LIVING WITH WATER
- extend urban life of Galveston City onto the water

Delft University of Technology
Master Architecture
Studio Delta Interventions
Graduation report P5

Student

Fangfei Liu
student number: 4300505
e-mail: levmoy@hotmail.com
telephone: 06-59543297

Mentor

Architecture: Anne Loes Nillesen
Building Technology: Koen Mulder
External Examiner: Jan Jacob Trip, Ivan Nevzgodin

Cover photo

James Nielsen
Houston Chronicle, 23/09/2013. Galveston
Moore's bronze sculpture for the victims and survivors of the 1900
Storm on Seawall Boulevard.

June 2015
CONTENTS

Report structure

Chapter 1 Delta
1.1 Galveston bay introduction
1.2 Hurricane
1.3 3X3X3 mapping
1.4 Why Galveston city

Chapter 2 Galveston research
2.1 History of Galveston city
2.2 Two boundaries
   2.2.1 Sea wall
   2.2.2 25th street
2.3 Intersection

Chapter 3 Urban design
3.1 Urban & Water research
3.2 Position/proposal/urban scale research question
3.3 Urban design strategy
3.4 Urban design
   3.4.1 site study
   3.4.2 historical buildings
   3.4.3 sea level study
   3.4.4 function design
   3.4.5 master plan
   3.4.6 urban design fragments

Chapter 4 Architecture
4.1 urban center design
   4.1.1 site study
   4.1.2 site plan
   4.1.3 function
   4.1.4 water part design
4.2 Landscape & architecture research
   4.2.1 architecture scale research question
   4.2.2 Exterior and Interior integration of architecture and landscape from the architectural aspect
4.3 Concept
4.4 Hurricane strategy
4.5 Land part Design
4.6 Material

Chapter 5 Structure
5.1 foundation
5.2 supporting structure
5.3 roof structure
5.4 façade system
5.5 solid core
5.6 glass core

Chapter 6 Climate

Chapter 7 Reflection

Bibliography
The structure of the report is also the structure of the whole process of designing and researching. It is like a chain with triangular links which are overlapping and connect with each other. Each ‘triangle’ is the main topic of one character which corresponds to one scale or aspect. There are six triangles in total corresponding to: Delta; Galveston; Urban Design; Architecture; Structure and Climate. One triangle includes three aspects to research and design. The concept of each aspect should be coherent with each other.
Galveston Bay is the 7th largest estuary in the United States, located along the upper coast of Texas. It is connected to the Gulf of Mexico and is surrounded by sub-tropic marshes and prairies on the mainland. (Eubanks, 2006) The water in the Bay is a complex mixture of sea water and fresh water which supports a wide variety of marine life. (Wikipedia)

A number of cities and towns, such as Houston city, Texas city and Galveston city etc., are separated around the bay. The bay is also surrounded by different waterscapes and wetlands which provide a complex ecosystem and valuable resources for the area. Galveston Bay provides numerous ecological services, economic benefits, recreational opportunities, transportation linkages, and aesthetic rewards to the people that live, work, and play around the bay. (Lisa A. Gonzalez, 2013)
Every year, about one hundred tropical disturbances roam the open Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. About fifteen of these become tropical depressions, areas of low pressure with closed wind patterns. Of the fifteen, ten become tropical storms, and six become hurricanes. About every fifty years, one of these extremely intense hurricanes will strike the United States, with disastrous consequences. (David Roth, 2010) Many American coastal cities are threatened by the hurricanes, with millions of Americans living at water’s edge, exposed to high risk of winds and flooding.

If taking into account storm frequency and typical storm tracks, as well as the population living at or below the elevation of a potential storm surge. The Houston-Galveston city area belongs to the top 5 vulnerable cities of the State. Typically, hurricanes will strike the Texas coast once every nine to 16 years, while tropical storms are more common than that. (Andrew Freedman, 2012) Among these the Galveston Hurricane in 1990 was the deadliest weather disaster in United States history. It had estimated winds of 145 miles per hour (233 km/h) at landfall, making it a Category 4 storm on the Saffir–Simpson Hurricane Scale. The most recent one is the Hurricane Ike on September 13, 2008, it struck the Upper Texas Coast, causing extensive damage with sustained winds of 110 mph (175 km/h), a 22 ft. (6.8 m) storm surge, and widespread coastal flooding. Ike was a powerful Category 2 storm at landfall, it was a large storm, and it drove a storm surge onshore that was more typical of a Category 4 storm. (Andrew Freedman, 2012)

The map on the right is the 100-year-storm of Galveston Bay. About 19,000 people of 22 cities are in the 5’ of sea level and 350,000 people are in the inundation zone. There are 48 cities are in the 25’ of the sea level.
During the 3X3X3 mapping analysis, Galveston City caught my attention. Comparing with the rapid developing Houston, I am more interested in who is gradually being forgotten. The maps elaborate clearly a story about the declining of a major city: Galveston.

The urban fabric map of 1865 shows that during the middle age of 19th century just a few towns were settled in the Galveston Bay Area. The relationship between these settlements and water is evident. The infrastructure map of 1865 shows that there is only two railroads established in this area, which is the Galveston-Houston-Henderson railroad built during 1861-1865, and the Gulf-Colorado-Santa Fe railroad (started in 1876, and continued in 1880-1883). At that time, there is no passenger train. And each railroad belong to different companies. The Galveston-Houston-Henderson railroad is the first railroad built in Texas, because of the demand of delivering goods to Galveston which was the main port for Houston’s production during that time. During that era, Galveston was the commercial center and largest city of Texas whose immigration and trade were from all around the world.

The year 1900 is the turning point of Galveston city. At that year, Galveston was struck by a devastating hurricane and the city stated declining from then on. Investors were afraid of its location, and invested in Houston instead. The oil discovery at Spindletop in Beaumont, Texas in 1901 prompted a new industry to be developed in Texas; the oil trade would transform Houston, the railroad hub of east Texas, from a smaller town into a large city. (wikipedia)

Houston kept developing and expanding very fast during the 20th century, more railroads are built in Houston to connect Houston city with other cities including Galveston. Galveston was connected to Houston and the mainland by passenger rail, but service was halted in 1967. Today Houston has developed into an international metropolis with a developed road system but not much connection with Galveston city. Broadway St. and the Blue Water Hwy. are the only road connections between Galveston Island and other cities. What’s more, Galveston city started to build the seawall after the 1900s’ hurricane. From the Urban fabric maps we can also see that the land of the Bolivar Peninsula was damaged heavily by the Hurricane Ike. Galveston City was much less suffered due to the protection of the seawall.

The coastline maps shows that the Houston Chanel becomes larger which is a result of the sediments. A lot of artificial changes have happened on the coastline of the Galveston bay due to the city developments and sea commerce. More links between the lakes are built today comparing with the historical coastline maps. People also create more ports along the costal line. The most obvious change is that a long artificial channel is built along the Galveston Island in order to make a ship line to link the Beaumont and Galveston City.
GALVESTON CITY

City Profile
Galveston city sits in a barrier island facing of the Gulf of Mexico along the Texas Gulf coast. Fifty miles south of Houston, Texas' biggest city, the island measures 27 miles long by 3 miles wide on its widest point. Given its location and barrier island status, Galveston Island is critical in the protection of the estuary system behind it, Galveston Bay. (Tanveerul, I., William M. and William S.)

Transportation Infrastructure
They are three main access points to the island. The main access is the Interstate 45 causeway to the north of the island connected to the Broadway St. of Galveston city. Broadway St. and the Blue Water Hwy. The second one is the Blue Water Hwy. built a toll bridge on the western end, but it doesn’t have the capacity or traffic of the first. And lastly one is a ferry service at the east end that connects directly to Port Bolivar and then straight to Highway 87, but it is only available during the summer time.

A City of Charm
Galveston is a city full of history and stories. Though it seems that Galveston Island is a dangerous place, a lot of people have lived there their whole life. They really care about this place. The population of Galveston city has decreased recent years, while the numbers of tourists has been fast increasing. Despite this, most of people chose to stay on the island. Many of them are living in the historical houses which has been survived from many hurricanes and certificated by the government. The marks of Hurricanes can be seen in a lot of places of the city. The Hurricane is an indispensable part of islanders’ memory. What’s more the tourism of Galveston develops very well due to its history, natural resources and the stories about hurricane.

For Tom Curtis, director of research communications at the University of Texas Medical Branch, Galveston is pleasantly full of contradictions, pride, character, and characters: “If Galveston didn’t exist, Tennessee Williams would have had to invent it.” (Rod Davis, 2002)
CHAPTER 2

The topic of this chapter is 'Galveston City': History, urban and hurricane. By studying the history I find that there are two clues in the history of Galveston city: urban development and hurricane prevention. The city developed with the seawall and strongly influenced by the hurricane. During the research on the city, two boundaries caught my attention: Galveston seawall and the 25th street. So I choose the intersection of the two boundaries as my site.
TWO BOUNDARIES
SEA WALL
LINEAR DISTRIBUTION
TRAFFIC SYSTEM

The City’s most heavily trafficked thoroughfares are Seawall Boulevard, Broadway Boulevard, and 61st Street.

