

Floa-Dation

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Abstract:

Floa-dation

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Plastic was a blessing as an invention. It has bought the world many conveniences and wonderful new experiences. However, it has built up to become a threat, not only to human beings but, more so to the other creatures on the planet. This material has been designed to be long-lasting. But Ironically now we are seeking for solutions to hide and destroy those ever-lasting materiality. What is exactly is plastic? How many types are there? How can we recycle more? Can we reuse plastic and how can we reuse it?

This thesis will focus on answering those questions but in a very theoretical way. However, my effort has been to offer architectural solutions in a very realistic way. Because it is my passionate belief that in the near future, the potential of plastic will be evident in real life, and we will be able to say, plastic, is actually a great invention not only just for the efficiency of human beings, but also for the environment.

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Chapter 1: PLASTICS NARRATIVES

- Plastic Stories: The Duck Travelers

In 1992, a shipping crate containing 28,000 plastic bath toys was lost at sea when they fell of a ship on its way from Hong Kong to the United States.¹² At the time, no one would have suspected that these plastic ducks would be still travelling the oceans throughout the world to the present day for nearly 20 years.

They have made their way to the Pacific Northwest, Alaska , Australia, as well as Peru, even to the east coast of America as well as France and Scotland.

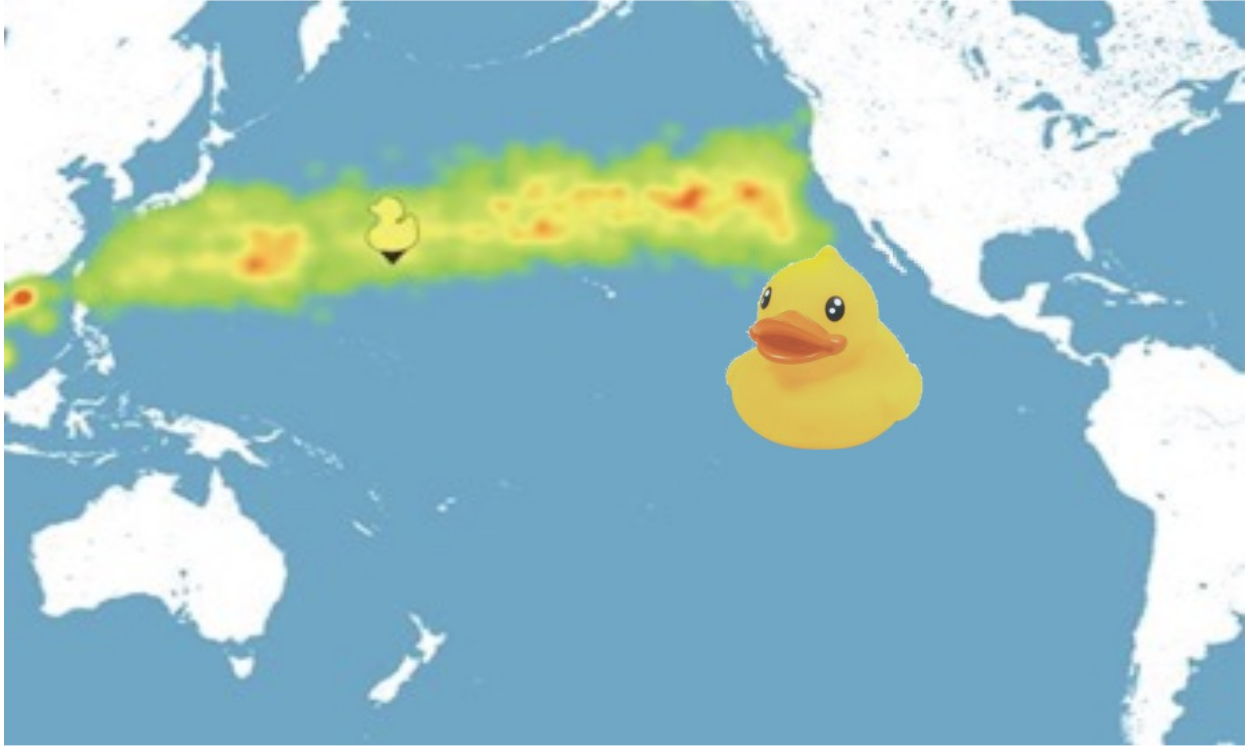


Figure.1

Of course this fleet of plastic toys is still being discussed today for “revolutionizing our understanding of ocean currents, as well as for teaching us a thing or two about plastic pollution in the process”¹².

Especially at the “unknown known” parts of the planet earth. Things have actually been getting serious since human started to discover plastic islands on the Pacific Ocean, that are mostly made of plastic bags and bottles.

So, the question is about how many plastics human society is actually generating a daily basis.

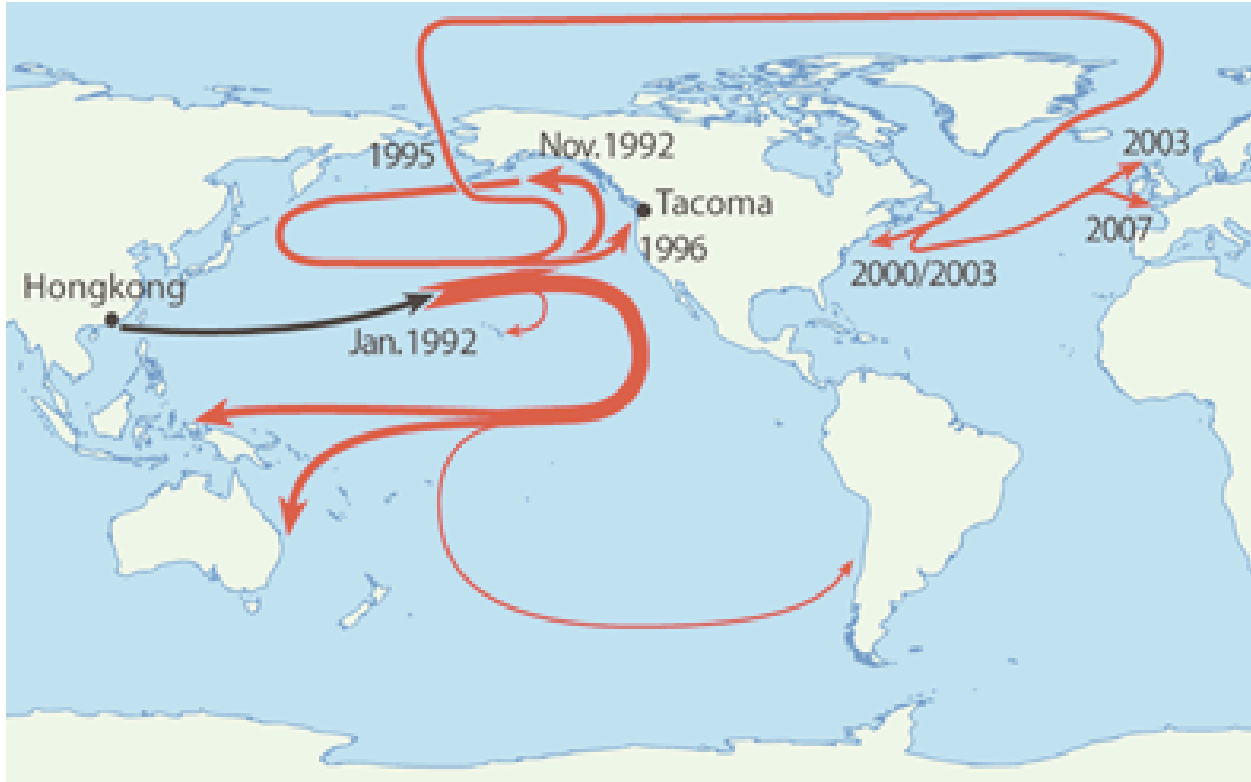


Figure.2

- Plastic DATA: World Plastic Facts

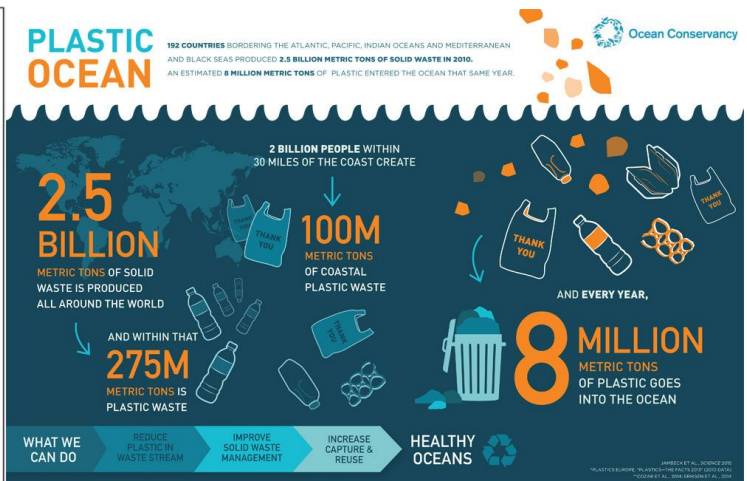
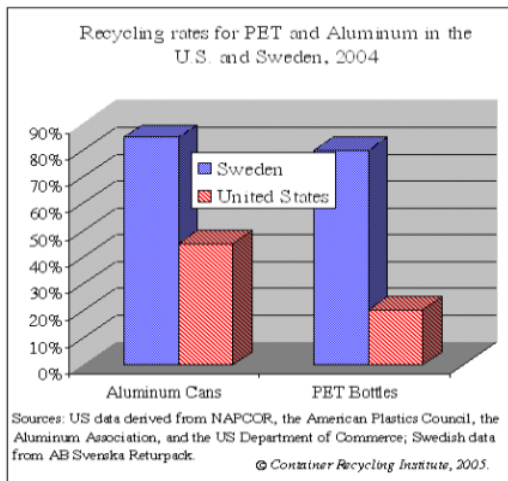


Figure.3

There is more research being done every day showing how much plastic wastes we are actually generating day by day and how much plastic is actually being recycled and reused. As Figure 3 indicates², the recycling rate of plastic bottles in the USA is currently even lower than 20%, but at the same time, Sweden, has reached over 80%. However, the plastic waste every year has been increasing steadily, with an estimated 275 million tons of plastics produced just in 2013, among that are 100 million tons that from 30 miles within the coast line. This data clearly indicates that a certain amount of plastic was never actually recycled. And if they have not been properly landfilled (hundreds of feet underground), then where did they actually go? The answer is “they might just be somewhere around us”.

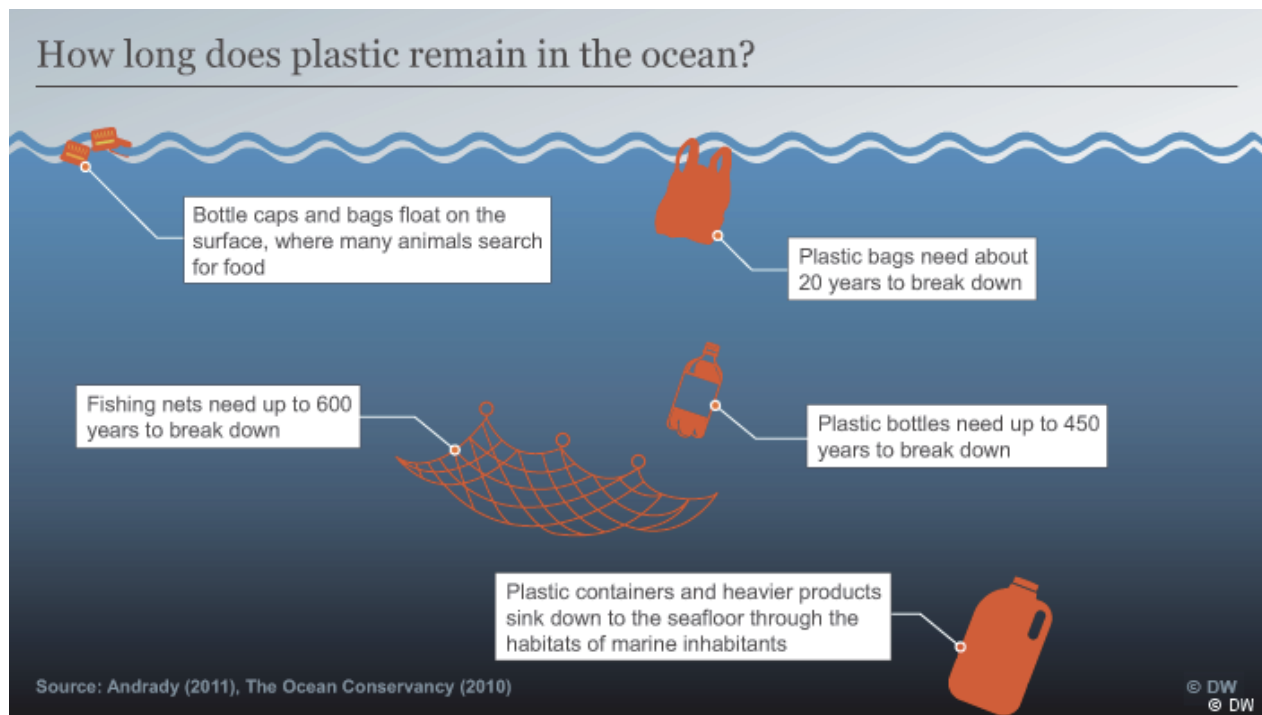


Figure.4

It is not a joke to say “they are just somewhere around us”. These man made materials normally take over 450 years to naturally deteriorate, they live (exist) longer than anyone of us. Many types of plastic are extremely stable in a lot of environments, water, and air and also up to certain temperature (up to 80°C). This property is one of the most important reasons that they have been used as packaging material for numerous products from all kinds of food to even some chemical reagents.

