STILL WATER
WATER-RELATED SANATORIUM
AND PUBLIC WATERFRONT DESIGN
DICHAO WANG 4314433
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Foreword


Delta Intervention is a graduation studio aiming to deal with design projects in water related areas, which covers urbanism, architecture and landscape architecture fields. Students in Delta Intervention Studio are allowed to carry on their own researches based on the current situations of chosen site. According to a set of conventional research methods, we are trained to state a systematic architectural solution in a delta area by a series of amphibious architecture solution methods thought from a series of seminars and lectures in studio.

My final design project is UTMB Waterfront Rehabilitation Center in Galveston. It is an amphibious building as one part of UTMB's future expansion plan. Actually it consists of three parts, first is the design of main building on the dike, second is the floating houses as extra patient facilities along the port, third is a comprehensive landscape design of the whole port area as a public waterfront space. All three parts elaborate a view of multiple layers of water protection measurement.

This Graduation Project mainly present the first part, go deep into technical, constructional and installations details, while the inner relationship between a water related building and the urban environment is also presented as an important context in the design progress.

The whole project will be divided into two main parts, one is the Research Part, which is mainly about the current situation of Galveston Bay area and also surrounding environment of the chosen site. It can answer 'why do I choose the site'. This part is the supporting material for the second part, Design Part. The design part aim to display a process of decisions rather than a solitude final production.
Chapter I. Research Part

1. General Introduction
Delta Intervention Graduation Studio

2. Site Introduction
Mapping/Urban Analysis/Ecology/Water Condition

3. Problems Statement
Water Risk/ Economy Depression/ Current Situation

4. Design Assignment
Chapter II. Design Part

1. Urban Intervention / Design of Mass
   Amphibious Architecture Method/ Multiple Scheme Comparison

2. Interior Organization

3. Technical Design
   Steel Frame/ Infrasplus Floor

4. Facades

5. Installations
   HVAC System/ Double Thermal Activation/ Removable Material

6. Appendix
Introduction
Delta landscapes speak up to our imagination. They are deliquescent landscapes, where land mingles with water, where the solid meets the fluid, the tactile the endless, the defined the undefined. They display natural dynamics and ecological richness, and are attractive places for settlement and culture, for industry, trade and tourism. Worldwide, they are the site of ceaseless processes of transformation and urbanization. Their dynamics, their variety and their beauty are a challenge for designers of cities, infrastructures and landscapes.

Due to a changing climate and new insights concerning sustainability, new interventions will be needed. In addition to safety and better water-systems, there is a need for stronger spatial identities and new cohesion between cities and their water-landscapes. This asks for interdisciplinary cooperation between architects, urban designers, planners, civil engineers and landscape architects. Delta Interventions therefore is an interdisciplinary studio which, on a wide variety of scales, deals with transformations in delta landscapes.

In 2014-2015 the studio will focus on both the Galveston Bay (Houston, Texas) and the Dutch IJsselmeer area. The projects within these areas can vary from large scale concepts and strategies to small scale designs or bottom up interventions; from buildings, constructions, public works, outdoor spaces, to urban areas, landscapes and regions.

Delta interventions is a design studio with a strong emphasis on the reciprocity between research and design. During the graduation year student will further develop design skills and learn how to use and develop different research and design methods. You will be challenged to reflect on them. You will learn to integrate knowledge from other disciplines and to get in control of complex integral design assignments. This focus on design gives you the opportunity to produce a strong
and visually attractive portfolio project. The studio stipulates sufficient experience and pleasure with designing in previous years of your study.

The Galveston Bay area in Houston is the frontier of Texas faced with Mexico Gulf. It is an important county with historical value and also important Health Care facilities and Insurance Institution. High water risk within this area cost enormous casualties and properties losses. Dutch's advanced experience on water risk management has been proved practical on their own coast, but how it will be related to a foreign site should be further examined. Besides, different traditions of amphibious architectures in Galveston are also precious complement to Dutch's experience. Differ from Dutch's coast, the United States West Coast is a place with high frequency of storm and hurricane. How can Architects intervene to some extreme situation, will be found in Delta Intervention Studio.
Galveston

Galveston is a coastal city located on Galveston Island and Pelican Island in the U.S. state of Texas. The community of 208.3 square miles (539 km2), with its population of 47,762 people (2012 Census estimate), is the county seat and second-largest municipality of Galveston County. It is located within Houston The Woodlands Sugar Land metropolitan area.