Seawall Boulevard provides an east/west connection for Island residents and experiences heavy tourist-related pedestrian and vehicular traffic.

Broadway Boulevard is the primary access corridor into Downtown from the mainland. It is also a historic avenue with a lot of historical buildings along its both sides.

61st Street serves as the conduit for travel from I-45 to the West End, and can experience significant traffic in the summertime and on holiday weekends. 61st Street is also a major evacuation route for the West End.

PROBLEM
As for public transit the Island originally had 7 working trolley routes, but after Hurricane Ike, the infrastructure suffer even great damage but return to operations quickly. Right now the system faces problems with low ridership attributed mainly to reduced accessibility and unreliable and limited service. In order to support the tourist industry and provide a higher quality of life, the island transit system must undergo a thorough restructuring to improve its quality. [Shannon Van Zandt, 2012]
CITY ZONING

The diagram on the right shows that the main commercial areas are mainly separated along the Seawall Boulevard and secondly Broadway Boulevard.

Figure 1-4 are the land suitability analysis for Galveston Island. Deeper shades of color indicate higher land suitability for the determined use. (Galveston City State of the Community Report, 2012)

**Conclusion**

Galveston City area where is protected by the seawall is more suitable for both single family and multifamily housing which is consistent with the location of the older neighborhoods.

The narrow strip of land along the seawall is also good for commercial uses because of its relationship to the water and possible tourist traffic.

Industry should be located towards the north and along the gulf and the bay to further the geographical advantages of the port adjacent to the bay and the gulf. (Galveston City State of the Community Report, 2012)
Local people’s major activity is spreading along the 16km trail on the seawall. And the seawall area is also one of the most famous tourism attraction in Galveston. A lot of ‘activity-lines’ are in turn arranged along the seawall.

Activities Linear Distribution Along the Seawall

- Commercial Line
- Seawall Boulevard
- Seawall passage
- Seawall
- ‘See-wall’
- Beach and Piers
- Sea
Commercial Line
Restaurant
Hotels
Rental Stores (bicycle / boat / water related activities stuffs)
Shops (gift / water related activities stuffs)
Supermarket

Seawall Boulevard
Consider reducing the speed limit on Seawall Boulevard to increase pedestrian safety while further reducing the local perception of the Seawall Boulevard as a thoroughfare.

City of Galveston Comprehensive Plan, Adopted October 27, 2011, Engineering, Inc. for the City of Galveston, Texas.

Seawall Passage
having a rest
Waterfront exercise
Cycling
Running
Watching the sunset

Galveston SEE-WALL
The world’s largest and longest outdoor mural. The mural on the seawall is almost two and a half miles long, depicting both marine and beach life.

Beach, Piers and Sea
Sunbath
Fishing
Swimming
Surfing
HISTORIC DISTRICTS

The City of Galveston is proud of its unique community character. Over the years, residents have sought to create a city that expressed the values of the community and reflected the diversity of cultures that chose Galveston as their home.

Galveston has been described as having the most intact collection of late nineteenth and early twentieth century buildings in the United States. Most of these properties are not large, “highstyle” buildings, but rather small cottages with vernacular interpretations of popular styles of the time.

Galveston’s locally-designated historic districts comprise a significant portion of the eastern part of the city. Four areas, to date, have been designated as local historic districts in Galveston. The East End Historic District was created in 1971 and consists of approximately sixty-six blocks. The Silk Stocking Historic District includes all or a portion of nineteen blocks and was established in 1975. In 1994, the Lost Bayou Historic District, including all or a portion of twenty-three blocks, was created. The roughly thirteen blocks, known as the Strand/Mechanic Historic District, is the only predominantly non-residential district, which was established in 1988. (City of Galveston, Historic Preservation Plan, 2012)

Another invisible one should be added is the historical district along the seawall. The history can be trace back before 1950s during the Galveston Open Era. Though most buildings were destroyed by the hurricane, the rebuilding process never stops. The historical value of this area were not removed by the hurricane of which the newly built building can take advantage.
BOUNDARY

The 25th street can be seen as the boundary of the modern part and the historical part of Galveston City.
CONNECTION

In history downtown Galveston was the center of all activity, and banks, merchants, public buildings, and churches radiated from strand area. (Denise Alexander, 2010)

Today downtown Galveston is still the central of main attractions which offers an intriguing selection of shops, restaurants, galleries, and museums within a perfect radius for self-guided tours.

25th Street, also known as Rosenberg Avenue, is a north/south corridor that is both a commercial and residential street and serves as a connection between the Downtown and the Seawall.

IU-2.6 Enhance 25th Street as an Important link Between Downtown and the Seawall Corridor.

City of Galveston Comprehensive Plan, Adopted October 27, 2011, Engineering, Inc. for the City of Galveston, Texas.

PROBLEM_ The areas on both side of the 25th street have equal value to develop. But the map shows that the real situation is quite unbalanced on two ends.
INTERSECTION
The site is on the intersection of the two boundaries.
CHAPTER 3

The topic of this chapter is ‘urban design’: hurricane, urban and architecture & landscape. The ‘urban design’ chapter is to answer the three urban scale research questions of this three aspects. I set my position of using water adaptive strategy for Galveston City after the research. And then come to the urban design process. From the urban aspect the research question is how to extend the urban life of Galveston city and tourism activities to the waterfront? My proposal is creating a recreational system onto the sea. The system can be seen as an artificial landscape on the sea combined with buildings. So the research question on ‘Architecture & Landscape’ aspect is how to provide different layers of water related experiences? The research question on hurricane aspect is how do different parts of the recreational system deal with flood threat depending on its character? The urban design is the result of all the three aspects.
URBAN & WATER

EXTENSION . MULTIPLE . ADAPTIVE
WATER ADAPRIVE ON DEMAND_for both urban and architecture scale

Abstract
The paper describes that the strategy of urban and building design for waterfront city should develop more on the direction of water adaptive comparing with water defensive. This position was proved in three progressive aspects: welcome water; expend to the waterside; go onto the water. The paper want to prove that it is necessary and the future trend for the waterfront cities to develop with water to meet the future demand. So as the conclusion, the Galveston city can use the same strategy.

Instead of hiding the city behind the seawall, the city may have another choice: go on to the water and develop a water adaptive system to build a close connection of city and water.

Key Words: water adaptive; urban strategy; wet feet architecture; future challenge

People were attracted by water, but at the same time they are afraid of water due to the damage it brought. ‘The innate force within water represents the essence of Yin and Yang where good cannot exist without evil.’ (Maggie Toy, 1995) Building the high levees, seawalls and sand bags used to be an effective way to defend the flood, but it brutally separating the city and water. What’s more, because of the climate changing and water level raising, the ‘isolation strategy’ is not sustainable and cannot meet the future challenge and people’s demand.

Waterfront city were keep finding another ways to deal with water in history. For instance, in 1992 the Department of City Planning issued the New York City Comprehensive Waterfront Plan, the first time in the history of New York that a long range vision was offered for the entire shoreline. ‘A bold rethinking of the water’s edge as a place not only for commerce and industry but also for people to live and play, the plan proposed ways to reinvent the shoreline for public access and productive uses.’ (Amanda M. Burden, 2011) And now living with water is taken into consideration more seriously than before. A lot of works both on technical and political aspects have been done in recent years. It is time for waterfront cities to welcome water and even go onto the water. And it is also the time for their architecture to live with wet feet. (H2OLLAND: Architecture with wet feet)

GALVESTON
The map shows the movement of people’s leisure activities. Red point stands for tourist and blue point stands for local residents. Tourists’ movement mainly focus around the attractions while the residents’ movement mainly focus around the green areas or parks near their neighborhood. Most of the activities are far from the sea.

The seawall area is a local favorite for both tourists and local residents. But people’s major activity is spreading too long along the 16km trail on the seawall. The water related activities are still limited. Though there are several piers and pier buildings expend to the seaside on the beach and the, there are little places which can provide people with a close interaction with the sea.
WELCOME WATER

On an urban scale, areas of water which used to be treated more as dangerous places now are treated as valued public space. The water has always been more than just an enemy to city builders and polder engineers. It had to be kept under one’s thumb, to be dammed and drained, but cities have always profited from the water too.