- Plastic and The Ocean Environment: Impacts on Ocean Animals

While plastic have been benefitting human life in a lot of ways, the truth is they have also been harming us, if we are not handling them well. They are not only just harming us, they are also harming our friends, those creatures that co-exist on the planet earth with us. Over the years, many new stories have reported that dolphins or sea turtles have been killed by eating plastic waste, because plastics can not be digested by the acid our stomach generates, so day by day the material just takes over the space in the stomach of those ocean creatures. Eventually they will die because they can not eat anymore or digest any other food they ate after the plastic wastes. And they die miserably.



Figure.5

Plastic was a monumental invention in the past century. It has been benefitting human being in a lot of ways ever since. The reason why it is such a successful invention and was widely used in a lot of fields is due to its extremely stable quality.



Sperm whale found washed ashore in Indonesia. WORLD WILDLIFE FOUNDATION (WWF - INDONESIA)

Two flip-flops, 115 drinking cups, 25 plastic bags, and four plastic bottles were among the plastic found in a dead sperm whale that washed ashore in Indonesia.

Figure.6

November 2018, a sperm whale was found dead on the beach in Indonesia. With 115 drinking cups; 25 plastic bags; 4 plastic bottles inside of its belly. It really only takes that much, to kill such a large creature as whale.

- Plastic Landfills

Currently we are defining most of the plastics that we recycled as landfill trash. Using Seattle as an example, plastic landfill trash is processed in the North and South transfer stations and then shipped down to Arlington, Oregon by train. The total distance is around 313.8 miles, meaning Diesel Fuel is being burned at the following rate according to the 2015 CSX system-wide train efficiency metric.

$229,562,353,000 \text{ ton-miles} / 487,540,790 \text{ gallons} = 471 \text{ ton-miles per gallon.}$

$15,228,895 \text{ LBS} = 7614.4475 \text{ gallons} * 2.666 \text{ USD/gallon} * 267.9 \text{ miles} = 5438401.3 \text{ USD}$

Therefore **5,438,401.3 USD** every year just to transfer our problems to another place and bury them deep down underground, so the problem of plastic waste is not being solved and we need to be able to address those problems better than we do now.

The Columbia Ridge Landfill and Recycling Center's waste disposal contract with Metro is set to expire in 2019.

George Plaven - East Oregonian
Published on February 2, 2017 8:47PM



PHOTO CONTRIBUTED BY WASTE MANAGEMENT
The Columbia Ridge Landfill and Recycling Center is located south of Arlington in Gilliam County, and directly employs 90 people.



Figure.7

It has been reported recently that Arlington, Oregon is getting close to reach its maximum landfill capacity. This means we need to pick another location to send our landfill trash in the Pacific Northwest area. This is a dangerous sign because there are very limited land resources. And once a piece of land is being used as landfill site, it will no longer being livable anymore because of the pollution from the landfill trash.

- Plastic Types

Over the years, material scientists have been focusing on enhancing this magical man-made material by lowering its density as well as reinforcing the chemical structure of the material so that it gets even stronger. Their hard work has paid off because real breakthroughs are emerging from this process, plastic, continues to be developed into an empire. It is important to understand the different types of plastic in order to understand their properties. There are 7 main kinds of plastic that are:

1. Polyethylene terephthalate (PET or PETE or polyester);
2. High density polyethylene (HDPE);
3. Polyvinyl chloride (V or Vinyl or PVC);
4. Low density polyethylene (LDPE);
5. Polypropylene (PP);
6. Polystyrene (PS);
7. Other (O) – all other plastics;

Among all these kinds of plastic, the Low Density Polyethylene (LDPE) has been used more and more commonly through the recent years, due to its very special characteristics, described as “(Polyethylene) the most widely used family of plastics in the world. The versatile polyethylene polymer has the simplest basic chemical structure of any plastic polymer (repeating units of CH₂: one carbon and two hydrogen molecules) making it very easy to process and thus extremely popular for numerous low value applications - especially packaging. LDPE polymers have significant chain branching including long side chains making it less dense and less crystalline (structurally ordered) and thus a generally thinner more flexible form of polyethylene. The characteristics of this kind of plastic are strength; toughness, flexibility, resistance to moisture, ease of sealing, ease of processing.”

In today's society LDPE is being widely used in bags (grocery, dry cleaning, bread, frozen food bags, newspaper, garbage, etc.), as well as some squeezable bottles (honey, mustard), and food storage containers. We see this plastic in different forms in our daily life everywhere we go.

- Plastic Calculator

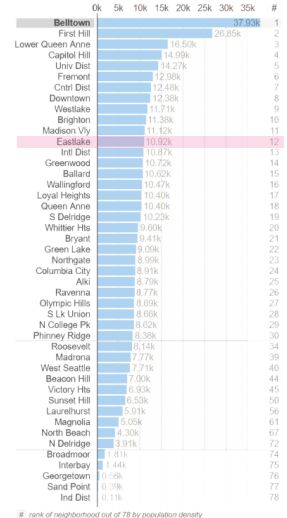
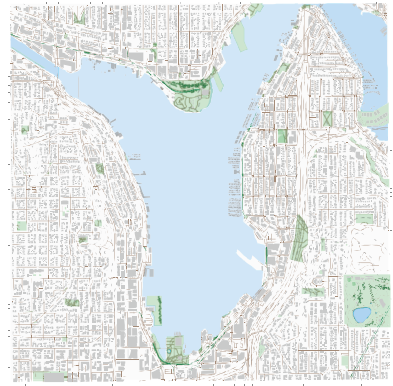
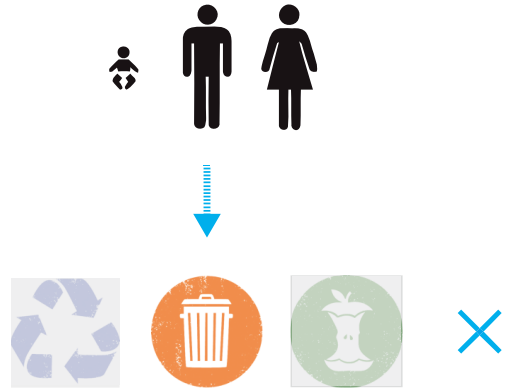


Figure.8

Average American
 Generate **185lbs** of
 Plastic Trash Per Year

Lake Union Area
 2 Miles * 2 Miles
 *10.92K = **43,680** People



Figure.9

This diagram shows that this area generates :185 LBS*43,680 Person

=8,080,800 lbs of plastic trash yearly

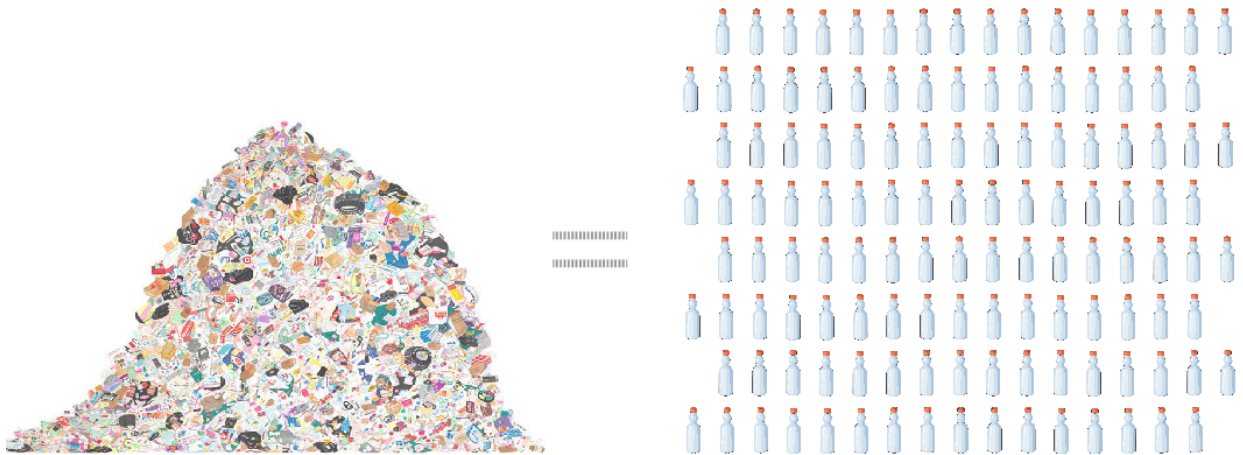


Figure.10

And that equals to

8,080,800 lbs * 50 per lb

=404,040,000 Bottles

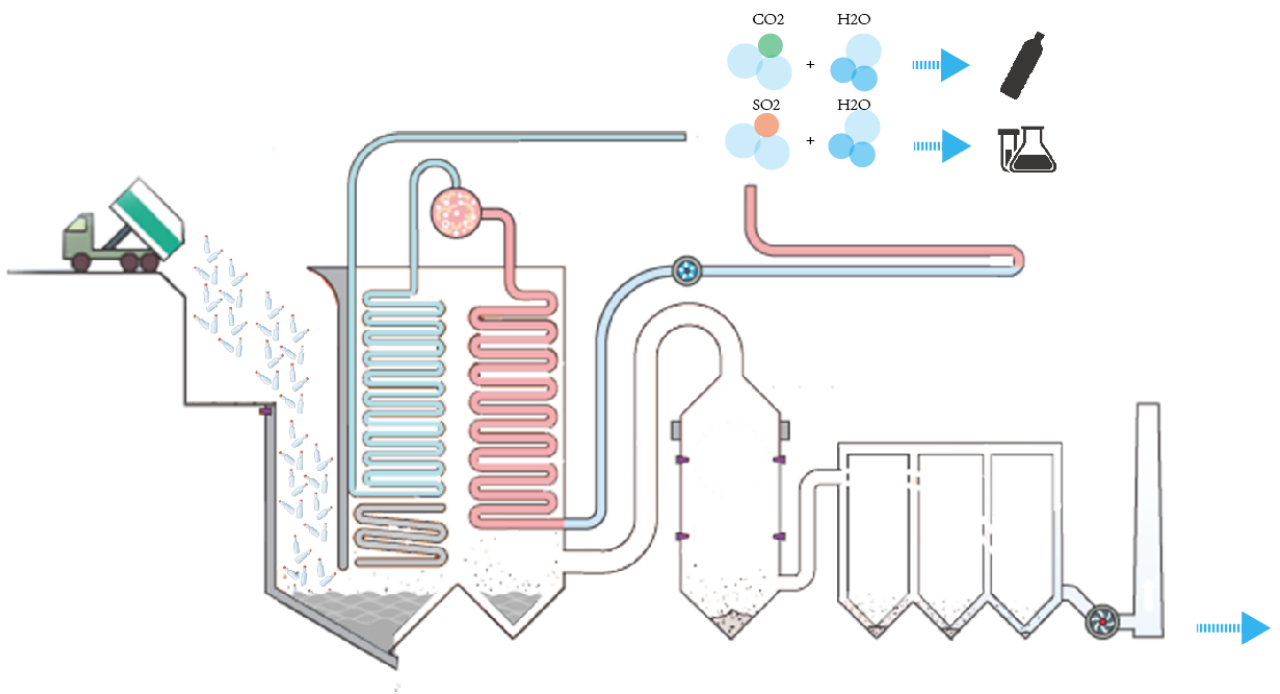


Figure.11

With the current technologies, it is possible and safe to melt and reshape LDPE plastics and during the process we will be able to collect some gas such as: **CO2, SO2**

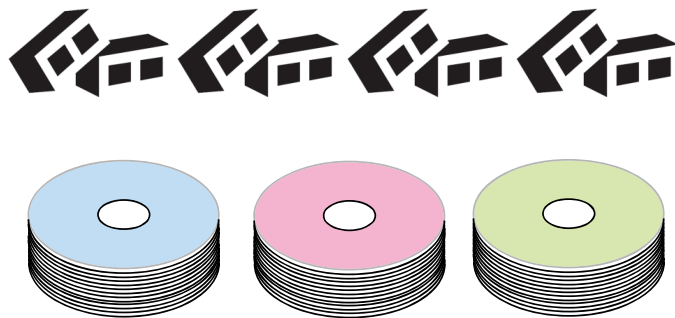


Figure.12

Among the final products that can be made from these recycled plastics are: **Compressed Plastic Bricks** and **3D printing plastic material**;

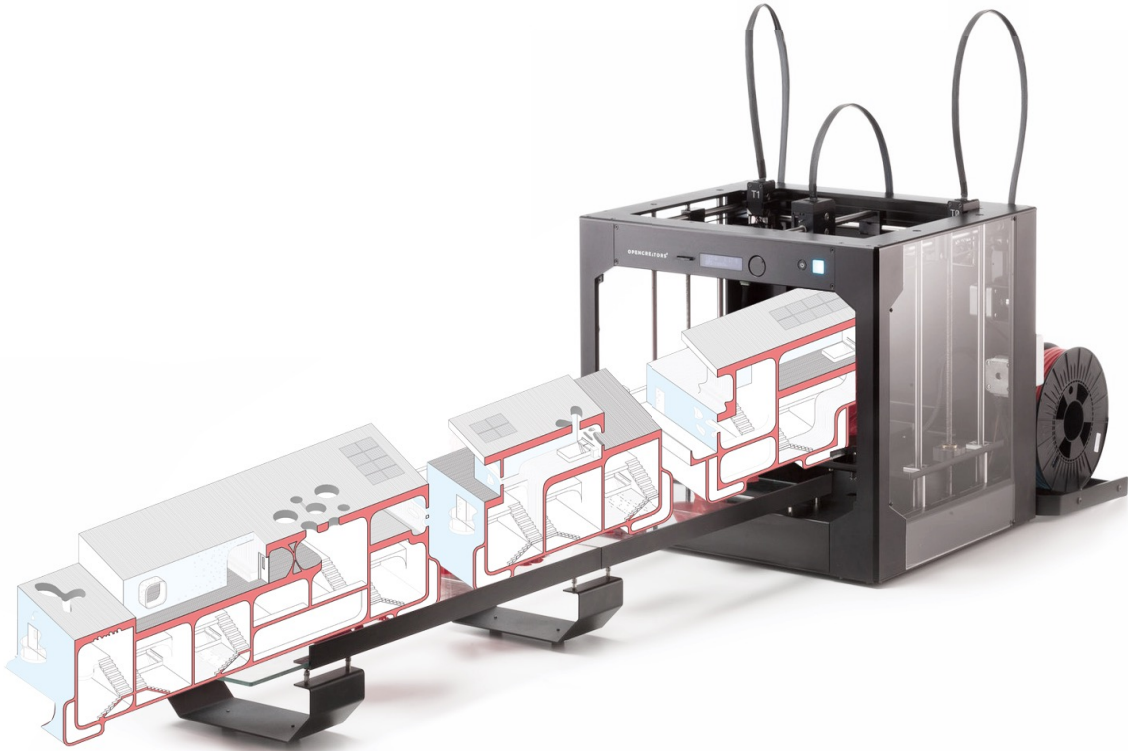


Figure.13

Thus buildings can be made **This way**, as the Figure.13 is showing, with 3D printing technologies become more mature and complete, we will be able to print bigger scale models like houses.