Named after Bernardo de G lvez y Madrid, Count of G lvez (born in M laga, Spain), Galveston’s first European settlements on the island were constructed around 1816 by French pirate Louis-Michel Aury to help the fledgling Republic of Mexico fight Spain. The Port of Galveston was established in 1825 by the Congress of Mexico following its successful independence from Spain. The city served as the main port for the Texas Navy during the Texas Revolution, and later served as the capital of the Galveston County.

There is two-hour driving from Galveston to Houston City Center and there are no public transportation from Galveston to Houston, the most efficient way is to rent a car.
3. DELTA INTERVENTION

Delta Intervention Studio

Figure 1-2-3,4,5,6,7,8
Houston Street Photograph
(Source: Author)
Houston

Houston is the largest city in Texas, the forth largest city of America, with population of 2 million. The population of Houston in 1900 had already reached 45000, it increased to 1.9 million in 2000 and broke 2 million in 2004. It is famous for their astronomy industry, petrochemistry industry, and modern art (especially visual art). It is the sixth largest harbour of USA. There are 1500.7 km² land area and 57.7 km² water area.

Houston was originally established by two real estate entrepreneurs, Augustus Chapman Allen and John Kirby Allen in 1836. The Allen Brothers purchased 6642 acres of land along Buffalo Bayou and found a city named after Sam Houston, who is a popular general and was elected as President of Texas in September 1836.

Kathryn J. Whitmire was elected as the first female mayor of Houston, who was in office from 1981 to 1991.

Lee P. Brown is first African American Houston mayor, as the Whitmire's successor, he was reelected twice to serve the maximum of three terms from 1998 to 2004.

Texas has 254 counties. Houston locate in the south-east coast area who has the highest population density in Texas state.

Since establishment, Houston keep expansion throughout 20th century. From a tiny spot along Buffalo Bayou to a 6th large metropolitan of United States. The development of railway system and the discovery of oil are two most important historical events resulting in the boom of Houston's population and urban scale.

During the mid-age of 20th century because of the oil crisis the development of Houston experienced a period of stagnant, after that the development of medical care facility and astronomy industry replaced the oil industry as the new growing point.
Figure 1-1-10
Houston Urban Expansion Progress
(Source: Author)
Galveston is famous for its historical district on the island and the UTMB campus nowadays. Within the historical district, there are several places of interests such as the train station museum, the Rosenberg Library and historical streets.

Because of the coastal location, Galveston is regarded as a holiday resort, especially Houston people drove to Galveston during summer vacation, thus tourism is one of the supporting industry of Galveston.

Bay Area
Texas locates on the south coast of Mexico Gulf, within the Texas administrative district there are six bay along the coast, which are Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, Laguna Madre.

When it comes to the Galveston Bay, based on the administrative division of Houston, Galveston Bay area is surrounded by 5 counties, which are Liberty, Chambers, Harris, Brazoria and Galveston. There are 6 bay areas belong to Texas along the Mexico Gulf.

The Bay can be divided into four parts, Trinity Bay, East Bay, Galveston Bay, West Bay.

Houston Urban Analysis
The mapping analysis show the distribution of industry area (brown) and greenland (green) within Houston City. It shows that along Buffalo Bayou there is the main industry area because of the convenience of shipping transportation. Lack of green landscape is one of existed problem of Houston's urban situation. Large area of greenlands are far away from the city center.

The establishment of railway system and the discovery of oil is two important period of Houston's urban expansion.