Take Netherlands for instance, for generations, the Dutch struggled to reclaim land; building polders and securing them with dykes to prevent flooding. In recent years, there has been a radical change in attitudes to water in Netherlands, where it is now welcomed as an enrichment of the urban environment. (Christian Burchard and Felix Flesche, 2005) Now the river dams in practically all the ‘dam’ towns served not only as flood prevention measures but as public spaces. Similarly, the canals in Dutch cities were conceived not only as waterways but as pleasant public environments. Houses with a view of water are desirable, so moats, pools, small lakes and canals are being dug in new housing estates and recreational zones all around the country, in order to build the houses alongside them. Filled-in canals in old city centers are being re-excavated. In some places, polders are even being turned back into lakes. Certain architects have gone so far as to suggest flooding a famous polder like the Haarlemmermeer Polder in order to build a ‘water city’ there. (H2OLLAND- Architecture with wet feet) (Figure 3.1.1)

Buildings near water are also undergoing changes in Netherlands. No longer do they stand tidily at the waterside as in historical Dutch cities, but more and more they are stepping halfway out into the water or cantilevering over it. (H2OLLAND- Architecture with wet feet) The buildings in flood-prone areas such as immediate vicinity of rivers and flood relief areas, are also preparing to ‘welcome’ flood more actively. Besides the traditional elevated building or floating building, new types of building are design to make people in flood risking area live more unhurried and convenience. Among these, amphibious building is under well development. The height of the traditional pile buildings is fixed and can only deal with the flood below certain level. While the amphibious houses could ride out the storms, rising with the tides from 15 to 25 feet, then settling back down to the ground when the water is gone. Its foundation is always floating above floods. (Amphibious Architecture: Foundations Float Above Floods) This makes the building more flexible with different levels of flood. The floating building also has its shortage. The infrastructure is often not designed to cope with the exception circumstances where high water levels are rare but extreme. It means that a floating property can become isolated. Comparing with that, the amphibious houses are connected to the public infrastructure such as roads, sewers and main electricity. (Anne Loes Nillesen and Jeroen Singelenberg, 2010) (Figure 3.1.2)
EXPAND TO THE WATERSIDE

Another strategy of living with water is to expand the urban area to the waterside. It is better to make preparations ahead rather than to hide. Many cities started building the public spaces on the seashore to extend the urban life to the waterfront and provide a new space for citizens to interact and enjoy the water.

New Plymouth is situated on the west coast of the North Island in New Zealand. It was first settled in the early 1820s by whalers who hauled their boats ashore around the mouth of a small stream. Later a breakwater pot was built, railway yards constructed on the reclaimed land across the mouth of the bay, and the city established inland turning its back on the Sea. It remained this way for most of the twentieth century until 1995 a new master plan proposed a physical and visual link between the city and the forgotten waterfront. The foreshore plan was completed by 2005 after a ten-year period process with the intention of reconnecting the city with the sea. Coastal walkway, green spaces, wide pedestrian were built to extend the existing city grid across the road and railway line to terminate at piers facing out to the ocean. (Ralph Johns) (Figure 3.1.3)

Besides, many ‘watermarks’ have emerged instead of landmark. For example, New York has laid down planning strategies for Brooklyn Bridge Park and, soon, Governors Island, and as other cities throughout North America do the same (Figure 3.1.4). New architecture of the waterfront deserves the time, resources, and talents of serious design, not only in the planning stages, but as it is designed and built. (Van Alen, 2001)

Rebuild Competition ‘Rebuilt by Design’ were held in New York this year to call for everyone to build a more resilient region. There are many proposals on integrating recreational open public spaces with the flood prevention system of the city (Figure 3.1.5). The goal of the plan is to make the communities around the South Shore’s bays more resilient in the face of future extreme weather events and sea level rise, but also strengthen what makes living near the bays great in the first place. They not only want to keep Long Islanders safe in the face of future extreme weather events and sea-level rise but also make “bay life” safer, healthier, more fun, and more accessible. (Rebuild by Design, 2013) The competition ended up with many promising projects and strategies. The result shows that we have a lot more choices than building the fence.

Even bridges, long regarded as purely functional structures are more and more often becoming the material for architectural design and a new territory to develop. It is treated as one of the crucial elements in the waterfront cities with the functions of connection and accumulation. Cities start to build public spaces like parks, event plazas or multi-function spaces on the bridges. Washington D.C is going to build its first elevated public park on the foundations of an old freeway bridge spanning the Anacostia River. OMA + OLIN finally wins the design competition by creating a literal intersection and a dynamic, multi-layered amenity for both sides of the river (Figure 3.1.6). Clearly the water is making waves in both architecture and urban planning.

Figure 3.1.3 Part of the New Plymouth foreshore. A concrete promenade offers space for varied recreational activities, and cantilevered wooden platforms along sections of the walkway enable people to connect with the water.

Figure 3.1.4 Brooklyn bridge park master plan

Figure 3.1.5 One of the winning proposal by BIG. It envisions a 10 mile protective system that encircles Manhattan, protecting the city from floods and storm water while simultaneously providing public realms specific to the needs of the city’s diverse communities.

Figure 3.1.6 Winning Proposal for Washington D.C’s first elevated park on bridge by OMA + OLIN.
GO ONTO THE WATER

When mentioning ‘go onto the water’ the first word come to us may be ‘floating’. Human has a long history of floating on the water and living on the water. Actually people have already achieved more than just ‘floating’: the floating building can even go deeper into the water. Sweden had its first underwater hotel in 2000 (Figure 3.1.7). Above the waterline there is a raft with a typical red Swedish wooden cabin which looks no difference with a normal floating building. But below waterline, there is a twenty-four-tone bedroom with panorama windows on all sides offering fantastic views of the underwater view. (Christian Burchard and Felix Flesche, 2005)

Floating structure is not a new product, but it used to be utilized on a small scale or as the individual choice. Later, it is increasingly used on an urban scale as one part of the urban development strategy. For instance, Berlin, a city with hundreds of kilometers of shorelines, have already had the idea of creating public leisure areas and small-scale residential districts on floating structure since 2002.

The rage of floating structures on offer has grown considerably in recent years. The floating dwelling, for example, is steadily gaining ground: a new type of house that floats yet resembles a land-based property in its design and construction. (Anne Loes Nillesen and Jeroen Singelenberg, 2010) The floating spaces like gardens, roads are now featured on a larger much scale: a floating community. It is also an effective method to react to the increasing urban density.

The houseboats have attracted the attention of architects again in recent years as well. In the Netherlands, floating dwellings have their origins in converted ships; many were adapted to residential use in the aftermath of World War II. Then came the houseboats, usually built on concrete barges that have always been popular within their niche and have the image of a free state. (Anne Loes Nillesen and Jeroen Singelenberg, 2010) Uburg, a new residential district built on artificial islands of dredged-up sand in the IJmeer, has a neighborhood consisting entirely of architect-designed houseboats (Figure 3.1.8). The project is the first large-scale water-based neighborhood to have been realized in the Netherlands. (Anne Loes Nillesen and Jeroen Singelenberg, 2010) And more were built after that.
People are attracted by the water, but at the same time they are afraid of water due to the damage it brought. Building the high seawall used to be an effective way to defense the flood, but it brutally separating the city and water. Nowadays 'water adaptive' strategy is gradually taking the place of 'water defensive' strategy. Galveston City should be brave to go onto the water and find then the solutions actively.

**URBAN SCALE RESEARCH QUESTION**

**URBAN**

How to extend the urban life of Galveston City and tourism activities to the waterfront?

**PROPOSAL**

The proposal of the project is extending the urban life of Galveston City and tourism activities to the waterfront. Providing public spaces and buildings for the citizens to interact and tourists to enjoy their holiday. Thus people’s activities are gathered at a specific recreational system instead of spreading them too thin along the trail on the seawall. At the same time, the balance of 25th district will be retrieve. The system is an artificial landscape built on the pier over the sea combined with numbers of public buildings.

**URBAN SCALE RESEARCH QUESTION**

**ARCHITECTURE & LANDSCAPE**

How to provide different layers of water related experiences?

**HURRICANE**

How do different parts of the recreational system deal with flood threat depending on its character?
STRATEGY

The project will be divided into different height to provide water-related experiences in different layers.

The landpart of the buildings will connect the water part buildings by bridges to gain more ways of people access.

The main part of the spaces on the water will be elevated above the seawall 2.5 to 3 meters to meet the future demand. The lower layer can be resilient: floating or easy to recover.
URBAN DESIGN
SITE STUDY

1. Menard Park
2. McGuire Dent Recreational Center
3. Parking Space
4. Pleasure Pier Gift Shop

Historical Sites
5. Historical Pleasure Pier
6. Murdoch's Gift Shop
7. Balinese Room
8. Hotel Galvez

- hotel
- Restaurant
Historical Pleasure Pier

1906-1916
Electric Park brought amusement seeking tourists to Galveston after its opening. Located at 23rd & Seawall Blvd, just two blocks from the current Pleasure Pier, this electric amusement park lit up the Galveston sky with thousands of incandescent bulbs.

1943-1961
Recreational facilities for US military during World War II. The original Pleasure Pier includes rides, arcades, an aquarium, and a fishing pier.

