be predicted 24 hours ahead. When a storm is approaching then the floaters pull up so that the waves won’t damage the equipment.

All of the moving parts are located above the water line to help with maintenance of the equipment. The first demonstration was in Denmark it has operated 4 years and survived 15 storms.
3.3 Hydroponics

Hydroponics is a method of growing plants without soil and by using only water with minerals that the plants need to grow. Their roots are submerged in water that flows down a ramp or conveyor belt.

There are two types of methods to grow plants using hydroponics. The first is sub-irrigation and the second is top irrigation. Basically you have your plants submerged or barely touching the top of the water.

This type of growing plants can help eliminate the amounts of space needed to grow vegetable plants and allow you to grow any type of plants in any land conditions.

3.4 Desalination

Desalination removes minerals from saltwater, to make it drinkable for human consumption. This process can also be used for removal of salt from soil, this is mainly an issue for planting crops.

Desalination was first used in excessive amounts on ships and submarines. Now there is more production in devices to help bring fresh water to countries and cities that don’t have fresh water. Even though it cost a lot the cities and countries using this method can have fresh water but this issue is worldwide and most of the places don’t have options for fresh water.

1% of the population is dependent on desalination, and with only 3% of the world’s water being drinkable this shows that there is a greater need for desalination.
3.5 Photovoltaics

Photovoltaics is a method for generating electric power, it harnesses the sun’s rays and converts it to energy from the electrons from the sun’s rays.

The solar panels are composed of solar cells and these solar cells are what capture the solar rays and turn them into electric current.

Solar Photovoltaics generators no pollution, there are no moving parts, just the grid connections can be a problem and it depends on direct sunlight.

3.6 Living Wall

A living wall is a wall that has plants in the wall to help produce fresh air and consume the carbon dioxide in the air. They can also be used for decoration, a vegetable garden or just a green wall.

These walls are simple to operate, affordable, highly affected, and long lived. They are reliable and available to everyone.

To install one of these living walls, you must first install a furring strip so the moisture does not go into the building wall. Then add a watering system to the wall with planting systems.

The walls can take on any type of plants; the wall will provide everything a plant needs to grow. A living wall is simple and proven to work for areas with low growing areas for farming.
3.7 Waste Management

What goes through your mind when you hear waste management? Trash right? What if I told you it was a renewable energy? Thus right just like wind, solar and hydroelectric the trash can be a renewable energy source.

Proper waste management can produce enough electricity to power 440,000 homes and this is the same amount as 2.2 million tons of coal a year would produce.

There are a few countries out there that are using garbage as energy and they are running out of garbage. Sweden is one of the countries, their recycling programs are one of the top in the nation.

There are several ways to start helping with the amount of garbage that end up in the landfill instead of using that for energy to be put in our homes.

3.8 Titanium Dioxide

Titanium Dioxide is a material that removed the nitrogen oxides from contaminated air, it converts that to nitrate that is harmless. This is all done by the sun and then is washed away by the rain.

The Nitrogen oxides cause acid rain and by applying the Titanium Dioxide to concrete surfaces this will eliminate the toxic pollutants from the air.

At Eindhoven University of Technology a few researchers discovered this technique of applying the T.D. to surface of concrete made to research the affects it had on the air. The results were shocking that the air was so much cleaner within the few hours that the study was done in.

Any surface can be coated in this and it will purify the air and all you have to do is to let nature wash the surface off.
A wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity.

Wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as a part of a strategy to reduce their reliance on fossil fuels.
Section 4: Program
The Bubble Diagram gives a better understanding of what needs to be placed with other activities with in the program.

This first diagram shows a connection between living and research in the program. Having a green space separate part of the program allows you to escape from the day to day hassle.

A big part of the program is having the technology to do research for a regenerative community and to allow tourists to experience and understand a new way of living.

With the food being on the mainland, it will be difficult for it to be shipped out there every day. The program will have to incorporate some food production.

Along with all of the comforts of every day life this program has a retail section, cafe, apartments, medical and a green park.
This second diagram shows the interaction with the incorporation of green space in food production, living and research. This gives a better feeling to the program instead of having it on its own.

This model shows a strong relationship between Living and food production, research and technology eco-tourist and boats. Living and boats as well as Living and Research.

This diagram also takes some influences from the first diagram and combines them with the new situation.

This Program Block makes everything accessible to each program, as well as the incorporation of green space.

This is the program block that I will be focusing on, having a centralised space where everything will be accessible to everyone.
These diagrams show how the previous block program diagrams would fit in the proposed structure. Each section is color coordinated with the appropriate activities as shown in the block program diagrams on the previous page.

While making program block, there were a few areas that I wanted to make sure was in the design of the structure. These are some of the types of programs that will be incorporated in the structure of the ocean community.
4.5 Food Specifications

Daily Food Needs:

Land Per Human:
1 Human = 140 Square Feet for a Vertical Garden
1,400 Square Feet for a Roof Top Garden

Daily Protein Intake per human per year:

- Pork = 42 Pounds
- Beef = 58.5 Pounds
- Chicken = 136.5 Pounds
- Fish = 39 Pounds

Land Per Animal:

- Pork = 2,000 Square Foot Per Pig
- Beef = 0.8 Acres Per Cow
- Chicken = 110 Square Foot Per 6 Chickens
- Fish = 1.5 Gallons of Water Per Fish

Vertical Garden Food Types:
- TOMATOES
- BEANS
- CUCUMBERS
- SWEET POTATOES
- CAULIFLOWER
- POTATOES
- BEETS
- ONIONS
- POLE BEANS
- MELONS
- CARROTS
- GOURDS
- MELON
- BEANS
- PEAS
- RADISH
- TURNIP
- CABBAGE
- SQUASH
- BEETS
- SPINACH
- BROCCOLI
- PEPPERS
- GARBAGE
- GARLIC
- HERBS