The transportation network in Houston is centered on the city center, weaved by ring roads and radius roads. The construction of highway from Houston to Galveston make Galveston accessible besides the railway. Nowadays there is already no passenger train drive to Galveston.
3. DELTA INTERVENTION

Delta Intervention Studio

Figure 1-1-20
Houston Houston Industry Area and Greenland Distribution
(Source: Author)

Figure 1-1-17,18,19
The Galveston Bay Area
(Source: http://tidesandcurrents.noaa.gov)
There are five main education institutions within Houston city. Which are the Rice University(1), University of Houston(2), Texas Southern University(3), University of St Thomas(4), The University of Houston-Clear Lake(5).

Besides, there are also other popular place in Houston. Among which the most famous ones are Texas Medical Centre(A) and N.A.S.A Center(B).

N.A.S.A center locate to the south east of Houston’s urban area while Texas Medical Center is close to the city center. Texas Medical Center is the world’s largest medical center with one of the highest densities of clinical facilities for patient care, basic science, and translational research. Meanwhile the Buffalo Bayou’s Industrial Area(C) is also famous port for the delivery of agriculture products and petro-chemistry products.

There are four main supporting economy of Houston, the Oil industry, the Bio-chemistry industry, the astronomy industry and the Petro-chemistry industry.
3. DELTA INTERVENTION

Delta Intervention Studio

Figure 1-1-7
Location of NASA and Medical Centre.
(Source: Author)

Figure 1-1-8
Houston’s colleges and Universities
(Source: Google Image)
Figure 1-1-9
3*3*3 Mapping Analysis
(Source: Delta Intervention Studio)
3. Delta Intervention

Delta Intervention Studio

Railway System
1865

Water Condition
Current Situation

1865

Railway System
1905

Urban Fabric
Current Situation

1905

Railway System
1968

Railway System
Current Situation

1968
UTMB

The University of Texas Medical Branch is a component of the University of Texas System located in Galveston. It is an academic health center with 11000 employees and a medical school that is the oldest in Texas. Established in 1891, it has schools of medicine, nursing, allied health professions, and a graduate school of biomedical sciences, as well as an institute for medical humanities.

The UTMB Campus located on the Galveston Island, which is close to the port area. The main road of Galveston, harborside driven connect two main district of Galveston Island. One is the city center, or the Galveston His-
3. Delta Intervention

Delta Intervention Studio

There is a U-shape waterfront area close to the campus and our site is within this area. There are a few ports of cruise ship near the district so that a good view should be taken into consideration.

The U-shape waterfront area locate on the end of the Harbor area, which is the only 'sight gallery' to the sea from the campus. UTMB campus is surrounded by residence area, there is a ville district on the east and normal residence on the east, the U-shape waterfront area act like a buffer zone to separate the industrial area and tranquil residence zone. What's more, compared with the south coast line of galveston where the Ike dike has been built after 2008's hurricane there is nothing on the north coast even UTMB had suffered from the hurricane almost the same level.

Because of the strong seawall on the south coast, there is few high-qualified waterfront urban space for local people, especially on the north coast where harbor occupied almost the whole coast line. Therefore, the U-shape waterfront area seems to be a focal point of all contradiction including urban landscape, medical universities’ expansion, surge protection and transportation.
The site of this project remains nature land with curved paths and green areas without artificial management.

The residence district is planned based on a grid system and is full of small-scale residences. The infrastructure system and block outline are planned within a regular form.

The UTMB campus texture is totally different from all surrounding areas, with many education buildings and open outdoor areas. It is an area with multiple building plans and low density, represented by a special texture.

Harbor area is Galveston's typical urban texture with a large area of hard paving ground and regular shape container yards. The coastline of the harbor area is straight and artificial, contrary to natural coastline.

Two core districts of Galveston: The Strand Historical District and the UTMB campus are two core districts of the Galveston urban organization, lying along the same main road with a distance of about 4 km.
Two Core Districts of Galveston

The Strand Historical District and the UTMB campus are two core district of the Galveston Urban organization, which lie along a same mainroad with distance of about 4 km.

Natural Land Texture

The site of this project remain nature land with curved path and greenland without artificial management.

Residence District Texture

The residence district are planed based on a grid system and full of small scale of residence building. The infrastructure system and block outline are planed within a regular form.

Campus District Texture

The UTMB campus texture is totally different from all surrounding area with lot of education buildings and open outdoor area. It is an area with multiple buildings plan forms and low density, which is represented by a special texture.