1965
Flagship Hotel opened

Destroyed by Hurricane Carla

1974 gift shop opened
1983 Hurricane Alicia - minor repair
2008 Hurricane Ike /destroyed - 2009 rebuilt

Open in the summer of 2012. One of the most popular tourism attractions in Galveston. Winter time only Friday and weekends open.

Murdoch’s Gift Shop

History
late 1800’s Murdoch’s Bathhouse opened
1900 Hurricane /destroyed - 1901 rebuilt
1909 Hurricane - repair
1935 Hurricane - repair
1961 Hurricane Carla /destroyed - rebuilt/structures changed
1974 gift shop opened
1983 Hurricane Alicia - minor repair
2008 Hurricane Ike /destroyed - 2009 rebuilt

The gift shop is originally Murdoch’s Bathhouse which is one of Galveston’s most historic locations.
Hotel Galvez

The hotel was built in 1911, eleven years after the devastating hurricane that killed some 6,000 Galveston Island residents and leveled most of the buildings on the island. The hotel occupies the site where the Beach Hotel, Electric Pavilion, and Pagoda Bathhouse once stood.

Balinese Room

1929 ‘Maceo’s Grotto’ entertainment venues
1932 ‘Sui Jen’ Chinese Restaurant
1942 ‘Balinese Room’ expand to 183 growing pier
1957 closed
1961 Hurricane Carla / structure damage - repair
2001 reopened
2008 Hurricane Ike / totally destroyed - rebuilt in the plan

The Balinese Room was a well-known nightclub in Galveston, built on a pier stretching 183 m out of the Galveston Seawall over the waters of the Gulf of Mexico. It was totally destroyed by Hurricane Ike.
SEA LEVEL

The tide floating range of on the south of Galveston Island is not very large. But Galveston has a very high risk of being flooded. The elevated building outside the seawall will not be influenced by the daily tide floating.

The diagram below shows that the large waves of Hurricane Ike overtopped the seawall. What’s more the seawall raising project are in plan. So the new building should be elevated higher than the seawall.
FUNCTION DESIGN OF MASTER PLAN

urban center
tourist center
gallery area
boathouse hotel
swimming pool
other service buildings
wooden decks

The whole system has two entrances. One entrance at the urban center area, another is the tourist center area. The existing parking lot can be shared by both entrances. The main part of the new recreational pier is designed as a circle around the historical pleasure pier providing a continuous system for people's activities: walking, running, cycling, etc. The two branches lead to the areas which a relatively privacy: swimming pool and boathouse hotel area. Two swimming pools are added at the boathouse hotel area to make this area more public. And this area can also work as the water barrier for the gallery area behind.
The new pier is mainly constructed by wood including three height levels with 2~2.5 height differences. Different height levels are built by wood in different color.
The topic of this chapter is ‘Architecture’: hurricane, urban, architecture & landscape and public space quality. I choose the urban center as my main project to develop. Hurricane prevention strategy for architecture should coherent with the concept for urban scale: go on to the water, resilient strategy not defensive strategy. The project is a public building: urban center. It is the future city living room of Galveston. So it should be open enough and the public space quality should be guaranteed from all aspects. And my research question on architecture scale is: how to integrate Galveston urban center with the landscape from both exterior and interior?
URBAN CENTER

MAIN PROJECT

important connection of the city and the recreational system

LAND PART/WATER PART
EXISTING RECREATION CENTER STUDY

FUNCTION DIVISION
All the facilities in the park and the recreation center are owned by the government of Galveston. The Recreation Center is free for any resident, employee, or long term visitor of Galveston with a valid state ID. Besides all the facilities, the center also offers yoga course, guitar course, art course, crafts course, computer course, boxercise etc. They also provide after-school programs for youth. In addition, the center also provides guiding tour for the tourists. Among all the visitors, 80% are local citizens and 20% are tourists.

PROBLEM
The facilities in the center is abundant but the number and the space is quite limited. For example there are only 8 computers in the computer lab and 2 table tennis tables. Almost all the courses are taken place in the multi-function room with different time tables. There should be more rooms and facilities for more people and flexible usage. The outdoor stage is seldom used and it blocks the view from the recreation center.
URBAN CENTER

The urban center is separated into two parts: land part and water part which a connected by the bridge over the Seawall Boulevard. The urban center can be seen as a strong connection of the city and the recreational system. Both two parts choose the same design method to keep the continuity of the architecture. The form of two parts are sloped green roof.

For the water part, the roof can expand the connection of the building and the seawall passage and lead people to the nice view of the sea. For the land part, the site used to be a park which used to provide multiple activities for the local people. The sloped green roof will be the extension and strength of the existing park and public activity instead of reducing them. Two parts echoes each other on two sides.
FUNCTION

WATER PART

East part_Sports Center_5000m²
Full size basketball gym X 2
Table tennis table X 8
Billiard table X 8
Fitness center_770m²
Office/Storage room_6Sm

West part_1600m²
Lecture Hall_245m²
Restaurant_500m²
Office X 5_70m²X 5 = 350m²
Washroom/shower room_290m²

LAND PART_7200m²

Library_650m²
Urban living room_420m²
Rehearsal room X 2_355m² / 255m²
Activity room_180m²
Meeting room X 2_5m X 6.5m = 32.5m² X 2 = 65m²
Computer room_10m X 7.5m = 75m²
Exhibition room X 2_7m X 10m = 70m² / 7.5m X 8.5m = 63.75m²
Chess room_7m X 10m = 70m²
Café_270m²

Office X 4_70m²X 4 = 280m²
Storage room X 8_80m²X 8 = 640m²
Washroom_100m²
**NUMBER OF PEOPLE**

**WATER PART**

- East part: Sports Center, 254
  - Entrance Hall: 60
  - Full size basketball gym: 36
  - Table tennis table: 8 x 4 = 32
  - Billiard table: 8 x 2 = 16
  - Fitness center: 50
  - Aisle: 60

- West part: 308
  - Lecture Hall: 170
  - Restaurant: 80
  - Office: 5 x 10 x 5 = 50
  - Aisle: 8

**LAND PART**

- Main part of the building: 430
  - Entrance Hall: 70
  - Library: 100
  - Urban living room: 85
  - Café: 45
  - Chess room: 16
  - Rest Space: 40
  - Aisle: 90

- Isolated room
  - Rehearsal room: 2 x (100 + 70) = 170
  - Activity room: 40
  - Meeting room: 2 x (14 + 14) = 28
  - Exhibition room: 2 x (35 + 45) = 80
  - Office: 4 x 10 x 4 = 40
LANDSCAPE & ARCHITECTURE

INTEGRATION . EXTERIOR . INTERIOR
LANDSCAP AND ARCHITECTURE

The urban center is an important link of the city and the recreational system. The artificial pier system on the water and the park on the land can both be seen as the landscape below the urban center which can be called lower layer landscape. And the sloped green roof can be seen as the upper layer landscape which forms the building. The building is not isolated, it is close related to the landscape.

ARCHITECTURE SCALE RESEARCH QUESTION

How to integrate Galveston urban center with the landscape from both exterior and interior?

MAIN PART: LAND PART

In this case, both of the water part and land part are elevated higher than the seawall to avoid the water problem. So they are facing the same level hurricane challenge: wind problem. But the land part has more complicated landscape and function than the water part. So the land part of urban center will be the main part to develop.
EXTERIOR AND INTERIOR

Integration of architecture and landscape from the architectural aspect

Abstract

There seems always a boundary between architecture and landscape. Architecture and landscape have its own dominant territory: interior and exterior. The strong and self-conscious architecture vocabulary strengthen the boundary and the even worse thing is sometimes architecture and landscape are on the opposite side: the construction of the building may destroy the landscape. Architecture can be more than itself by integrating with landscape. The integration is the also the future trends form ecological perspective. Actually the boundary has already been blurry, there are many buildings are well integrated with landscape in various ways. Contemporary architecture has been strongly influenced by the concept of landscape in recent times. (Daniel Jauslin, 2010)

The paper focuses on researching these cases and classify them into different categories to learn how they integrate architecture with nature.

The selected cases is divided into two categories: exterior and interior. Exterior means the exterior elements of architecture becomes one part of the landscape and interior means landscape goes into the architecture. And each category includes three aspects depending on different situation: connection; co-existence and creation. As for the exterior: 'connection' is the direct way of connection; 'Co-existence' is the situation when architecture is designed to fit the existing landscape; 'Creation' means the architecture can create a dominate landscape or landscape can create architecture. As for the interior: 'connection' is the situation when the shelter of building is built on a larger scale landscape and make the enclosed part the interior of the building; 'Co-existence' is keeping the existing smaller scale landscape inside the building and the landscape plays an important role; 'Creation' is creating a landscape system inside the building which plays a dominate role.