Figure.14

Each house will cost = **15,000 Bottles**, Which makes **45,000 Bottles** per floating unit, **89,800 Units** can be provided just around lake union area.

Chapter 2: PLASTIC AND ARCHITECTURE

- Material Matters

We are constantly searching for new materials, from construction to manufacturing. People may see architecture as a somewhat more old-fashioned profession that often relies on traditional building materials. However, advances in building technology are constantly happening, and materiality is always on the front line of those revolutions.

So why does the materiality of architecture matter? Henri Bergson made an argument more than 50 years ago, he states: "An intelligence which aims at fabricating is an intelligence which never stops at the actual form of things nor regards it as final, but, on the contrary, looks upon all matter as if it were carvable at

will . . . In short, it makes us regard its matter as indifferent to its form.”⁵ My understanding of this idea is that, different materials represents different expression even with the same quality of space. Architecture particularly, it normally represents the most advantage technique at that very moment. As in the case of 19th century brownstone apartments, when sandstone was discovered as a very efficient and popular material, they became the representative architecture samples of that era.

- Plastic as Material

In recent years, architects as well as engineers have started to pay attention to the new term of “Embodied Energy”. According to Henri Bergson, the definition of embodied energy is “Sum of all the energy required to produce any goods or services, considered as if that energy was incorporated or ‘embodied’ in the product itself.”⁴ This idea has a major impact on architecture in terms of promoting architecture as the exploration of using different materials and design strategy to achieve higher performance of the building itself. We do not see people building new brownstone buildings anymore, instead there are a lot of bold experimental moves in terms of material selection in many recent architectural projects. Architects and builders have begun to think more about how to achieve the best spatial conditions condition with the most environmental friendly solutions as well as the lowest energy cost on site. This is how “Double-Skin Facades” as well as PVC plumbing systems using foam as insulation entered our daily life. So what makes a material good? If it is the properties of being cheap, accessible, sturdy, and light weight... then it seems like plastic just fits them all. And yet some people keep questioning the usefulness of this remarkable material which haven’t been making their way into the main architecture material market. However, there are always great example from the materiality front line using plastic as building material and have achieved many wonderful results.

- Plastic in Architecture

Architecture is a very special in relation to materials because it not only matters to functionality but also relates to the aesthetics of the building in many cases expressing the architect’s original concept. There

are different kinds of concepts can be delivered with different materiality. From solid, transparent and modern to historical. At the same time it is not always about the exterior appearance but also about the interior elements, lighting fixtures and wall finishes as well as the structural membranes. The use of plastics in architecture is a very popular topic with constant experiments in changing the boundaries of building materials with very interesting results, we are constantly challenging the boundaries of materiality for those fields and we have been getting interesting results.

While plastics have not been commonly adopted in building construction in a major way, there are examples of projects where plastic is featured as a major building material. In those projects, plastics has played different roles as the following case studies will show.

1. Case Study : Plastic as building skin

Name: Water Cube

Location: Beijing, China

Usage: Olympic Swim Center

Plastic Usage: Skin & Lighting;

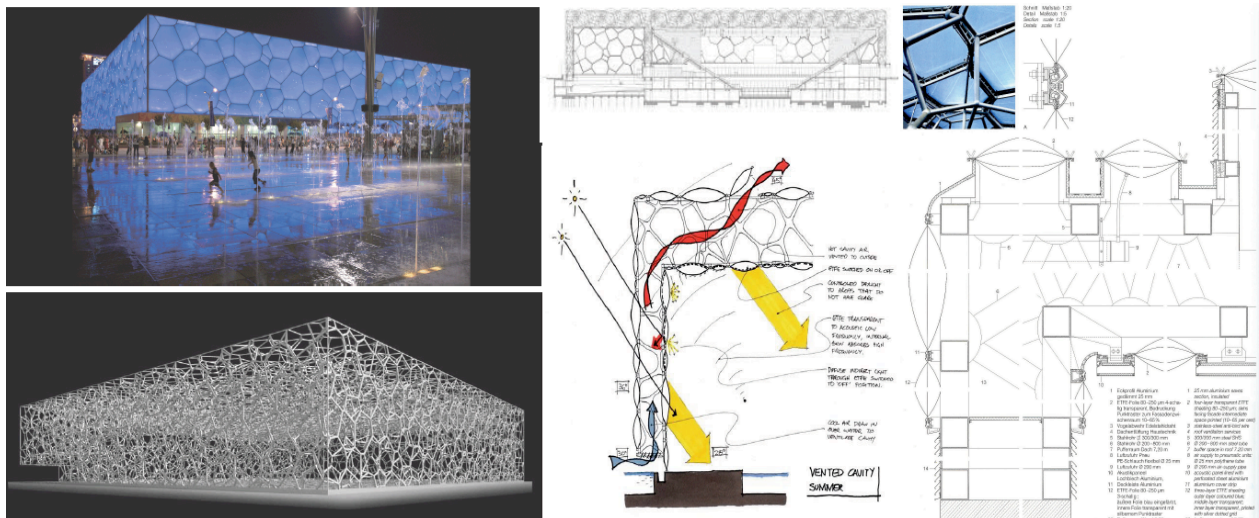
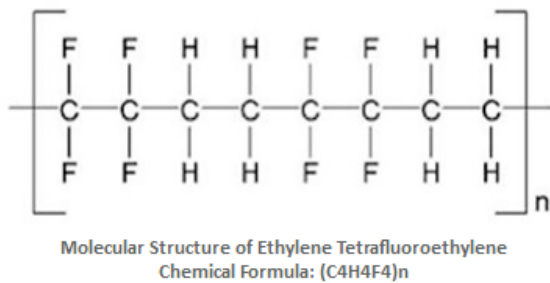


Figure.15

This project was built for the 2008 Beijing Olympic as the National Aquatics Center. It is viewed as a blend of architecture and advanced technologies. It is the first building in the world built upon “the soap bubble” theory¹³, but the most special part in relation to this thesis is that it is based on the use of ETFE (the ethylene-tetrafluoroethylene copolymer) membrane for insulation.

As the detail drawing is showing. This material played the main part of achieving the original concept as “making a bubble house”. It was not only used as membrane but also offers the space and opportunity to create a very magical and dramatic light illusion as the light can hit through the structure and showing on the exterior side of the skin. It is a great of example of how the use of plastic can make a design vision coming into life.



ETFE is also an extension of plastic family, it is structured as the image on the left. ETFE copolymers are basically alternating copolymers, and in the molecular formula, they are isomeric with polyvinylidene fluoride (PVDF) with head to head, tail to tail structure.¹³ As the rest of the plastic

family, it is very light weight and very stable as a chemical product, so it proved to be an excellent material choice for building this iconic building.

2. Case Study : Plastic as building structure membrane;

Name: Suvarnabhumi Airport

Location: Bangkok, Thailand

Usage: Airport

Plastic Usage: Structure;

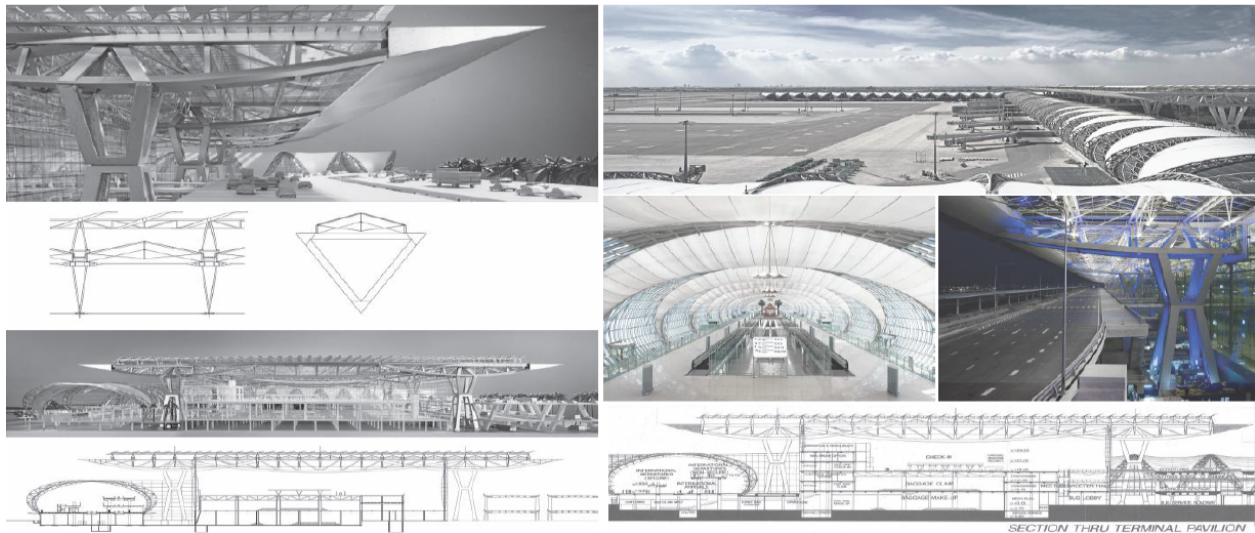


Figure.16

Until recently, multilayered membrane structures were generally designed with added mass in order to meet thermal and acoustical requirements, but this typically also led to a loss of transparency. An alternative solution was explored at the Suvarnabhumi Airport in Bangkok⁶. The concourses linking the main building and the gates are enveloped by a membrane structure with a three-layer assembly specifically developed for for this project. While the outer polytetrafluoroethylene (PTFE) coated glass-fibber membrane controls influences from the environment, the transparent middle layer reduces noise to a comfortable level. Both layers form a pneumatic cushion that improves the load bearing behavior for short-term loads. Thus, this assembly takes advantage not only of the specific behavior of each layer but also of the additional effects of the synergy between them. The radiative emissivity of the micro perforated inner textile membrane is greatly reduced due to a special low-emittance (low-e) coating. With this assembly the required comfort level in the passenger-occupied zones can be maintained, while the building skin remains translucent⁵.

This is another great example that shows that materials from the plastic family can help to solve design problems and fulfill tasks normal material can not. They are not only good at being stable building material but also great at helping architects expressing the original design intention.

3. Case Study : Plastic as building skin

Name: Bloom House

Location: Los Angeles, CA

Usage: Residential

Plastic Usage: Lighting; Wall Finishing; Furniture;

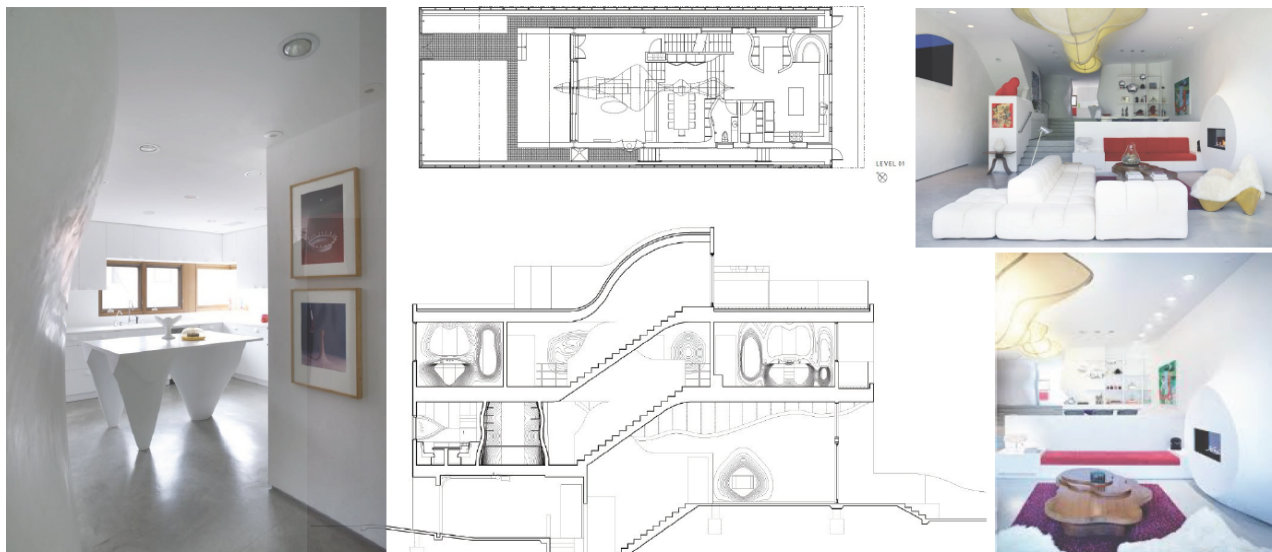


Figure.17

The Bloom House was built in Los Angeles, California. As a single family house, the inspiration came from the approach to molding walls in curves, at the scale of both rooms and furniture. All of the mechanical equipment that was not custom made, including the fireplace, cabinets, lighting, kitchen appliances, and bathroom fixtures, is integrated into custom-shaped surfaces. Inside of the bathrooms and kitchen, all the smaller elements such as sink, mirrors, door handles and even ceilings are custom made to give the space a sense of completion. The very bold design move had given a very high requirement as to the materiality. A great deal of research took place in terms of looking for the right material for this

special project. And eventually the decision came to plastics for two main reasons:

- a. Plastics are very easy to mold into other shapes;
- b. The finish product is very durable and will be able to last as long as needed.