Harbor District Texture

Harbor area is Galveston’s typical urban texture with a large area of hard paving ground and regular shape of container yards. The coast line of Harbor area is straight and artificial in order to keep ships working, differ from natural coastline.
The Old Red

The old red is the landmark of UTMB campus, which is the oldest building with typical colonialism style in the campus. Now it is used as the Graduate School of Biomedical Science. Interestingly, the old red is the only one survived from countless storm and hurricane, there must be some principles in its structure system which provide a high quality in water prevention.
Figure 1-2-20, 21, 22, 23, 24, 25
UTMB Campus Photograph
(Source: Author)
Port Transportation
The port of Galveston suffered significant water damage to facilities and the community’s sewage and storm water drains are in need of much repair to avoid major flooding in the next heavy rainfall.

Health Care & Education
UTMB campus require the highest water safety level within the island and even though it suffered from water damage which may cost enormous economical lost, especially the damage of some health care installations.

Economy Challenges
The port transportation and Health Care & Education are the two main economical support of Galveston. Including other industries like maritime industry, tourism and financial & insurance service, there is estimated 2.3 billion dollars of investment per year till 2008. However, they both face with some significant challenges.

According to the database of Galveston’s GIS system we can easily see the distribution of important historical spot in the Galveston. And the U-shape waterfront site is included in the undevelopment plan zone, from the UTMB’s official future plan about the land usage, there are some health care and education facilities to be built, which agree with our design conception.

From the flood prevention map we can see that the position of the Campus require the highest water safety all around the island, which means some water prevent measurement need to be done to inforce the water safety especially in the north direction.
The hurricane Ike in 2008 makes a landfall at Galveston as a large Category 2 hurricane. Its large size contributes to a storm surge that is as high as 6.1m which inundates many of the barrier islands off the texas coast. Hurricane Ike caused 84 deaths in 2008, ranking the first place on the list of hurricanes causing known deaths. Hurricane Rita in 2005 caused 59 deaths, ranking 2nd place. Hurricane Allison in 2001 caused 23 deaths, ranking 3rd place. It seems the hurricane damage becomes increasingly fatal when it comes to the 21st century. Galveston as the Texas’s frontier faced with Mexico Gulf, suffered from this series of hurricane. During the Hurricane Ike, UTMB suffered from the storm and flood, which caused financial loss. Even though UTMB locates on the highest land of Galveston Island, the flood invaded into campus from the north coast.

After that, UTMB carried out a series of policy to enforce the water prevention level of all facilities.
After Hurricane Ike, various flood prevention measurements were issued, and various flood risk prevention research were carried out. Multiple layers of surge protection from urban scale to construction scale obtained increasingly approval. In the case of Galveston, the protection of the north coast are also ought to focus on multiple layers. Both water gates on the estuary and surge protection are assumed in the future construction plan.
When it comes to the height calculation of the surge protection, it corresponds to aspects of civil engineering and water conditions. From the image, we can see the MSL height here in Galveston is 3.9m.

The general calculation method is that:

\[
\text{Dike Height} = \text{Maximum Tide Height} + \text{Wind Set up} + \text{Sea Level Rising Height} + \text{Safety Height}
\]

Considering that the dike lift the harborside driven and the lifting height should not hinder the harbor area's transportation. So we calculate a general height of the dike is 3.6m.
Figure 1-2-34
Galveston Satellite Map before Hurricane Ike
(Source: NASA)

Figure 1-2-35
Galveston Satellite Map after Hurricane Ike
(Source: NASA)
The UTMB campus located along the main coastal road. The building distribution of the campus seemed overwhelming concentrated in their inner environment. The elevation along the main road applied stone and concrete as their main material, which seems too strong and closing without enough windows and light materials. The lack of connection between the campus and the waterfront is an increasingly essential problem of this area.
The Strand Road and the University Road is the two main axies domaining the whole campus. The two main cruise ferry are also located close to our site which are important spots of water transportation.
Urban Fabric Analysis
From the urban fabric analysis we can see that surrounded with four different typical urban texture of galveston. Our site is located in an intersection spot of the city. A boundary of different income family, a boundary of different urban district.