The research tries to find the answers of following question in each case to provide inspiration for the future design. When taking landscape into consideration what will architecture be like from different situation: connection; co-existence and creation. As for the exterior: 'connection' is the direct way of connection; 'Creation' is building the land. That is architecture's original sin. A building makes something new, but does not do so in a void. What was once open land, filled with sunlight and air, with a distinct relationship to the horizon, becomes a building. The artifices of humans supersede what nature has deposited on a given place. The bulk of a building stops air, sunlight and views......Some buildings even hope to move as far away as possible from the land on which they rise. In all cases, a building is one thing above all else: not the land.’(Aaron Betsky, 2002)

Buildings replace the land to exist and keep everything belongs to landscape outside, then a clear boundary between architecture and landscape occurs. It seems that building cannot co-exist with landscape in the same space. As for exterior, architecture is built on the land isolated sometimes even as an invader; while as for interior, landscape just works as a decoration providing a limited fantasy of nature for the people. Architecture and landscape seems have its own dominant territory: interior and exterior. ‘Landscape architecture’ sounds belong to an in-between territory. But its definition from oxford dictionary, ‘the art and practice of designing the outdoor environment, especially designing parks or gardens to harmonize with buildings and roads’ (Oxford2012,3) shows that landscape architecture is, more accurately, artificial landscape whose dominant territory is still exterior.

One of the improtant reasons for the existence of this boundary is strong and self-conscious architecture vocabulary. It is sometime happen like this that architects have evolved a new attitude to the design of buildings as a response to the sites (landscape) but end up with exceptional brutal work: strong and self-conscious basic geometrical form, straightforward construction materials, which shows more response to its context and intrinsic concerns.(Thomas Deckker, 1999)

‘The history both of architecture and landscape seems to have set the rules for understanding the two sides as opposites; this tradition has been established since antiquity and started to change only very recently.’ (Daniel Jauslin, 2010) From one aspect, human have the equal need and desire for shelter and nature. From another aspect, there are a lot of valuable things architecture can take advantage of from the landscape, architecture can be far more than itself. Connecting with landscape can help to improve the space quality of architecture from interior and architecture can be the extension of the landscape and public activity from exterior. So it is important to explore how to break the boundary and integral architecture with landscape to achieve a win-win situation. ‘The exploration of the territory between architecture and landscape reveals how relationships that transgress disciplinary boundaries can contribute to the definition and enrichment of a discipline. This in-between territory also engages each discipline's expanded field of relationships, including other disciplines such as urban design and ecology.’ (Anita Berrizbeitia and Linda Pollak,1999)

The research question of the paper is how to integral architecture with landscape from the architectural aspect. By studying the design method from typical cases to help the future design, also learn to make choices in different situations and to know what can achieve. There are different ways of integrating architecture and nature which can be summarized into general idea: exterior and interior. Architecture becomes one part of the landscape from exterior; landscape becomes one part of architecture from interior.

1 INTRODUCTION

Key words: exterior; interior; landscape; architecture; integration; strategy; method; space quality; ecology; adaptability; luxury; case study; artificial.
1 EXTERIOR

A building is defined according to the Oxford dictionary, as a structure with a roof and walls, such as a house or a factory. (Oxford2012, 1) The roof and walls are the crucial architectural elements which make the building become the shelter. The space which is enclosed by the roof and walls is called interior and the rest what it stops outside is called exterior. The shelter can be the important link between architecture and landscape from exterior.

1.1 Connection

When the shelter becomes landscape itself and connect with the existing landscape, building becomes part of the landscape. Doing this can not only extend the public space above the building but also provide more possibilities for the public activities.

1.1.1 One element connection

Sloped green roofs is a common way to connect landscape and architecture (figure 4.2.1). The roof of the TU Delft library is well welcomed by students especially in the sunny day (figure 4.2.2). It is a good place to take a nap or have picnic. The sloping roof also has the visual function in the case of Bushwick Inlet Park. The community building of Bushwick Inlet Park becomes one essential part of the park not only because of the landscape connection but also the visual connection. Bushwick Inlet Park is the centerpiece of the Greenpoint-Williamsburg Waterfront. The parkland is situated at the water's edge while the building with a sloped green roof is on the other edge of the park. A multipurpose athletic field for soccer, football, lacrosse, etc. is set in between. Thus the landscape on the roof becomes an auditorium for the sports match and a gazebo for the water view (figure 4.2.3). (Arch daily, Bushwick Inlet Park / Kiss + Cathcart, 2014)

1.1.2 Multiple elements connection

More than one element can be utilized to connect the architecture and landscape with an integral design method (figure 4.2.4). Claveles is a residential and hotel project in La Pereda, Spain. The building contains numerous mild planted slopes which consist the roof and the walls of the building (figure 4.2.5). The hill-like shelter is shaped by these curved strips to reduce the impact on the environment. (Arch daily, CAEaCLAVELES Residence+Hotel / longo+roldán arquitectos, 2013)

1.1.3 Complete connection

A more extreme way of connection is to hide architecture into the landscape (figure 4.2.6). In other words, the shelter is the landscape. In this environment domain situation, architecture appears in a very motif way. The hotel on Alps designed by Matteo Thun expressed this idea well. It is a mountainside hotel which consists of 11 individual units that is partially nestled into the hillside. Architecture is well protected by the shell of earth. The building is not invader but part of the landscape. (figure 4.2.7)
1.2 Co-existence
In a lot of cases the existing landscape especially the trees need to be cut down to leave the space for the buildings. But by using special architectural design method the natural landscape can survive and help to improve the space quality in return (figure 4.2.8).

Huaxin Business Center in Shanghai is a smart example of dealing with the architecture and existing natural landscape. There are 6 old camphor trees on the site which were supposed to be cut down. But the architect successfully kept the trees in the site by establishing an intimate and interactive relation with them. The building was elevated to leave the whole ground for the public landscape (figure 4.2.9). The main body of the building consists four suspended volumes with steel trusses. The northern two volumes stretch horizontally with “Y” and “L” shapes to interweave with the old trees. Openings on the wall are left for the branches. The trees provide the nice view for the building in return (figure 4.2.10). The volumes are supported by 10 pieces of combined steel and concrete walls which are all covered by reflective stainless steel panels to reflect the surrounding landscape (figure 4.2.11). The visual trick not only make the landscape continue on the ground floor but also make the building look like suspending in the air. (Arch daily, Huaxin Business Center, 2013)

1.3 Creation
The exterior landscape can be created by the building which provides a domain public territory for the area (figure 4.2.12). Artificial landscape in turn can create building in a landscape way.

1.3.1 Architecture creating landscape
The extension of the Staedel Museum in Frankfurt is built below the original museum’s garden (figure 4.2.13). The doubly-curved roof slab constitutes the whole landscape of the garden with the building hidden underground. The roof slab are covered by a total of 195 roof lights, varying in diameter from 1.50 m at the outer edge to 2.50 m at the highest point in the center. The lights are also the roof windows which can control the daylight come into the building. It is the connection of exterior landscape and interior building. (Arch daily, Staedel Museum / Schneider + Schumacher, 2012)

1.3.2 Landscape creating Architecture
The pier is the artificial landscape on the sea. Yokohama Passenger Terminal can be seen as an elevated artificial landscape made by 430 meters-long boardwalk of grass and wood deck (figure 4.2.14). The building entrances like slits and trenches in the surface in between the wooden flow. The method of starting with the landscape and ending with the architecture makes the building formed “naturally”. The wood steps continue to the interior of the building and become the wall. The entrance is made transparent by the glass. Thus the continuity of space can be both seen and experienced. (Arch daily, AD Classics: Yokohama International Passenger Terminal / Foreign Office Architects (FOA), 2014)
2 INTERIOR

The space enclosed by the shelter is the interior of the architecture. When the landscape exists in the building as a dominated system; playing a crucial role in creating space or becoming an indivisible architectural elements inside the building, architecture is integrated with landscape from interior.

2.1 Connection

When architecture dominates, the landscape is introduced to the building and it is continuous from outside to inside. When landscape dominates, architecture is like a cover on it, the enclosed part of landscape becomes the interior of the architecture.

2.1.1 Architecture domination

When landscape goes into the architecture the boundary will be broken (figure 15). A house built at an altitude of 8500 feet in the Rocky Mountains brings the natural landscape, the granite boulders, into the building (figure 16). All the elements indoor, columns and fireplaces etc., give way to the rugged landscape. The house in Joshua Tree, California, designed by Ken Kellogg, connects landscape in the same way. The landscape appears in a stronger way, controlling more elements of the building to connect to exterior (figure 17). For example, using the landscape material for interior; intersecting the rock-like walls and glass walls to fuzzy the boundary.