What is very special about this project is that, plastic was being used in several different ways. Wall finish are the first one. This is very effectively done since many of the walls are designed to be unorderly shaped curves. Plastic is also used in the light fixtures that take on the shape of curved walls, The use of plastic for these elegantly shaped ceiling lights keeps the overall structure very lightweight. Last but not the least is all the customized furniture, where the use of plastic has given the designer a lot of freedom to improvise with all the furniture. It would be very difficult to build these forms in more traditional materials such as wood or metal. However, plastic have given all those “crazy” designs possibilities of coming into real life, and they do so in the bloom house. All of the pieces in this house have work very well together, from big to small, they make a very harmonious scene in this highly customized project.

China creates their first 3D printed bridges

POSTED ON JULY 31, 2017



The School of Architecture and Urban Planning at Tongji University in Shanghai has created the first 3D printed pedestrian bridges in China. The two bridges were made of plastic and measure 11 meters and 4 meters long.

With China's latest adventure in 3D printing, they thus join the ranks of other countries who have incorporated 3D printed bridges into their cityscapes: [The 3D printed concrete bridge in Spain](#) and [the 3D printed steel bridge in the Netherlands](#). Created under the "Shanghai Digital Future", a project that is being led by the school, the school is hoping to highlight how technologies today can revolutionize architecture and construction.

Figure.18

4. Case Study : 3D Printed Bridge

Name: 3D Printed Bridge

Location: Shanghai, China

Usage: Bridge

Plastic Usage: Structure, Finish

This project is a great example of human exploration in 3D printing technology. The use of waste plastic as a building material shows that it is very reliable and long lasting.

All those examples above are solid evidence of how plastic is moving into the architectural market. They show that there are a certain amount of projects out there testing this product for us, and have been getting great results.

- Plastic Itself and Potentials

Every step in the history of contemporary plasticity is full of accidents and reversals of fortune between plastic as material and plastic as concept. Architects/artists discover plastic on their way to looking for something else.⁶ Just like how Marco Polo found China.

Although, we have been very experimental about plastics in architecture, there is one more very special quality about plastics, we have not been fully taking advantage of, yet. – The fact that they are very light weight, they float on in the water, and remain very stable for hundreds of years even with no maintenance at all. For any structures around the water or being adjacent to the water, they are a great choice as material for foundation.

The following chart (Figure.18) shows the density of different kinds of plastics as well as water, it shows that the density of Polyolefins are all smaller than water (1.0g/cm^3). Which giving solid evidence for the ability of plastic to float on water.

Density of Common Plastic Resins:

Plastic Resin		Density g/cm^3 at 70°F
POLYOLEFINS	PP (polypropylene, #5)	0.90
	LDPE (low density polyethylene, #4)	0.92
	LLDPE (linear low density polyethylene, #4)	0.92
	Mid-density polyethylene	0.94
	HDPE (high density polyethylene, #2)	0.94-0.97
Water		1.0
Nylons		1.02-1.14
ABS (acrylonitrile-butadiene-styrene)		1.05
PS (polystyrene, #6)		1.05
Polycarbonate		1.20
PVC (polyvinyl chloride, #3)		1.29-1.44
PET, polyester (polyethylene terephthalate, #1)		1.38-1.39

Base on the Buoyancy Formula⁷:

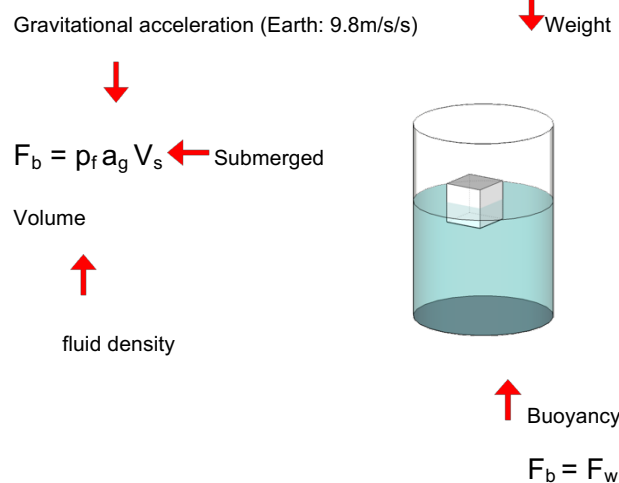


Figure.19

From this calculation it is clear that if a piece of plastic block is 10ft by 10ft by 1ft, it will be 92% in the water and 8% floating out of water. However, it can do even better than that because if air is added inside the plastic block, this move will be able to lower the average density of the plastic block significantly.

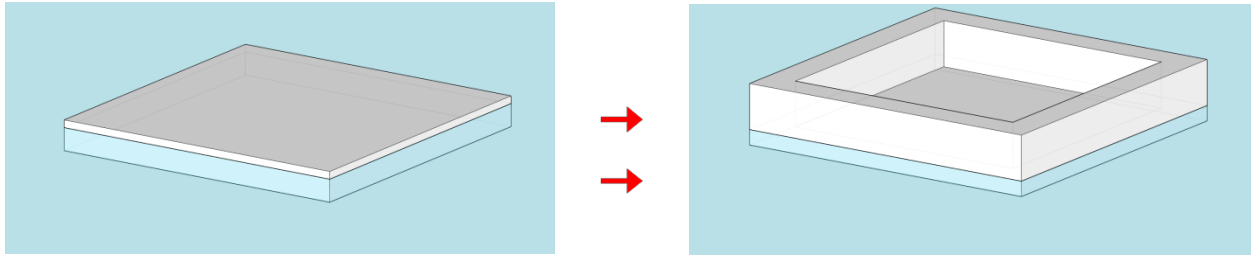


Figure.20

Just like the plastic water bottle, the more air is inside, the better it floats. This is because of the average density of air is at $1.225 \times 10^{-3} \text{ g/cm}^3$.

With further calculation we will be able to calculate how much weight this plastic foundation can hold on the water, because the buoyancy needs to be bigger than the sum of the weight of the foundation itself plus the dead weight (architectural materials) as well as the live weight (potential maximum human weight).

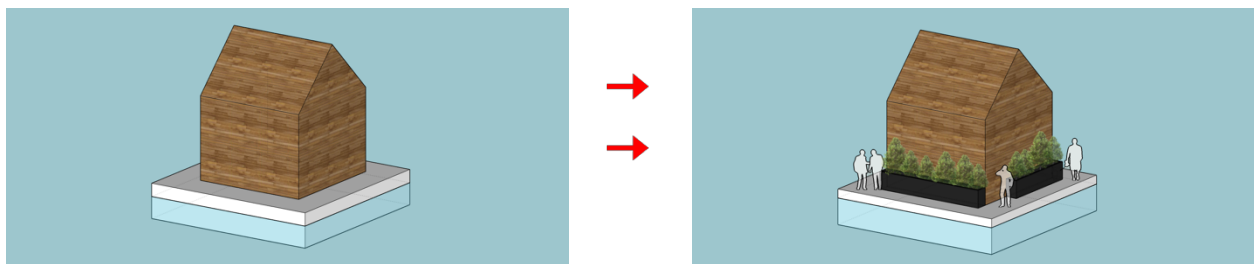


Figure.21

- Plastics and Hopes

Due to its location Seattle is facing the global warming and sea level rising situation, as the sea level raising map is showing. Currently there is much land in the area that collating from 3-15 feet above from the sea level, in the next 200 years, it will be a challenge for the city of Seattle to keep those lands

available. The task is out there waiting for us to come up with creative but effective solutions. Rethinking the use of recycled plastic is the beginning of one of the potential solutions for this problem. This seemingly bold move will resolve many of the conditions faced by structures adjacent to the water. Even if they are buried in the soil, we can still expect them float up when the water raises.

However, with this technology developing day by day, we are still seeking for an opportunity to show the world that plastic can be trusted as a very stable building material. This thesis argues that the demonstration of plastic's effectiveness needs to be both educational and experimental. Thus the selection of the site is based on the desire for high visibility and plenty of population flow for this special program.

At the same time, being able to host students and conducting research purpose would be the most idea situation, because what we need is not only update recycle plastics to reuse plastics, we really should be able to express this idea to as many people as possible, especially young people. The goal is to get them to remember, to learn, to keep this idea in mind and show as many people as possible as they grow up and starting spreading their ideas to more and more people in this world.

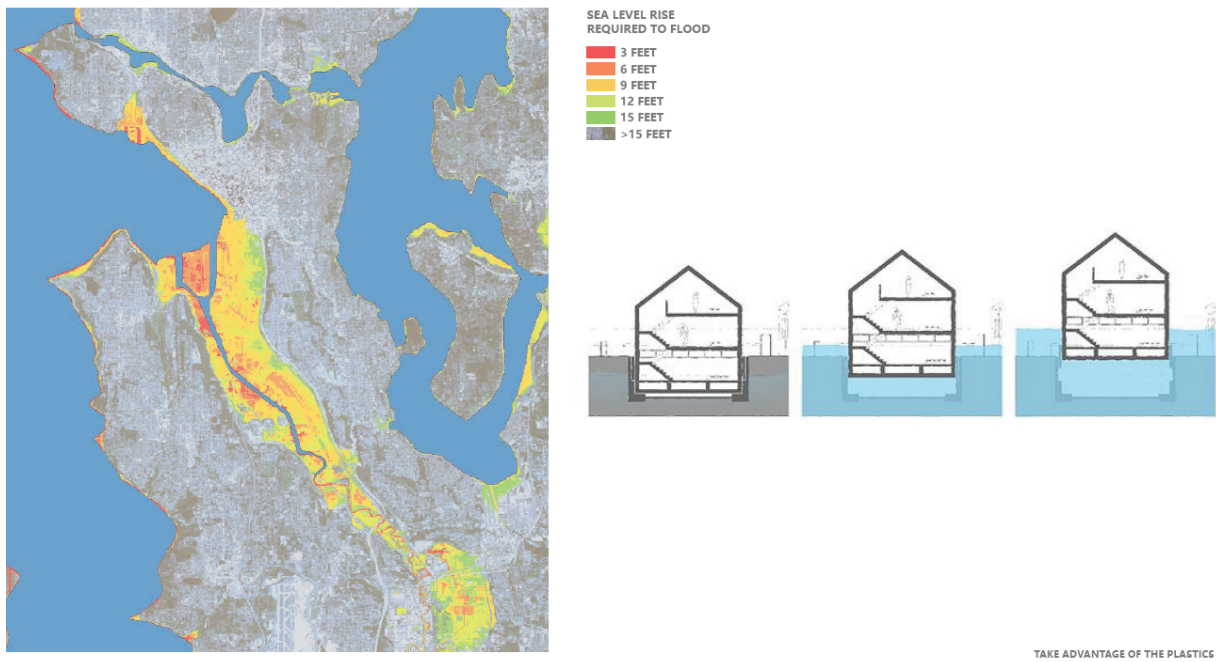


Figure.22

Chapter 3: SITE SELECTION

- Culture of Floating Homes

Floating homes are more than just a type of construction. It represented culture of a city. For decades it is a solution for flooding and taking advantage of the coast lines and crowded cities¹¹. It was a revolution change for the housing types.

Seattle serves as an excellent example where, first floating home was built to house the workers of the logging camps. One-story buildings called Crude, were built on rafts to follow the logs down the river. Later in the 1920's some houseboats were built as permanent homes for men who lived from the water: fisherman, boat-makers and a few bootleggers and other questionable types thrown in for color. The

“Classic” houseboats were born in the 1920s, characterized by their round “sprung” roofs and built with craftsmanship of boat-worker ¹².

The real explosion of houseboats in Seattle started in the 30s, some of the house boats which were built at that time still exist until today. It was a blooming season for houseboats in Lake Union, Seattle. Over 2000 houseboats were built by the end of the 1930s. With the end of the depression, the people who were living in the houseboats began to change. The respectable poor of the 1930s were replaced by a more Bohemian crowd, who pursues their life without - or with little tolerance of – either government intervention or the usual social conventions. However, in the 1950s, current government decided that this restless group has to go. They were in the business of cleaning up city slums with urban renewal funds, and the houseboats, those dwelling units on the water were high on the demolition list, and since then, those original houses were to be replaced by over-water-apartments or businesses ¹². Government projects were encouraged to build wherever there were houseboats docks ¹².