The Current Situation
From photographs we can see that large scale of vegetation on our site, unplaned landscape and land functions, qualified view of the water area, which is the most valuable landscape resources of this site.

Due to the surge protection measurement, the ground level of the harborside driven will be lifted up as the dike area. Which means that the visual connection from the campus to the U-shape waterfront will be cut off. The parking area on the waterfront area become less accessible. Also there are two fairy port within the U-shape waterfront area, it is necessary to rebuild the connection of the waterfront area and the inner urban district.

Figure 2-1-3
U-shape Site and Surrounding Environment
(Source: Author)

Figure 2-1-4
Real Situation of U-shape Site
(Source: Author)
The Street Elevation Analysis
The UTMB campus located along the main coastal road. But the whole building distribution of the campus seemed overwhelming concentrated in their inner environment. The elevation along the main road applied stone and concrete as their main material, which seems too strong and closing without enough windows and light materials. The lack of connection between the campus and the waterfront is a increasingly essential problem of this area.
BREAK UP
The position of the dike break up the connection of the campus and waterfront area both in aspect of transportation and view.

PARKING
There is parking space for the university on both side of the U-shaped site. Now the accessibility of the parking space seems to be impossible.

CONNECTION
It require a entrance from the lifted main road to the parking space as well as a connection from the parking site to the Campus building.

WATER RISK
Due to the U-shaped site, there is potential water risk on the site. The dike can protect the campus except the site outside the dike. Hereby the design of the new building must fully take the flood risk in to consideration.

BREAK UP
The position of the dike break up the connection of

PARKING
There is parking space for the university on

CONNECTION
It require a entrance from the lifted main road

WATER RISK
Due to the U-shaped site, there is potential
MEASUREMENT APPLIED IN THE FUTURE

Faculty Recruitment
- Expand priority research programs
- Increase clinical service and revenue
- Support enrollment growth

Health System Capacity Management
- Meet patient's needs
- Support academic programs
- Increase revenue

Facilities Restoration and Expansion
- Repair/mitigate Hurricane Ike damage
- Renovate/modernize existing facilities
- Plan for facilities expansion

CAMPUS STROM MITIGATION PLAN

Mission Critical Functions
- Located above 20 feet in existing buildings
- Located above 25 feet in new buildings

Uses Below 20 Feet
- Classrooms, conference rooms, and noncritical functions
- Protect against water infiltration where feasible
- Life safety and mission-critical functions to be preserved
- Designate alternate locations/arrangement
Are you satisfied with the current facilities in the Campus?

Are you satisfied with the current transportation condition in the Campus?

Are you satisfied with the current environment in/surrounding the Campus?

Do you think it lack waterfront landscape in Galveston's urban district?

Do you worry about the water safety in UTMB?
Problem Statement
1. LIFTING
The building on piles owe a good adoptable to water risk while flood period and keep a comfortable connection to the waterfront area.

2. FLOATING
Floating house can lift up and down based on the water level, and movable if fixed with drive engine. Can survive from flood devastation.

3. PREVENTING
Buildings along dike can be regarded as an expansion of the dike, it can prevent water tide by the strong concrete form and ensure the interior safety.
SCHEME 1

ADVANTAGES
A good condition of view
Well adaptable to the flood-risk environment

DISADVANTAGES
Lack of connections to the ground environment
Single entrance easily resulted to the chaos of circulation

SCHEME 2

ADVANTAGES
Floating house can lift up and down according to the water level, can survive during flood period. Can merge into the ground environment. A good type to organise complex program of sanatorium and hospitals.

DISADVANTAGES
Lack of connections to the UTMB campus area. Far from the main road, bad accessibility. Not visible, bad accessibility.

SCHEME 3

ADVANTAGES
A good way of architecture distribution to dominant the site. Multiple entrances for the complex programme. Good condition of view. Solve the problem of parking spaces accessibility.