The landscape can go into the building by introducing (figure 18). The Louvre Abu Dhabi Museum, designed by Ateliers Jean Nouvel, create a water garden on the coast by introducing water into a complex of buildings with level and harmonious proportions embraced by the sea. (Hall Napoléon, 2014) It is estimated that the project will completed in December, 2015. By creating semi-enclosed layout, the water landscape appears among the museum pavilions (figure 19). By adding a huge cupola on the two-thirds of the building group, the exterior landscape becomes interior. The roof is based on one of the major symbols of Arabic architecture at a diameter of around 180 meters. The design of the roof is described as “Pierced with openings to look like interwoven palm leaves, a traditional roofing material in the Emirates, the dome resembles geometric lace. Sun filters through the dome like a delicate, protective rain of light, similar to a claustra lattice or a mashrabiya, reflecting the constant tension between light and shadow in the country.” (Hall Napoléon, 2014) The rain of light fits the indoor landscape well in softening the space (figure 20).

2.1.2 Landscape domination

When the landscape plays a dominant role, the building is built like a shelter on it (figure 21). The part of landscape which is enclosed by the shelter becomes interior. A theater for the City of Flamenco, Jerez, Spain proposed by SANAA is an appropriate reference for the artificial landscape domination connection. Though the project has never been put into practical, it provides another perspective for architectural design. It starts with the landscape and ends with the building, starts with the large scale to meet urban fabric and topography and ends with the small scale to meet functional requirements.

The site is a void in the city, surrounded by the historical buildings. After studying the topographical potential of the site, the architects start from designing an opening amphitheater which occupied the whole void as the landscape, then they add a vast roof as the only structure to create a grand public theater space (figure 22). The project proposes a large flexible area for Flamenco, so they end with adding removable walls to enclose several smaller theaters of different sizes for the special events. The landscape which is enclosed becomes the stages for each theater (figure 23). When there are no special events, the walls go down to the basement to make the whole area an open public space. The free transformation has further strengthened the connection of architecture and landscape. (El Croquis, City of Flamenco, Jerez, 2006)
2.2 Co-existence
The concept “co-existence” is more than preserving the existing landscape inside building. The kept landscape can have much influence on the spatial quality and order. The landscape elements can be as important as the architectural elements. The importance is defined by the function instead of quantity. (figure 4.2.24)

2.2.1 Architecture Domination
When architecture dominates, the landscape can be kept inside by designing the architectural elements in a specific way, for example, the openings on the roof left for the existing trees. The Nordic Pavilion at the Venice Biennale shows the co-existence of nature landscape and architecture inside the building. The building is a showroom with three trees rising through the roof at the center of the main exhibition hall which define the order of the space. The building roof leaves the openings for the trees which fits the strip shaped ceiling well. The interior of the building is built in a very simple way with the white material to emphasize the central position of the landscape. The layouts of the exhibits all follow this order setting around the trees and build connection with them (figure 4.2.25). The landscape becomes the central element of the architecture in this case. It is a symbol of space, aesthetics and sequence.

2.2.2 Landscape Domination
When landscape dominates, the concept and the form of the building is decided by the landscape. Tree building built by Japanese architectural firm Tezuka Architects combined landscape element with architecture in a simple way to solve the problem of a tree standing on the desired building site: build a ring around it (figure 4.2.26). The tree centered space is an English language classroom and a waiting space for students who are riding buses home. Half of the ring is the space enclosed by the glass while the other half is several levels of open platforms. Besides the space order connection, due to the scale proportion of architecture and the landscape, existence of the tree is as strong as the building.
2.3 Creation

The interior landscape can be created as a system not only a decoration. The interior space division, structure system, architecture style can be designed by the landscape.

2.3.1 Real landscape

The interior of architecture can be built in a landscape way (figure 4.2.27). The showroom built by Kengo Kuma in Milan created an abstract zen style interior space by using the landscape method (figure 4.2.28). The exterior of the showroom is a simple the square box with glass façade on four sides, the interior of building is extremely enriched by the concrete artificial landscape. The topography of the landscape creates a terrain of depressions and elevations which defines the shape of water, the green area and the paths of movement. At the four edges of the square plan are the functional spaces which are defined by the landscape and architectural element, the façade, together (figure 4.2.29). Except the landscape system, there is no extra excessive decoration in the building, the pipelines on the ceiling are all exposed in a natural way without coverage, the furniture are set directly on the gravel. By using the elements pietra serena stone, bamboo, water and gravel, the interior space appears in an exterior way. (de zeen magazine, Urban Stories: Naturescape by Kengo Kuma, 2013)

Another stone scape showroom of Bologna also designed by Kengo Kuma shows the same method. The building is one of the refurbished buildings of the Former Hospital Bastardini. The flow-like new coneret landscape appears in the historical building in a flexible way. The contradictory of new and old elements appear in a harmonious way (figure 4.2.30).

The landscape is created in the Querini Stampia by creating a landscape of water control structures (figure 4.2.31). This landscape also operates as an apparatus that measures natural phenomena, revealing the interior of the building to be as unpredictable and dynamic as the environment outside. (Anita Berrizbeitia. & Linda Pollak. 1999)

2.3.2 Abstract landscape

Landscape can be imitated by the architectural elements in an abstract way, the utilization of branch column or the mushroom column, for instance (figure 4.2.32). The connection is built by these elements who have a double implication of both architecture and landscape. The landscape system is also the structure system. The order of the landscape reflects the order of the structure. The Nine Bridges Country Club-Clubhouse in Korea creates a forest in the building by using tree structure (figure 4.2.33). The forest consists tree like columns combined with net like grid shell constitute the structure system of the building. The structure and the floor are all made by wood who is most close to the nature. The “forest” area includes the reception zone, a member’s lounge, and a party room. The tree columns in the atrium reach to a height of three stories. The forest structure system is also combined with the ventilation system and lighting system of the building, making the landscape an inseparable part of the building. (Arch daily, Nine Bridges Country Club/Shigeru Ban Architects, 2015)
CONCEPT
Layer 1 _ Landscape

Site

sea high way & seawall park

Lower Layer Landscape

landscape above water landscape on the land

Upper Layer Landscape

TWO LAYERS OF LANDSCAPE

The two layers of landscape are connected on one end and open on the other. This reflects the character of public building and the water adaptive strategy.

Strategy _ unification of space and flood prevention strategy

open water adaptive

close water defensive
The two layers of landscape define two kinds of public territories: inner public territory and outer public territory. The lower layer of landscape is created to connect these two territories. The landscape also defines different kinds of public spaces: linear public space, central public space. The division of spaces defines people’s activities and the function of the building.
The form of landscape enclosed three different kinds of public space: outer central spaces, inner central spaces and linear spaces. The trees defines the main order of the space and become the central landscape strip. All the spaces are distributed around this landscape strip.

Inner central spaces defines the main entrance of the building and have more movements. They are the spaces where smaller building cores distributed: meeting room, computer room, washroom, rest room, exhibition room. Small curves defines the position of these smaller gathering spaces.

The rest spaces are large integral gathering spaces which make people stay with specific purpose: library, café, rehearsal room, urban living room.
Layer 3  **Structure**

The interior building cores and columns are like plants growing on the existing landscape. Building systems co-exist with landscape systems. And the buildings should follow the order which is set by landscape.

Layer 4  **Building**
After the main body of the building is formed, the outer layer comes last: roof windows and facade. Roof windows are added to catch the light and the outer façade is the last layer to design. It has the function of enclosing the whole system. The last two layers come last which means they are the most flexible elements of the building. They should be adjustable to fit different situations of the building.
HURRICANE
The building can be seen has a double layer wall system: the transparency, flexible outer wall and the isolated inner wall of each building/room. There are three kinds of inner buildings: solid core with solid concrete load bearing wall which is also the main structure of the building; glass core with removable glass façade; isolated concrete building which is solid enough to resist the hurricane.

The outer wall reflects the public character of the urban center. It is transparent and flexible, the exterior landscape can be seen clearly continue to the interior of the building. The interior building cores and columns are like plants growing on the landscape.
HURRICANE

The structure of the building should be strong enough for the wind resistance and protect the big roof from overturning. The solid core is the main structure to fix the roof together with the column.

When the hurricane came, there will be an early warning several days before. All the flexible walls and facilities can be removed to the solid core and isolated concrete building and be well protected. And the rest which is built as exterior elements are left to resist the hurricane. A net system insulated along the facade around the building will be pulled down and fix on the floor to protect the interior of building from hitting by the fragments of buildings or boats.

Thus can meet the demands of reducing damage and recover easily and quickly.
LAND PART
LAND PART

The space is divided in a flexible way: it is divided by landscape, material, height difference.
cafe area
The main material of the building are **concrete and wood**. They are common landscape material which also fit the flood area. The choice of material responds to the architectural concept. Different wood material are used to divide the space and emphasize the height difference in the building. The same material are also used on the furnitures.

Rusty iron door is used for the solid core. Usually the door is open and placed at the groove of concrete wall. The door is also a decorative element which looks like a piece of art work combined with the concrete wall.

**Polycarbonate** is widely used in the facades and roof windows of the building. It has much lighter weight than glass and has high flexibility. It also has low installation and maintenance costs, and easy installation.