- Lake Union and Floating Homes

Lake Union has been famous for the culture of floating homes since the 1920s. The revolution has been going from private homes to government buildings and to business buildings. It is a portrait of history in the past 100 years. Looking at lake union today, there are all kind of buildings there. As the map (Figure.22) below is showing, there are around 450-500 floating homes currently floating on the lake. Most of them were built from the 20s-50s. they have carried a long history and revolution of the city. However, from July 1, 2014, a regulation from he government of Seattle have been published to limit residential uses on the open water. As a part of the updated Shoreline Master Program, more floating structures are not allowed to be built as residential uses after July 1, 2014. ¹⁴

But, those current floating structures have been soaking in the water since the 20s, a lot of them need replacement and renovations. Which means, there are a lot of work coming up to update those current

floating structures, and what should we be doing is a big question that have been raised at this point of time. There are many problems with the current floating structure being used:

- a. Light blocking for the eco-system underwater, as many kinds of fishes and plants needs light to grow and reproduce. And the current floating structures just totally blocked lighting for those creatures;
- b. Current structure has been heavily involved to wood. Even if wood is a very common and widely used material for the Pacific North West. The still will need replacement or renovations every now and then. A more long-lasting material would be a better solution for those floating structure owners;
- c. Current floating homes are taking over the areas that is close to the water, which means, all of those beautiful docks are not open to public. Seattle is a beautiful place and everyone should be able to take advantage of the magnificent nature condition in this land. It would be great to give more opportunities for everyone to get close to the water and maybe park a kayak;
- d. As the population blooming in the Greater Seattle Area. Single families on the land has merged to row-houses and town-houses and even apartments for higher efficiency. And yet those floating homes on the water are still in the old-time style with very low density. It would be a great chance to update the housing layout as updating the floating foundation and put a higher density housing layout on site for the need of housing in Seattle area;

- Floating Foundation Evolution

There are two generations of floating foundation so far, every time there is an evolutionary change, it always must reflect on materiality.

In the late 1920s. When floating homes are blooming on lake union, those floating foundation were using log as the floating element. It is very conveniently built also has very sufficient material choice. However, wood is not known as an ever-lasting material choice, especially when it is soaking in the water. They get

old and will need replacement every couple decades. Also, there won't be any light passing through the foundation. Which mean fishes or plants down under are not receiving any lighting, and it is not a great result.

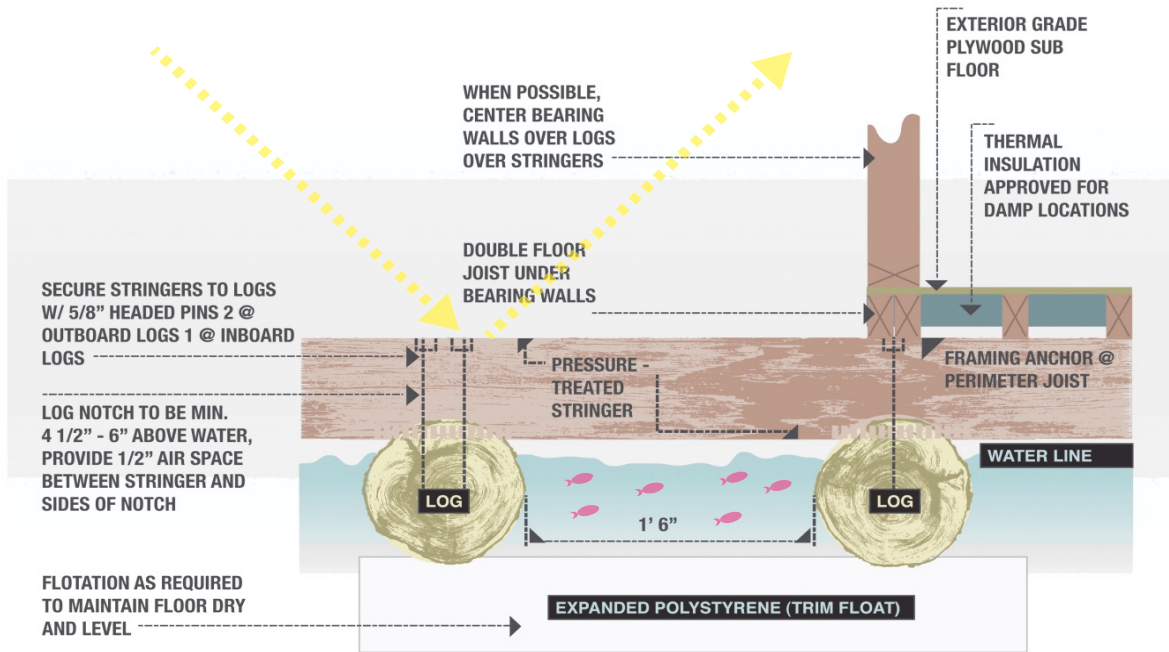


Figure.23

As the old floating homes getting old and need constant renovations, a new generation of floating foundation was invented and putting into uses on the water, with an evolutionary materiality change, and this material is known as concrete.

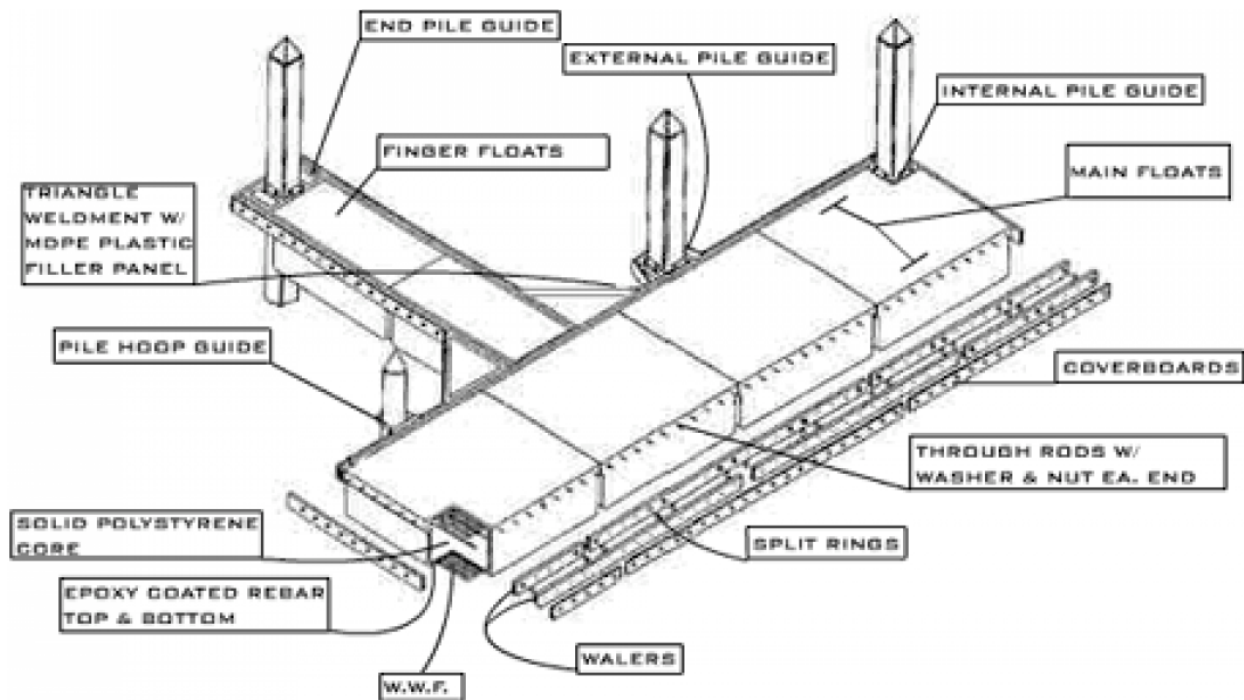


Figure.24

As the diagram is showing, the second generation floating foundation started to take advantage of a second floating element. As air has extremely low density compare to water (0.16:1), by sealing big percentage of air inside of the concrete blocks, it achieves great ability of floating and stay very stable for a very long period of time as it is made by concrete. It did solve one of the problem that log can not reach, but light still can not passing through the heavy concrete foundation, even if sometimes we leave openings on the dock, it still make a huge difference than having all light passing through the floating structure. And this is a very significant issue for us to address in the future.

As the quality and the quantity of lighting both have an impact on fish growth, 'Receptivity' of fish to light profoundly changes according to the species and the developmental status.¹⁵

- Site Selection

Lake Union is a very important part of the greater Seattle area. This project has focused on lake union area as it is on of the historic sites for floating structure. There are people from different generations built floating homes with technologies from different generations. On lake union within the couple miles you will be able to see human intelligence evolution through the histories.

There are currently around 450-500 floating structures as residential uses floating on lake union area. Most of them are single family housing. With either log or concrete as foundation. Those homes are mostly single family housing, with no public space, still pretty big foot print each house. Which maybe a waste of space at this age of time as Seattle is blooming in every way.

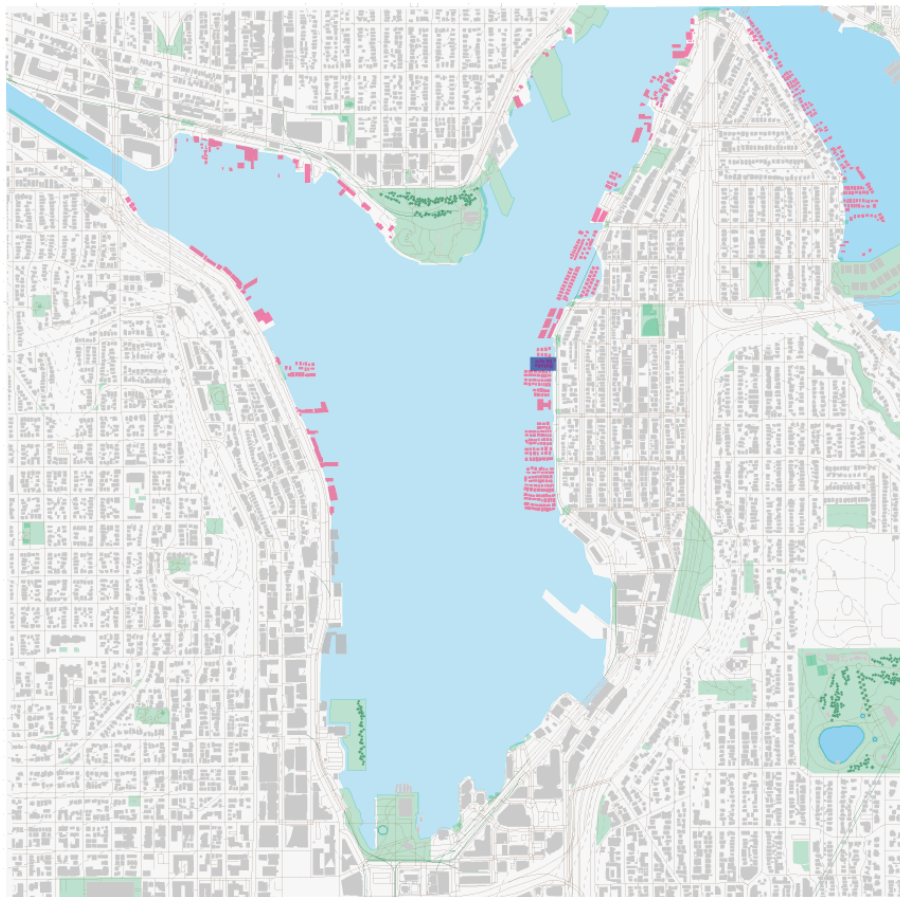


Figure.25

- Design Concept

There are a couple things to address through this project that have shaped the design strategy:

1. The very first is about celebrating the materiality. As the possibility of making a building out of plastic is an unknown, there are a lot of spaces for us as architects to explore on the front line. On that note, this project is experiencing a mixed language with curves and straight lines as well as molding all furniture and facilities into the building;
2. The second design concept is about a revolution to the public realm, the definition of where it should be and the clear separation of residential use and public use will be challenged. As the current situation is we are not having enough public docks on lake union and it is hard for people who does not live right by the lake to get anywhere close to the water;
3. The third part of the design concept is about: by using plastic which can easily be translucent or transparent, to shape a much more harmony relationship between human beings and under water creatures. Creating very friendly interaction between different species, with respect and more explosions. People who decide to live on the water will be able to live a brand new live style as being able to see what is actually happening under the water without disturbing them on daily basis;