Crop Gardens:
- CORN
- WHEATS
- GRAINS
- RICE
- APPLE
- ORANGES
- BANANAS

4.6 Living and Working Space

Residential Size:
- 4 Bedroom Apartment: 1,800 SqFt x (500/4) = Total 225,000 SqFt
- 3 Bedroom Apartment: 1,400 SqFt x (500/3) = Total 233,800 SqFt
- 2 Bedroom Apartment: 1,000 SqFt x (500/2) = Total 250,000 SqFt
- 1 Bedroom Apartment: 700 SqFt x 500 = Total 350,000 SqFt

Work Place Size:
- 500 People Working x 150 Sq Ft Per Person = 75,000 SqFt Office
- 250 People Working x 150 Sq Ft Per Person = 37,500 SqFt Office

Green Space:
- 500 People x 100 Sq Ft = 50,000 SqFt of Green Space
4.7 Energy Production

Wave Star:
40 Floats gives you 6 mws per cycle
1 mw gives you energy for 1,000 Homes

Solar Panels:
1 Solar Panel creates 200 watts of energy

Wind Turbines:
1 Wind Turbine can produce 6 Million kws per year, which is enough to power 1,500 homes

Water Turbines:
1 Water Turbine can produce 2 Million kws per year, which is enough to power 500 homes
Section 5: Site Analysis
5.1 Site Location

The site is located in the Gulf of Mexico, approximately 30 miles South of Pensacola. This location has an abundant amount of ocean life and sun light. This location is roughly 150 feet in depth, which the ocean floor drops off a little further away. This location is a perfect combination of elements needed for this community to survive.

5.2 Solar Studies

The design took into account the solar path in that area as well as the angle of the sun in certain times of the year.
5.3 Ocean Current Study

One of the important elements was water, the project is about harnessing the power of water for energy. The currents help us understand how the water will be flowing into the area so the placements of the tidal turbines would work efficiently.

5.4 Wind Study

The wind rose shows that the winds are coming from the north west and south east, this gives a good representation of where to place the wind turbines. The hurricane paths are abundant in this area so the design of the structure has to be sound enough to allow for a hurricane to hit it and survive the damage.
Section 6: Design Process
6.1 Early Design Process

Process 1:
This process started with the natural formation of an island from the ocean.

Process 2:
This process elongated the first process to take into account for the sun path. The elongation allowed the island to have more sun exposure.

Process 3:
This process carved away areas on the island to allow for the current of the oceans to flow through the island. This will allow the water turbines to produce an abundant amount of energy.

Process 4:
This process looked at the wind rose to determine that there needs to be high ground for protection from the harsh winds. With all of the elements implemented on the island this was the best combination for the location.

Process 5:
This redesign phase looked at the problem with a modular approach to allow for more communities to be added for future expansions. With living pods for living and one central tower for research and community needs.

Process 6:
This process is how the community could look when more modular systems were added.
6.3 Future Configuration Possibilities

- Configuration with One Pod
- Configuration with Three Pods
- Configuration with Two Pods
- Configuration with Four Pods
To show comparison and to give an idea of how big this pod is in comparison to objects that we know.

**Oil Rig**
- Size: 300 Feet x 300 Feet
- Population: 10 People

**Iceberg**
- Size: 200 Feet x 300 Feet

**Cruise Ship**
- Size: 150 Feet x 1,200 Feet
- Population: 8,500 People

**Horizon**
- Size: 150 Feet x 300 Feet
- Pods: 100 Feet x 50 Feet
- Population: 500 People

**Porgy Key**
- Size: 1,500 Feet x 1,500 Feet
- Population: 8 People
- National Park
Section 7: 
The Horizon
The Design of the Horizon is taken from process number 2 design. This design is a study of the sun and the form was elongated to allow for maximum sun exposure. This form was made and then stacked to allow the structure to be submerged in water and tower above the horizon. The structure allows living pods to be attached to the main structure and this number can grow with more people that want to live in the community.

The outer ring is a barrier between the ocean and the structure, it provides a safe zone for the structure. The barrier also has wave star buoys which will harness the power of the waves with the motion of the waves. This barrier also has wind turbines on the top, this will also provide energy as well as protection from the gust of winds.

The Horizon also has an underwater viewing area for the Eco-tourist as well as residents. There is research labs, living spaces, restaurant, vertical gardens, medical center, learning center, retail, and viewing areas.
In the section drawings you can see the observation desk in the Research Lab and as well as the lower deck. With the research lab there are office spaces then as you go up the structure you will see the relationship with the Eco-tourist and living spaces. At the top of the structure you can see the vertical gardens that will get an abundant amount of sun for the plants.
The structure supports several different types of technologies. The Vertical tower gardens will have skylights with louvers. There is a double pin connection to the pods to allow for movement with the water. Instead of having a helipad on the top of the structure it will be attached to one of the pods that is connected to the structure. The structure will be attached similar to an oil rig to the ocean floor.

The Horizon will also have observation areas, roof top parks, lounge areas and an educational center for Eco-tourism. The Eco-tourism is a part of this community to help educate people on the power and destruction of water.
Section 8: Floor Plans
8.1 Above the Ocean Horizon

Level 1:
- Retail
- Living
- Green Space

Level 2:
- Medical
- Living

Level 3:
- Medical
- Living

Level 4:
- Living

Level 5:
- Food Production

Level 6:
- Food Production
8.2 Below the Ocean Horizon

Level 01: Living
Technology

Level 02: Eco-Tourist

Level 03: Research Labs

Level 04: Research Labs

Level 05: Eco-Tourist

Level 06: Eco-Tourist
Section 9: Model Photographs