Multi-wall Polycarbonate is sufficiently flexible to allow moderate curves. It also can be bent in two directions to shape the **roof window pieces** of the building. The minimum cold forming radius is 24" for 6 mm thickness, 31" for 8 mm thickness and 94" for 16 mm thick material. Flexing or installing a sheet to the point of buckling can cause rapid deterioration in highly stressed areas.
CHAPTER 5

The topic of this chapter is ‘Structure’: hurricane, architecture & landscape, Structure. Depending on the hurricane prevention strategy for the building on chapter four, the structure of the building should be strong enough for the wind resistance and protect the big roof from overturning. The way of building the façade should also fit the hurricane prevention strategy: solid, folding or removable. The interior of building should be built in an exterior way to be solid. And the branch column is the response of both structure and ‘architecture & landscape’.
Ribbed Raft Foundation

1. soil condition of Galveston
'Galveston Island is known as a sandy barrier island because it is made up mostly of sandsized particles, with lesser amounts of finer mudand larger gravelsized sediments.' -Resource from Website of The University of Texas at Austin. Shallow Foundation are used when the soil strata affected by the building could resist the superimposed stress without causing excessive settlements.

2. economical and functional support system
One of these advantages is the ability of the foundation to support high column loads. When a building has several columns that support high loading conditions, placing a ribbed mat foundation can be more economical than placing several spread footings. Generally, when more than 50% of the building plan area is covered by footings, a ribbed mat foundation can be the most cost-effective solution. (Bowles, 1977)

3. Hurricane
The integral heavy foundation can fix the building better form overturn in the hurricane.
**SUPPORTING STRUCTURE**

**Solid Core:** built by load bearing wall

**Column:** Branch column

Upper end fixed to the beam
Lower end pinned to the foundation

$k = 0.7$
The tree column meet the concept of public space quality and hurricane prevention both well. Since the land part of the building is protected by the seawall and the water part of the building is elevated. There won't be much water problem for the building but the wind. The structure of the building should be solid enough to protect the roof from overturning. The branch column can provide a stronger column than normal one. What's more the space quality is improved by the branch column. It can be a symbol of 'landscape go inside' and provide more exterior sense to interior.
a/b. bended column deformation will happen easily.

c. missing the supporting angle. The angle for the branch column is important for supporting heavy load and preventing column from being warped by the hurricane.

d. strongest structure

Chosen column
A combination of c and d multi-steel-tube-column with one column in the middle support the joint of structure.
Column a has longer branches (4m) which are more easily be bendable than column b.

Smaller supporting angle makes stronger column.

The thicker branches make the column stronger.
policarbonate sheet
plant-bearing layer 200mm
protection layer 4mm
filter sheet
drainage layer 100mm
root barrier 5mm
mineral-fiber thermal insulation 80mm
vapor barrier membrane
blinding sand-cement 1:30 20mm
polishing fine aggregate concrete floor 60mm
blinding cement sand 15mm
water heating pipe tray <1>40mm
concrete 150mm
thermal insulation 30mm
damp proof membrane
ripped raft foundation
damp proof membrane
blinding concrete 50mm
premolded filler and sealant at expansion joint
COLUMN & ROOF WINDOW SECTION
lifting device
sunshading sliding rail
hidden roof light
air conditioning duct
suspended concrete panel
wooden grating
LIGHTS

hidden LED strip light

removable troffer
easy to maintenance, clean and replace.

light strip

light strip
**ROOF STRUCTURE**

**Braced Structural Frames**
The size of the unit is 9m X 10.5m. This frame system provides more efficient resistance against the earthquake and wind forces.

**Beam**
The sizes of the main beams on both direction are the same. The beams are continue on the W-E direction to form the 4m cantilever on both sides. The diagonal bracing also work as the secondary beams.
Composite Floor
The profiled metal sheets are used only as permanent formwork to enable fast progress and immediate provision of floors. Reinforcement is in the form of round bars. The floor acts like a ribbed concrete slab. With sufficient concrete cover to the reinforcing bars, the floor slab is, however, fire resistant. The concrete slab acts as a horizontal plate resisting wind forces.

Ceiling Construction

ROOF STRUCTURE
The roof of the building is green roof with round roof windows on the top of the branch column.
The roof window can be opened for the natural ventilation. One roof window unit includes 8 fan-shaped window pieces and one central fixed window installed on the intersection of the structure to hold the fan-shaped window pieces. The fan-shaped window pieces are divided into singular group and even group. When the window opens the singular group open first and then the even group.
The rain on the roof window is collected by the groove fixed along the even facade pieces and conducted to the ring of gravel on the roof which is connected to the drainage layer of the green roof.

The roof window is sealed by the spring element which has the similar operation principle with swing door. It is fixed on the wall and connects the window piece. It can be pushed down when the window opens and return while the window is closing. It can connect to the window closely during the whole process to seal the system.
The sun-shading system is combined with the structure above the column. It is a fan-shaped device fixed on the bracing beam. When sun-shading system opens, the device opens from both two sides which like a folding fan. The shading material is unfolded by the shifting bars on two sides which follow the circular sliding rail. The sliding rail is installed on the ring spaces around the branch column. The coverage of sunshades can also be adjusted depending on needs. The material used for sunshade is light-weight, light-transmitting and ventilated.
The flexible facade breaks the boundary of interior and exterior which makes the spaces and landscape continue freely. As more facade units open, more public the building becomes. The space inside can also extend to the outside easily, such as the cafe area.
FACADE SYSTEM

The facade is hanging on the cantilever of the beam. It can be removed easily or folded and hidden in the roof before the facade.
The facade is connected and fixed to the floor by the elements fixed on the adjustable component. The component is composed by two steel angle plates with two strengthening ribs which make the component move in two directions.
The whole facade is hanging on the cantilever of the beams by the $\phi 10$ wire rope. One vertical line of the facade can be seen as an unit. The singular units with pulleys are mainly lifted for the daily use and the even units with sliding rails stay as the frame to fix the moving units. Both of the two units can be lifted for the specific situation.

One unit of the facade consists several pieces of $1.6\text{m} \times 2\text{m}$ facade elements. When the facade closed the lower piece is hanging on the upper piece. When the facade open the lowest piece move first and lifted the the rest up one by one by the steel elements on the bottom.
FACADE TESTING MODEL STUDY_unsolved problems

1. How to deal with the influence to the façades caused by horizontal wind load? How to make sure the bottom façade piece clench exactly right when there exists wind load.

2. How should the pulleys and the tracks be designed to make sure the sliding smooth?

3. How to make sure the bottom façade piece vertical when it slides upwards? There are some cases where bottom façade piece roll over when testing the model devices. This will affect the regular sliding of the façades in spite of the façade units on both sides for fixation.

4. Heat preservation of the façades needs to be further dealt with.

5. Under special circumstance where even units also need to be opened, how to make sure they slide smooth with fixation on both sides also needs to be further investigated.
SOLID CORE
The concrete solid core is also the main structure of the building. The function of this solid core is wash room (ground floor) and auxiliary function room (first floor), so there is no openings on the wall. The door of the wash room is hidden in the wall which is only closed when the hurricane comes. The load bearing wall is set a little behind to achieve a separating appearance with the ceiling by the shadow.
concrete wall 230mm
thermal insulation 100mm
concrete wall 230mm

steel hidden door

a-a cross-cut

concrete stair detail

230mm exposed concrete wall

wall opening filled with epoxy resin

4>30/3 steel tube in precast concrete element
GLASS CORE

Contrary to the solid core, the glass core gives the feeling of light and transparency. The function of the glass cores is meeting room and computer room. The glass core is made of removable suspended glass facade. Spended curtains are used to block the view when needed. When the room is not occupied the curtain are opened to make the view go through.
wooden ceiling door for maintenance and removing the glass facade.

Removing Facade Steps
remove
unscrew

GLASS CORE

curtain close
CHAPTER 6

The topic of this chapter is ‘Climate’: structure, public space quality, architecture & landscape. The character of the building and the façade strategy decide the climate concept together. And the combination of ventilation fans and roof windows with column shows a strong connection of structure and climate.
WEATHER DATA SUMMARY

Location: Galveston Scholes, TX, USA
Latitude/Longitude: 29.3° North, 94.8° West, Time Zone from Greenwich -6
Data Source: TMY3 722420 WMO Station Number, Elevation 16m

MONTHLY MEANS

<table>
<thead>
<tr>
<th></th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Temperature (Avg Monthly of 3 Depths)</td>
<td>15</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td>25</td>
<td>27</td>
<td>26</td>
<td>24</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Wind Direction (Monthly Mode)</td>
<td>100</td>
<td>120</td>
<td>140</td>
<td>90</td>
<td>170</td>
<td>100</td>
<td>160</td>
<td>190</td>
<td>30</td>
<td>40</td>
<td>140</td>
<td>0</td>
</tr>
<tr>
<td>Wind Speed (Avg Monthly)</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

RECORDED HIGH - DESIGN HIGH:
AVERAGE HIGH - AVERAGE LOW - DESIGN LOW - RECORDED LOW:

COMFORT ZONE:

DESIGN HIGH: Non-Residential...
1% of Hours Above
5% of Hours Above
0% of Hours Above
DESIGN LOW: Non-Residential...
1% of Hours Below
5% of Hours Below
0% of Hours Below

TEMPERATURE RANGE:
-15 to 45 °C
Fit to Data

IMPERIAL RANGE:
-5 to 10 °F

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC Annual
CLIMATE DESIGN

The building has three climate systems: main system, regulating system and supporting system. Ground collectors are used to build the systems which are installed 2 meters below the foundation of the building.