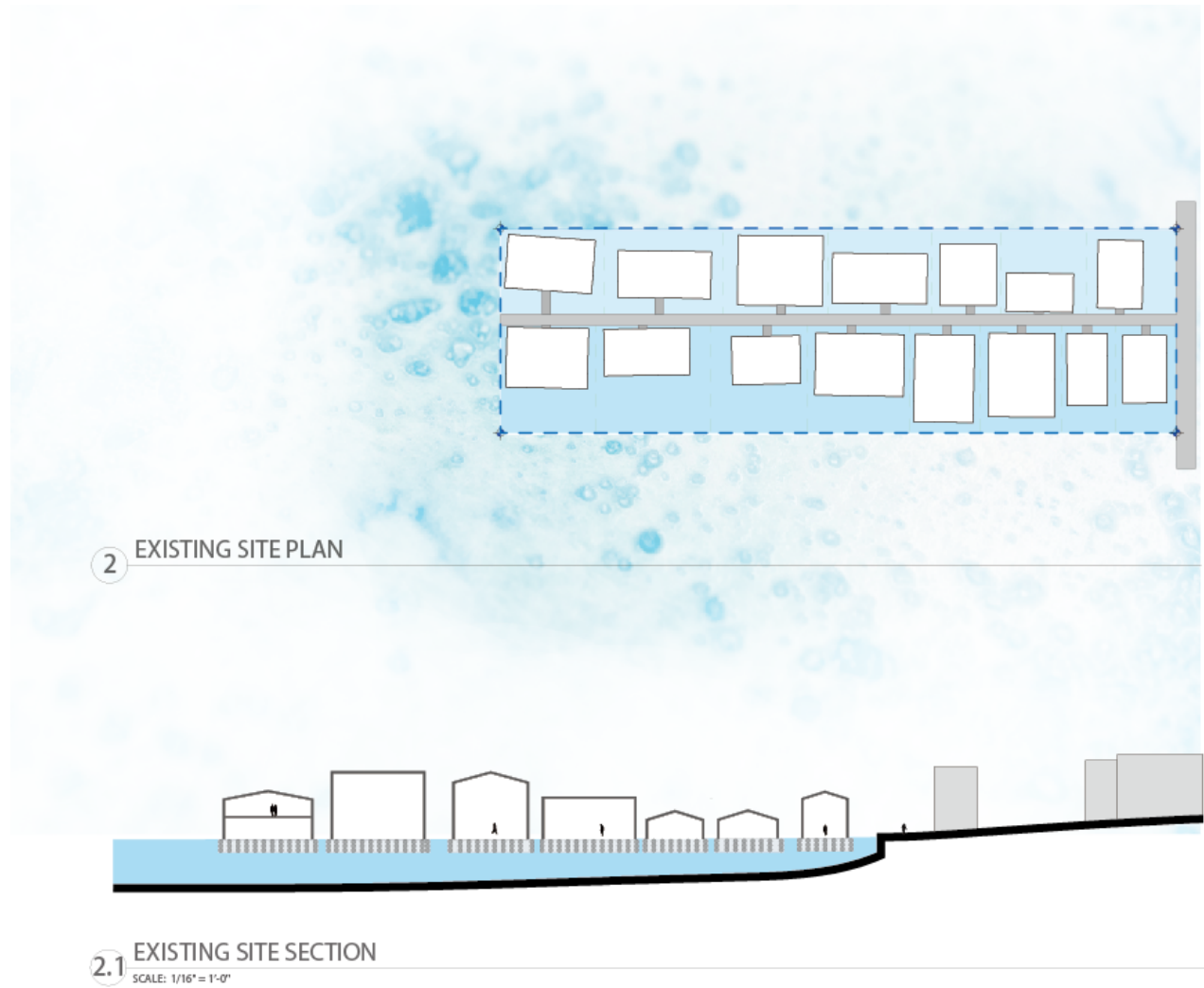


Figure.26

Chapter 4: Current Site Break Down

- Location and Current Condition

The site is one of those lots on the water locating on the Eastlake side of lake union. Currently with 15 single family housing and one private walk way to the units, besides that there is no public space no public amenity space or parking; also there is not green space on site.

Current floating foundations are all log foundation. As we know there won't be any lighting passing through the foundation also, the interaction between human on the foundation and fishes in the water is awkward.

Also as a site locating at Eastlake, the density of the housing unit is comparably very small, which means the land was not used very efficiently. As the row-house and town-house trend is expanding on the land. It is very necessary for structures on the water to adopt and react to this trend and merging it to the new constructions. So that we can offer more housing to the greater Seattle Area, especially around lake union. If you think 15 units cannot make too much of difference, there are 450-500 units totally just in the area, and if we can double or even triple them, it will become a huge impact on the housing market in this area.

Chapter 5: Design and Extension

-Residential Unit Density Update

As the proposed site plan is showing, the proposed condition has 39 units on site. Unit type varies from one bedroom to two bedrooms, besides from offering higher density housing, it gives opportunity for different families to find dwelling opportunities in this community. As the residents in this area has been changing from Seattle local families to younger generation people who works in downtown or Belltown. Often time single or newly married hoping to have kids. One or two bedrooms will be perfect family size for those new families or singles ready to start having a family.

At the same time the land use identity has changed, the public dock has become a public used dock with an access to a generous public space at the water front. For the use of offering people more chances of getting close to the water, also providing a chance of offering kayak parking to the public with a inviting gesture. Besides that there is one private dock on each side of the residential units rows. Offering private amenities to residents who is living here, give them a more private experience with water and nature.

Landscape elements are introduced into the site, molding into the casted plastic docks and walk ways. By using plants that is water friendly or preferring living on the water, it can create a more comprehensive eco-system. Also the translucent walk way and public docks will let more light go through the site.

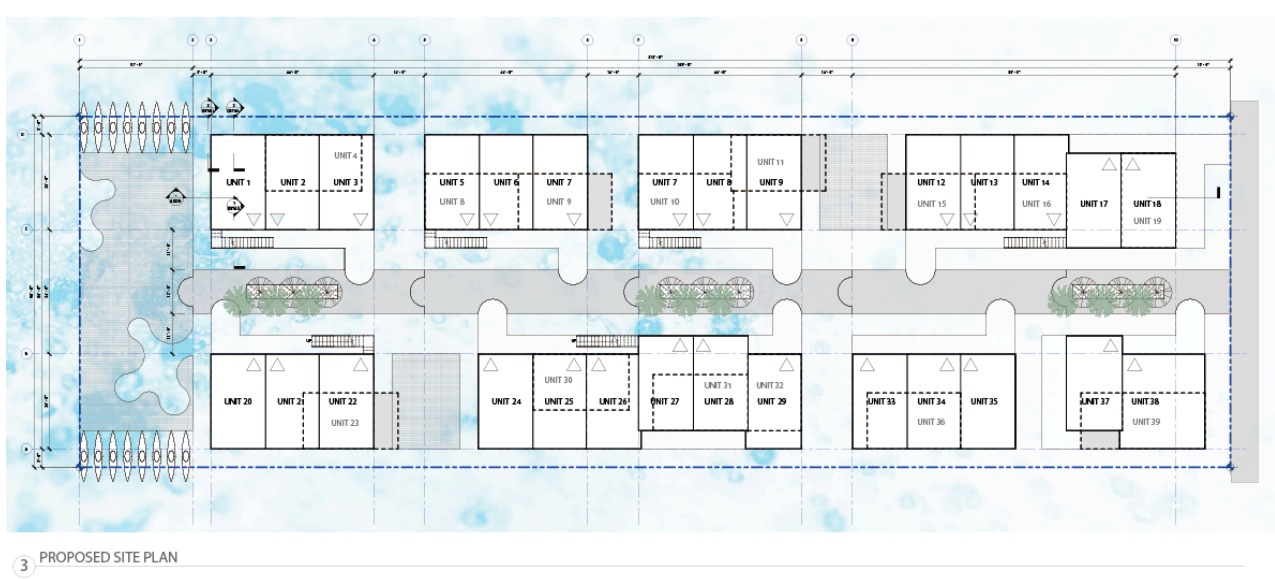


Figure.27

-Floating Foundation Update

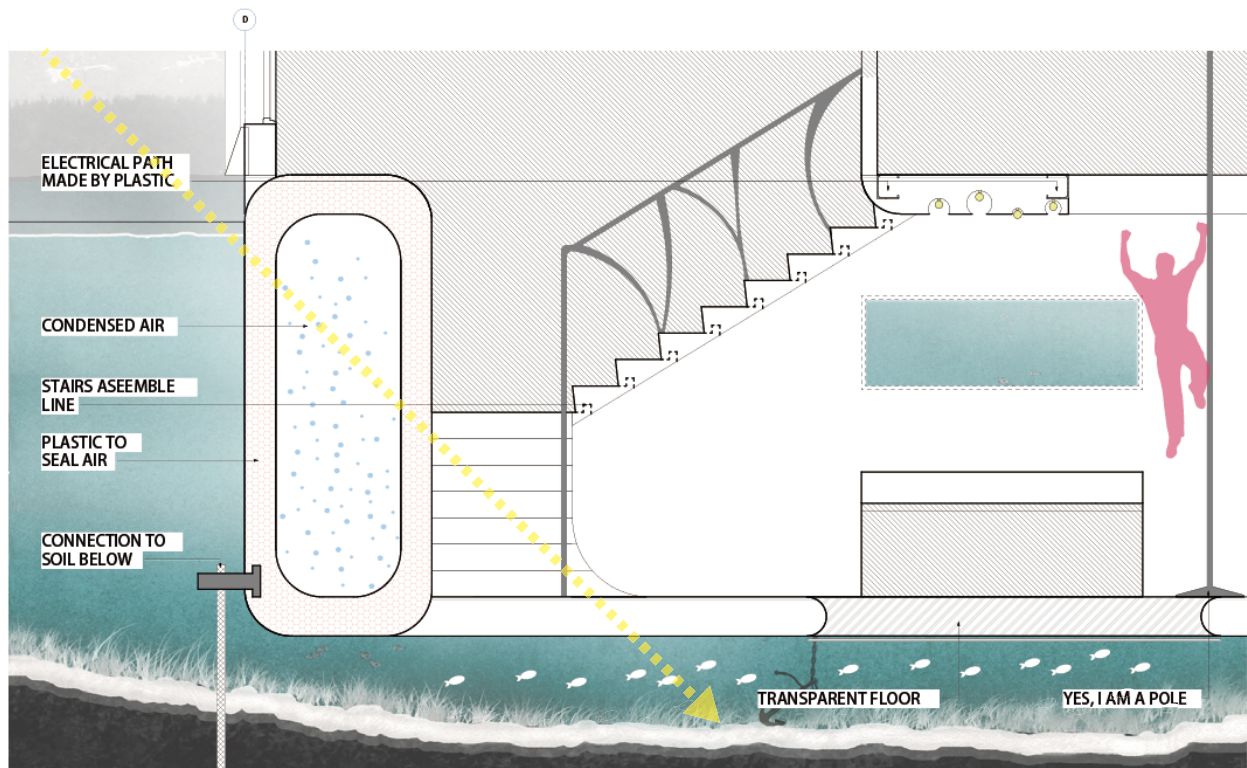


Figure.28

The new proposed floating foundation is a little bit similar as the second generation floating foundation made by concrete. They are both taking advantage of the low density of air, by sealing air inside, enhancing the buoyancy ability. However, the first change is to replace concrete with plastic, for the reason of stability and even lighter as a material. Besides that the foundation won't be the only part being molded. As a matter of fact, the whole house will become one whole element, each element is well planned not only serving as it was designed for but also as a molded furniture. For example, the foundation that stocking air is also a part of the stairs.

Besides that, as the diagram is showing. Lighting can easily go through the unit hitting the bottom of the lake. And that will be the biggest advantage of the newly proposed foundation type.

-Plastic Details Extension

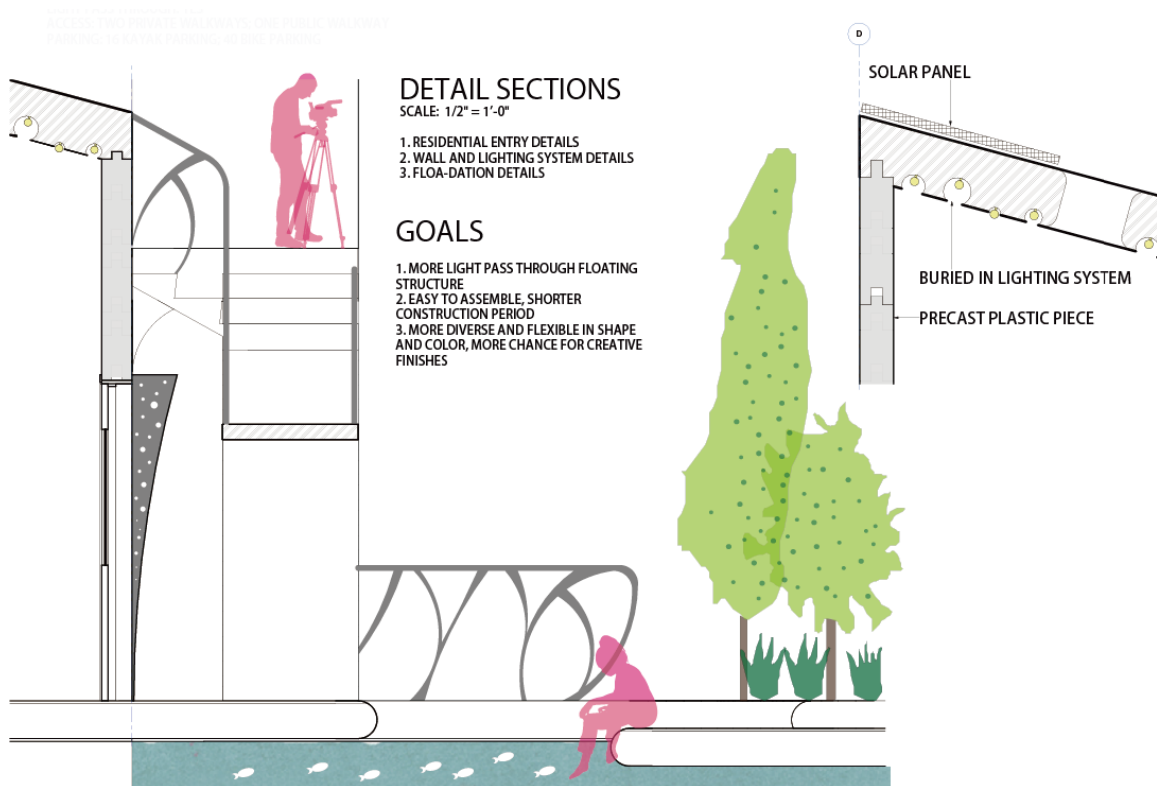
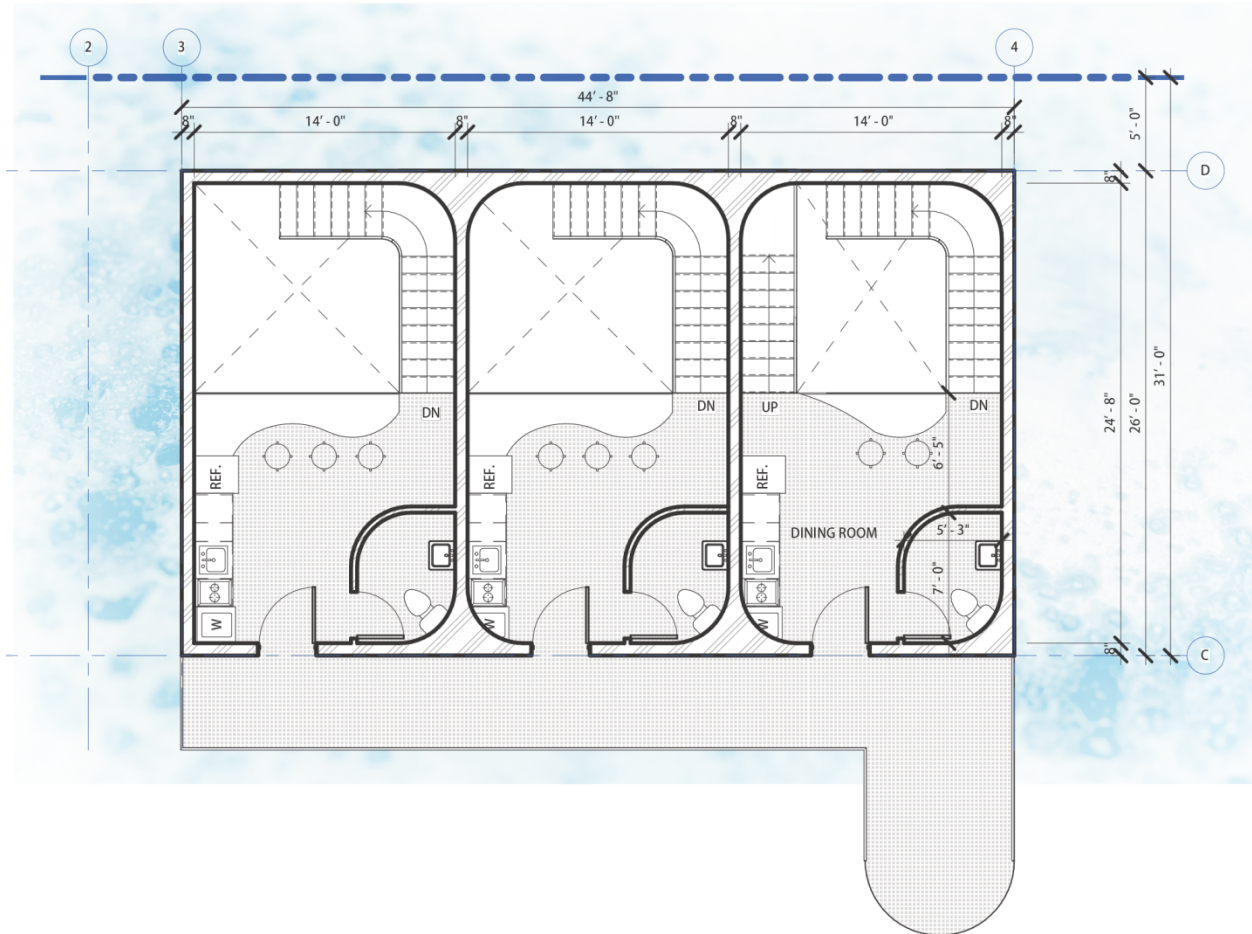