Main system:
Ground collector and concrete floor as thermal mass consists the heat exchange system.

Regulating system:
Ground heat pump system to provide extra cooling or heating to the floor if needed.

Supporting system:
Roof heat collector with air conduct combined with air – water heat pump helps to provide extra heat to the main system. Thereto windows can be opened in varying degrees to realize natural ventilation.

A: ground collectors
B: concrete floor as thermal mass
C: heat pump
D: hot water tank
E: roof heat collector

① heat exchanger
② water-water heat pump
③ air-water heat pump
The floor is heated on two sides. Roof window shutter and façade shutter are open to allow the solar radiation to heat the floor. At the same time the heat in the ground is transferred to the floor by heat exchanger. Heat pump can also help to heat the floor if necessary. The heat collected by the roof window can be stored in the ground collector. The hot water in the building is provided by the water-water heat pump. Some of the roof windows are opened to a very small degree to help realize natural ventilation in the room.
WINTER CLOUDY DAY

Roof window shutter and façade shutter are open. The heat collecting system on the roof is closed. The heat in the ground which is stored in the sunny day is transferred to the floor by heat exchanger. Heat pump can also help to heat the floor if necessary. The hot water in the building is provided by the water-water heat pump. Some of the roof windows are opened to a very small degree to help realize natural ventilation in the room.
SUMMER SUNNY DAY

Roof window shutter and façade shutter are closed to reduce the solar radiation. The heat on the floor is transferred to the ground by heat exchanger and heat pump can help to cool the floor if necessary. The heat collected by the roof window is transferred to the water by air-water heat pump which can be stored in the hot water tank. Some of the roof windows and fans on the roof are opened to help realize natural ventilation in the room.
SUMMER CLOUDY DAY

Roof window shutter and façade shutter are open. The heat on the floor is transferred to the ground by heat exchanger and heat pump can help to cool the floor if necessary. The heat collecting system on the roof is closed. The hot water in the building is provided by the water-water heat pump. Some of the roof windows and fans on the roof are opened to help realize natural ventilation in the room.
SOLID CORE CLIMATE DESIGN

Different ventilation strategies are used in different parts of the building. Natural ventilation is mainly used in the main body of the building which is mainly achieved by opening the facades and roof windows. The exhausting fan is combined with column and roof window to support the ventilation and cooling if needed.

Number of fans needed in the main body of the building:

\[
430 \times 50/3600 = 5.97 \text{m}^3/\text{s} \quad \frac{5.97}{3} \text{m/s} = 2
\]

The solid core share the same ground climate system with the main part of the building. In the solid core the air inlet machine is combined with floor. Thus the solid core can keep solid while at the same time achieve ventilation and get enough sunlight at the same time. Due to the special function, the rehearsal room has extra cooling machine inside.
REFLECTION

In this reflection the student uses a short substantiated explanation to account for the results of the research and design in the graduation phase (product, process, planning). The aim of the reflection is to look back and see if your approach worked, to understand the "how and why", and subsequently to learn from this. The choice of method (how) and argumentation (why) which preceded the research was a part of your study plan - the reflection must contain an answer to the question of how and why the approach did or did not work, and to what extent. Depending on the research and design, reflection on a number of the following aspects should be included (you may choose in which order). The reflection should be in the form of a text, with diagrams and sketches for purposes of illustration and clarification.

Aspect 1: The relationship between research and design
Aspect 2: The relationship between the theme of the graduation lab and the subject/case study chosen by the student within this framework (location/object)
Aspect 3: The relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework
Aspect 4: The relationship between the project and the wider social context

'Delta Interventions is a design studio with a strong emphasis on the translation of research output into design concepts.' (Design Delta Intervention for Architecture course information) It is also a studio which has a close relation to water. The project starts from the Galveston Bay and ends with the 1:5 details of the building. The research is also from the delta scale to the urban scale then to the architecture scale and finally the details. The process of developing the project needs a strong connection between each step. What’s more, another important factor should be taken into account during the whole process depending on the topic of delta intervention studio: hurricane. It should be reflected on every steps of designing. The structure of the design process is like a chain with triangular links which are overlapping and connect with each other. Each ‘triangle’ is the main topic of one character which corresponds to one scale or aspect. (figure7.1)

After the research on Galveston bay area I chose the Galveston city and after the urban scale research I chose the intersection of two boundaries as my site. After the research on the site and people’s activities, I made the theme of my project ‘Live with water’ aiming to extend urban life of Galveston city and tourism activities to the waterfront. My proposal is creating a recreational system onto the sea to provide different layers of water related experiences by the urban design. And by using different strategies to deal with flood threat on different parts of the recreational system depending on its character.

I chose Galveston urban center as my main project to develop since it is an important link between the city and the recreational system. The water part locates on the pier and the land part locates on the marine park. The artificial pier system on the water and the park on the land can both be seen as the landscape below the urban center which can be called lower layer system. And the sloped green roof can be seen as the upper layer landscape which forms the building. (figure7.2) The building is not isolated, it is close related to the landscape. So the architecture scale research question is how to integrate Galveston urban center with the landscape from both exterior and interior.

In this case, both of two parts are elevated higher than the seawall to avoid the water problem. So they are facing the same level hurricane challenge. But the land part has more complicated landscape and function than the water part. So I chose the land part of urban center to mainly develop. (figure7.3) The designing process are divided into different layers. The artificial landscape continue to the interior of the building step by step. (figure7.4)

The building has a double layer wall system: The transparency, flexible outer wall and the isolated inner wall of each building/room. There are three kinds of inner buildings: solid core with solid concrete load bearing wall which is also the main structure of the building; glass core with removable glass façade; isolated concrete building which is solid enough to resist the hurricane. The outer wall reflects the public character of the urban center. It is transparent and flexible, the exterior landscape can be seen clearly continue to the interior of the building. The interior building cores and columns are like plants growing on the landscape. (figure7.5)

The solid core is the main structure to fix the roof together with the column. When the hurricane came, all the flexible walls and facilities can be removed to the solid core and isolated concrete building and be well protected. And the rest which is built as exterior elements are left to resist the hurricane. Thus can meet the demands of reducing damage and recover easily and quickly. The hurricane prevention strategy is also coherent with the urban concept and building concept. (figure7.6)

The column, facades and roof window are all designed to meet the architectural concept and hurricane prevention strategy. I choose the branch column for the building since it meets the concept of public space quality and hurricane prevention both well. The land part of the building is protected by the seawall and the water part of the building is elevated. There won’t be much water problem for the building but the wind. The structure of the building should be solid enough to protect the roof from overturning. The branch column can provide a stronger column than normal one. What’s more the space quality is improved by the branch column. It can be a symbol of ‘landscape go inside’ and provide more exterior sense to interior. (figure7.7) The outer façade is made of several units which can be moved up and down flexibly for ventilation and as entrances. It also can be hidden in the roof when the hurricane comes. (figure7.8)

Living with water is not only live with water geographically but also spiritually and take advantage of it. The project tries to utilize water adaptive strategy on different scale. And the concept of each ‘triangle’ is coherent. By integrating architecture with the landscape the public space quality is improved and the public activities are extended from both interior and exterior.

The project is tentative to some degree: building a recreational system onto the sea for a barrier island. It seems like choosing a most dangerous place to do the most dangerous thing. For Galveston city, there can be many choices and strategies. My choice is a less common one than building in a safer place protected by the seawall, but it is worth trying. And many cities have already expand the urban area to the waterside successfully. What the project provide is an attitude and a possibility to live with water and enjoy water to the maximum degree. Extending urban life and tourists activities onto the water can make Galveston city more attractive and inject new vitality to the city. A new attempt always brings some risk, but the risk is not the reason to give it up. So one of the goals of the project is to solve the problem and reduce the risk by designing.
Structure

History Hurricane Public Space Quality

Galveston Bay Urban Architecture & Landscape

Figure 7.1: The structure of the design process

Figure 7.2: Two layers of landscape

Figure 7.3: Main project

Figure 7.4: Landscape continuity

Figure 7.5: Wall system

Figure 7.6: Hurricane prevention strategy

Figure 7.7: Branch column

Figure 7.8: Flexible facade
BIBLIOGRAPHY

A


D


F