Figure.29

There are two more details that are very important to the design strategy:

1. How the pieces come together. It may be too big to 3D print the whole unit. However, if the unit is printed piece by piece, they can be connected together by mortise and tenon structure. Just like the first detail is showing, those separate printed elements can easily being assembled together on site;
2. As the second detail is showing, the lighting fixture can be buried inside of the ceiling or inside of the wall, aside of creating more lighting possibilities it gives more dramatic lighting effect. Also openings can be more flexible as well, it can happen in more places also in uncommon shapes such as circle or any curves. It will be a great chance for more design opportunities and elements coming into those floating homes.

-Typical Unit Floor Plans

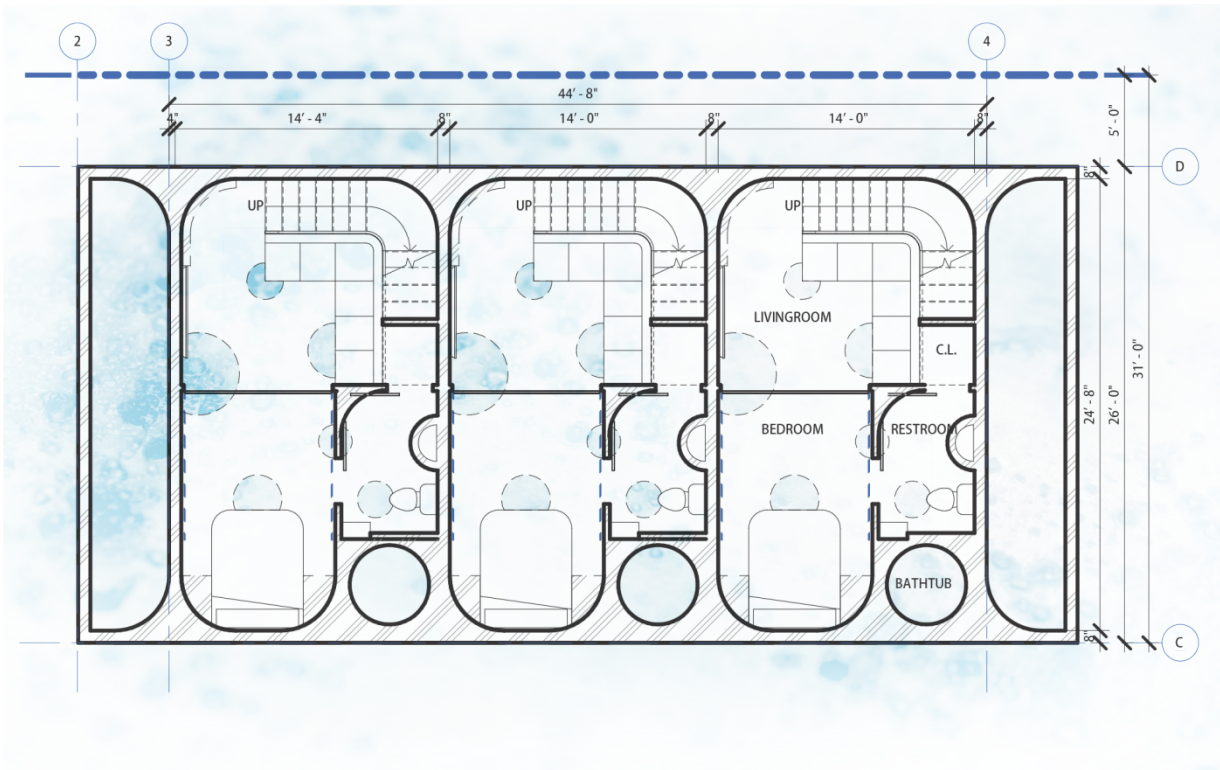


4.2 FLOOR PLAN - LEVEL 1 PLAN
SCALE: 3/16" = 1'-0"

Figure.30

The typical unit has three dwelling units. Two one-bedroom units and one two-bedroom unit. The entrances are on the ground floor.

As the the ground floor plan is showing, there is a dining area on the ground floor, with a guest bathroom and a dining table, there is a fairly large over height space to allow a lot of light passing through to the basement which is mostly under the water. Also there is a shared hallway space in the front for people to hang out, and living their social live at.

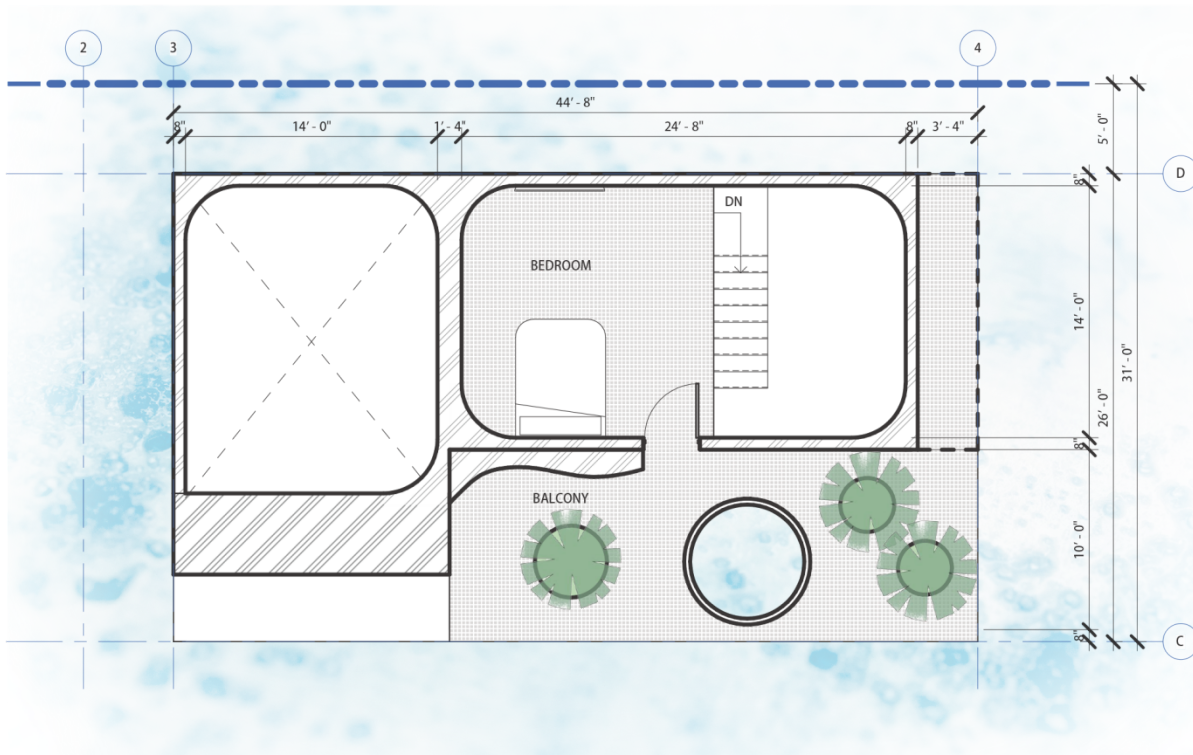


4.1 FLOOR PLAN - BASEMENT PLAN
SCALE: 3/16" = 1'-0"

Figure.31

The basement is sinking under the water, with a overhead living room space, master bedroom and master bathroom with molded bathtub and a walking closet,, it offers an opportunity for playing with transparent and translucent floor materials, and gives residents a chance to stay intimate with what is happening underwater in a very settle way.

Curves are introduced into the space as a leading language, as furniture are molded in place as one piece, totally embrace the idea of 3D printing which is able to achieve many more complicated shapes or finishes that traditional furnishing cannot competing with, creating a very modern and minimum sense of living experience as well as making the best of the very limited living space.

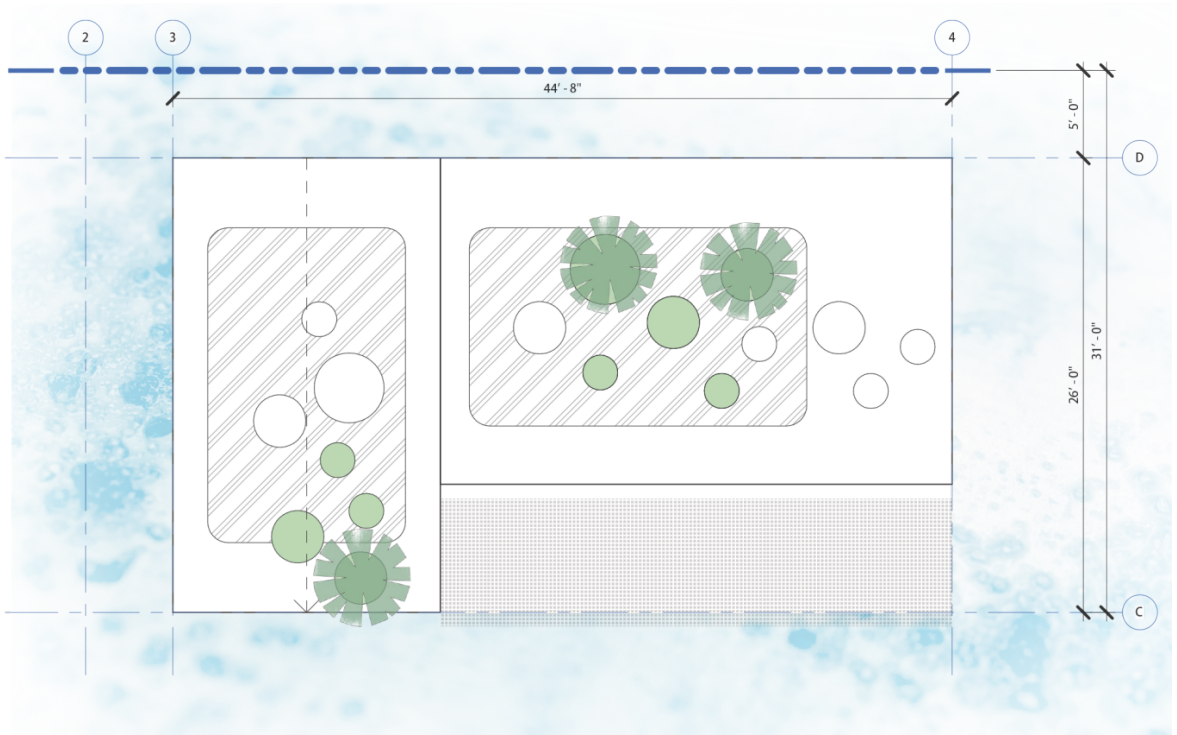


4.3 FLOOR PLAN - LEVEL 2 PLAN
SCALE: 3/16" = 1'-0"

Figure.32

As the second floor plan is showing, there is only one of the unit has a second bedroom on the top floor. This unit is designed for bigger families with young kids. It also included a lovely and very generous balcony for families to spend their time on. There are green spaces and a hot tub on the top of the balcony. It was be very lovely to stay in the bath tub at night all year round, watching the people on the dock or what is going on in the lake, or just enjoying a quiet moment by yourself.

There are many openings on the roof, allowing light passing through, also giving people opportunities to climb on the rood with a ladder. The circle shape can be openings or become green space on the roof. Collecting rain water and offering more green and a sense of alive in this project.



4.4 FLOOR PLAN - ROOF PLAN
 SCALE: 3/16" = 1'-0"

Figure.33

-Character Renderings



Figure.34

Image – 1: VIEW FROM STREET SIDE OF THE PROPERTY LOOKING AT LAKE UNION

Walking from the land side of the property to the water, the view shows the floating structure with a big public dock filled with people, life and planting. The buildings are regularly shaped with curved finishes, smooth and light and large, irregularly shaped windows.



Figure.35

Image – 2: VIEW FROM SPACING INBETWEEN THE UPPER FLOOR UNITS

This view shows the experience from walking in between the units. Seating and windows as well as the lighting fixture in the wall are all molded, also this image is showing the special quality and relationship between the public spaces and private spaces.



Figure.36

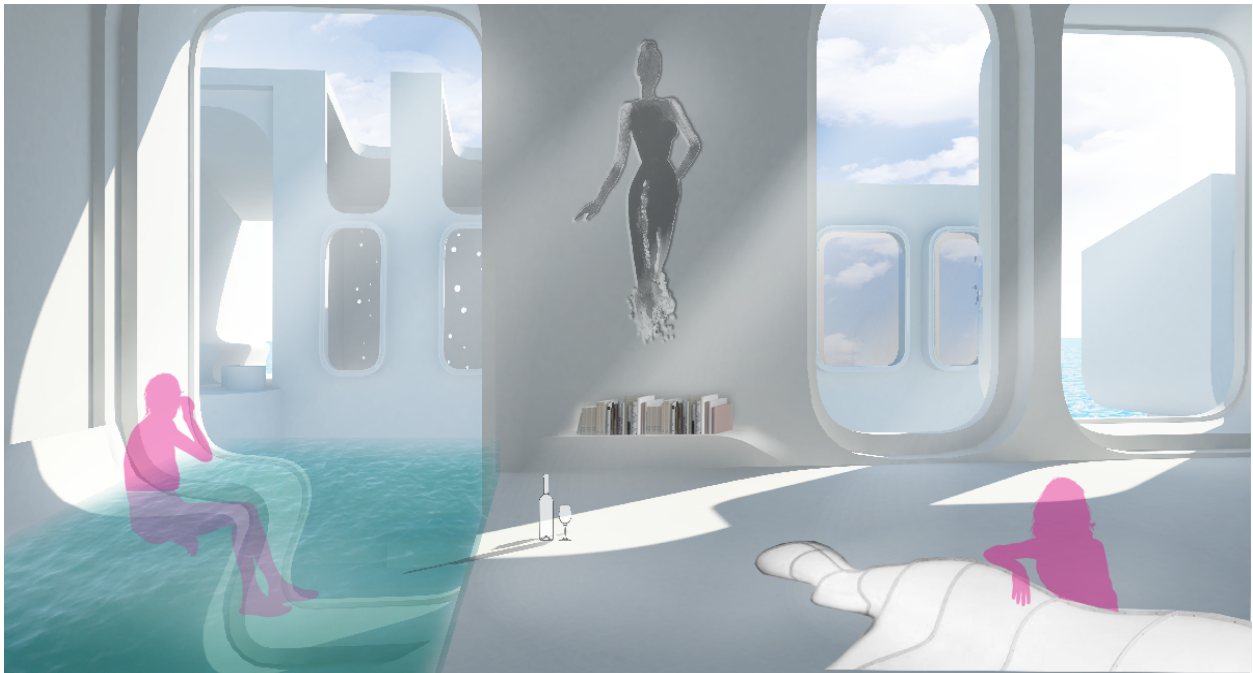


Figure.37

Image – 3&4: VIEW FROM INDOOR UNITS LOOKING OUTSIDE; VIEW OF THE MOLDED INTERIOR SPACE

Image 3 and 4 show the interior quality of the units. Furniture is all molded on site, including chairs, sofa, cabinets and even the decorations on the wall can be 3D printed with the house. The idea is that the owners will get an interesting experience to get involved in the early design process and print their favorite arts and furniture styles into the house they are going to live in. Also with plastic waterproof material, swimming pools can be brought into the house and residents can even sit in the water.

Also the lighting condition is a key point of these two images, aside from taking advantage of the natural light by having openings on the roof with less constraint. It will be possible to 3D print lighting fixtures with the house or bury the lighting fixture inside of the wall or ceiling. Giving an interesting interior lighting character to those units.



Figure.38

Image – 5: VIEW FROM BALCONY LOOKING TO THE PUBLIC WALKWAY

This image illustrates the experience from the roof top looking to the walk way and the public dock, it is showing the relationship between private life and public activities. The space creates the feeling of a very safe and dynamic community, with very warm and smooth lighting, the nights being very nice if you can spend them in the hot tub with a glass of champagne.



Figure.39

Image – 6: VIEW FROM LAKE UNION LOOKING AT THE PROJECT

This image is showing this project from the the perspective of someone on the water, if you are on the water at night, taking a short ride with your kayak or paddle board, you will be able to see this project glowing on lake union, with light being able to pass through the floating structure, it feels very heart warming and peaceful.

This approach is offering people more chances to get intimate with the water in a very friendly and less aggressive way compared to what we normally do. The goal is to create a harmonious relationship in between human, plastic and the world under the water, extending activities all the way from the land to the end of the public dock.

Chapter 6: Conclusions

I am so much more aware that of that this thesis is a highly theoretical hypothesis. The intent is not to offer a practical solution but propose an architectural approach to the problem of waste plastics in the environment. This study has sought to bring together many different subjects from chemistry to architecture, engineering and environmental science.

This project has been created in the hope for positive and good solutions to this very large problem. Plastic has been created in the hopes to make life better for humans. Society has benefited from this progress but at the same time has created many more problems for the creatures living with us on this planet. This is not just one problem that someone or one business can resolve. It takes all of us to work together and address this very pressing issue for our descendants. This thesis has aimed to take advantage of what plastic is, collecting waste plastic, and preventing them from going into the ocean

killing sea animals. Recycle as well as reuse, I believe we will be able to come up with better solutions for our future.

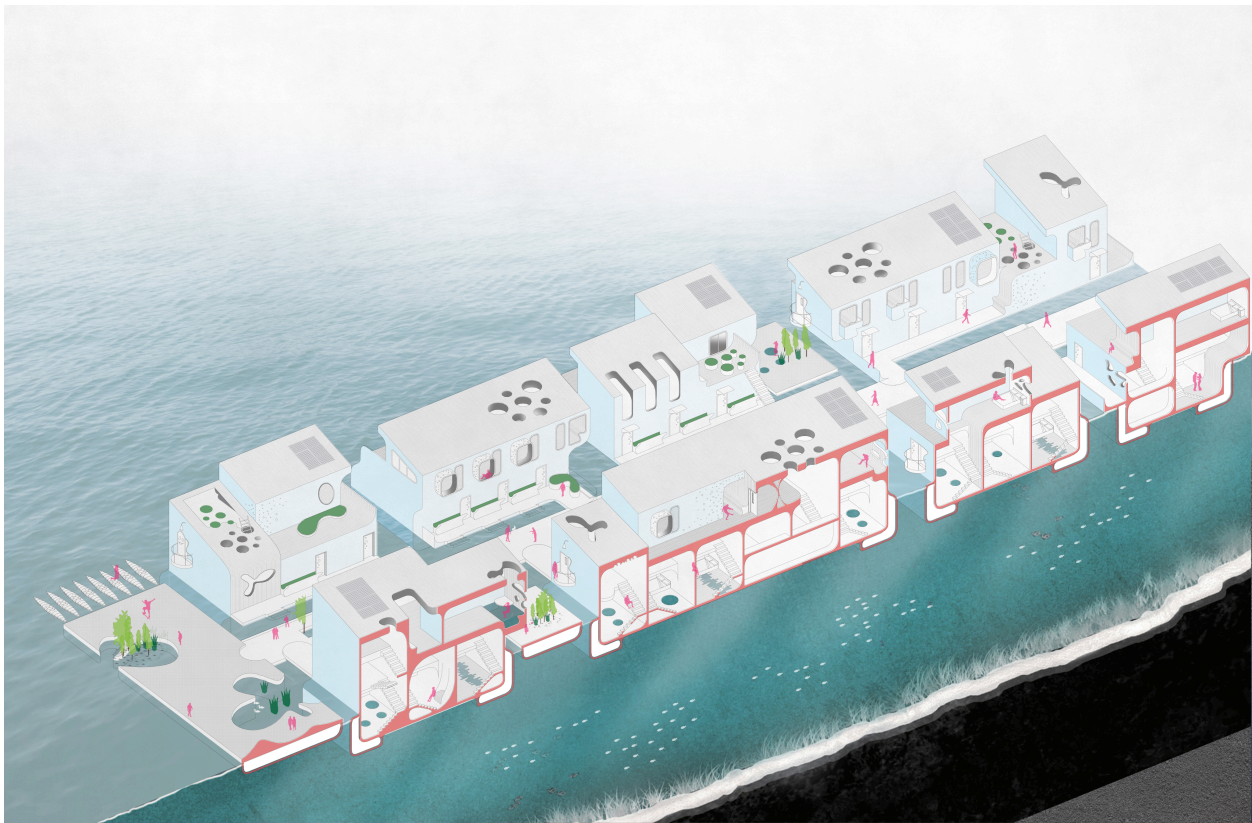


Figure.40

- Plastic and Housing

Society is currently producing over 4 metric million tons of plastic wastes per year, a tremendous number that cannot be ignored. As population keeps growing everywhere, we need more and more housing and human activity spaces. If plastic can be apply as a general architectural material, we will be able to take advantage of the stability and quantity of this material as well as its flexibility and create many more iconic architectural art work with less constraints than traditional materials like brick and concrete. Instead this plastic architecture will become a celebration of building forms and architectural lighting conditions. Even more, it can be an new era for building code and construction technology to update and move forward. Especially if the facilities can be molded into the building, the boundary of engineering and architecture will be changed again.

- Plastic and Sea Level Rising

As plastic floats on the water, it can bring about a brand new chapter for sea-level rising strategies. The newly built structures can react to the rising sea-level and floats up as the water level changes. It would be a evolutionary change to this unavoidable nature disaster which is slowly happening.

As the Seattle flood map shows, many land areas are in danger, especially in the south Seattle area, most lands only needing 3-5 feet of water to start flooding, which may happen slowly in the next 100-150 years. And we have to start thinking about strategies now starting from fundamental facilities. Plastic building foundation is one of the solutions that we are capable of working with.

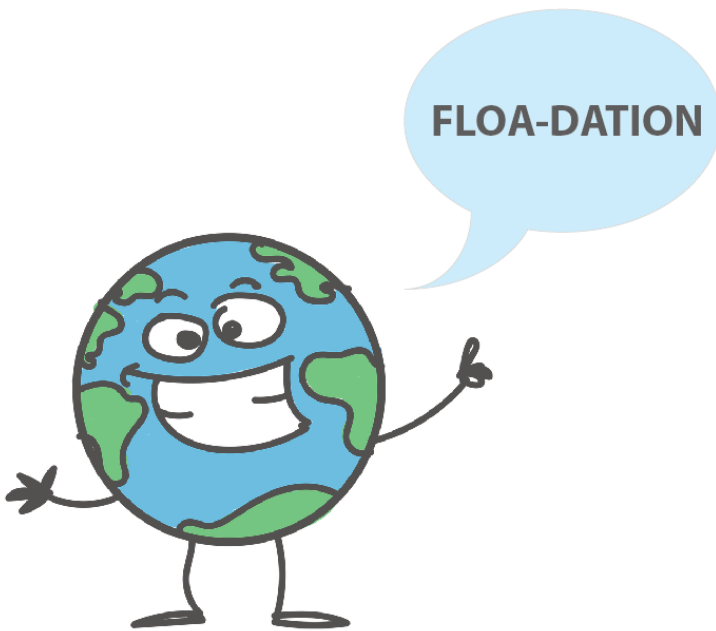
- Plastic and Under-Water Eco-System

Seattle is definitely not the only city that contains a tremendous amount of floating structures, many older cities near water have this floating history. However, those old structures are somehow hurting the eco-systems down under. By using plastic which can enable a new approach to let light pass through the building on the water. With the flexibility of controlling light, it will be a better consequence for the under-water eco-system.

- Plastic and Us

Human society has invented plastics and our faith in this technology has brought about good results. This was true until plastic began to harm us. It is important for us to understand the power of plastic, using plastic as a building material will be a great education for us and our child to understand the beauty of this profound material. To understand how much of a double-edged-sword it can be that something beautiful can be dangerous and we need to be smart and creative about solutions, and understand the basic science of plastic and embrace it as a challenge and opportunity.

All in all, I hope this project is able to draw more attention to plastic, to plastic wastes, as well as the relationship between human beings and plastic. We need to understand more to not be afraid; learn more to be able to taking advantage; embrace more to be able to connect. In this way then things do not rule us, we rule the things.



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