DISADVANTAGES
Too long distance between two main bodys of the architecture. Difficult to organise the circulation. Problems of daylighting.
3. DELTA INTERVENTION

SCHEME 4

ADVANTAGES
Both connected to the campus and the coastal site
Good condition of water safety

DISADVANTAGES
Hinder the construction of dike.
Lack of windows on coastal-side elevation.
The courtyard in the building has problem of drainage during flood time.

SCHEME 5

ADVANTAGES
Good condition of view.
Good accessibility to the UTMB campus.

DISADVANTAGES
Bad adaptable to the flood time
Isolated from the park area

SCHEME 6

ADVANTAGES
Good condition of view.
Both good connection to the site and campus area.

DISADVANTAGES
Bad adaptable to the flood risk (especially the entrance part).
3. DELTA INTERVENTION

SCHEME 7

ADVANTAGES
Both connected to the campus and the coastal site.
Good condition of water safety.
Visible to the users along the dike.

DISADVANTAGES
Ignore the parking space on the other side.
Too long circulation.

SCHEME 8

THE BEST SOLUTION
Due to the design mass selection, a building expanded beyond the dike will be regarded as a sort of land mark on the north coast of UTMB. However, it may bring about a series of problems. Firstly, the ground floor on the waterfront has the risk of water damage, so the construction of ground floor should be different from the upper three floors. Secondly, the building obscure the Harborside Drive, so the first floor on the dike should be liberted for the road.

The upper three floors act as different functions, because of the special terrances form, it looks like three boxes flowing in the air, the form represent the program clearly. Thirdly, the building mainly act as a connector from the parking space to the campus, therefore the entrance on the waterfront site and the main stairway guiding people from the port area to the trauma center’s big platform should be emphasized both formally and spatially.
FUNCTION DISTRIBUTION
Vertical distribution is the basis of the building's function programme. The training center part is on the top floor and the ground floor is only for temporary facilities because of water risk.

DETAILED PROGRAM
There is a part of intersection between the ranges of training and rehabilitation. For the rehabilitation part, it is divided into three groups. First is the department of therapy, including both normal therapy and some specific therapy with medical equipments (like ultrasonic equipment; ultraviolet equipment). The second is for all dietary and recreation demand. The third part is all administration and housekeeping program providing logistic guarantee. The intersection part is a series of treatment room as well as a training place, the interns provide nursing service to the patient as their own career training.
Department of Therapy
Therapy rooms mainly located on the 1st floor and 3rd floor. The 3rd floor therapy rooms are examining rooms and therapy rooms with medical facilities.

Department of Recreation
Department of Recreation are mainly on the 2nd and ground floor except gyms on the 1st floor. Cause 2nd floor contents large area of public space and is the main corridor from the parking space to the campus.

Department of Administration and Housekeeping
Each floor are equipped with relevant house keeping rooms.

Trainning Center
Training center is all on the 3rd floor, with a set of seminar rooms for lectures and laboratories for experiment and also offices and consultant rooms for the interns' career consultation.
The Original Program was based on the reference of rehabilitation center and the site's current situation.

Message from Gordon Blocker about the Medical Training Part

Interestingly, because of government budgets in the State of Texas, there is an effort to create more medical telecommunication capabilities so that doctors can provide health care via online. As a teaching facility however, it is first a source of income for general operations at UTMB and second, a training facility for interns and resident to get practical experience beyond a classroom/academic setting. Another way to put it could be called hands-on training for the young doctors.
PLAN
1. Concrete Core
The building has four cores in a row to solve the vertical transportation as well as ventilation and all other logistic supplement. Differed from some highrise building, here the core is not the main load bearing elements. In aspect of structure, the cores here are to add stability and offset horizontal wind load.

2. Steel Columns
The columns here are the main load bearing elements. The latitudinal direction is the main direction of the building. We designed the best position of the columns according to the bending moment.

3. I-Beam Frame
The whole construction system is steel frame. I-beams are the main beams of the building. We make decision on the dimension of the I-beam according to the span and support ability.
4. Concrete Floor
Floors are made of concrete, supported by the latitudinal I-beams. Beams along the crosswise direction act as simply connectors.

5. Subfloor
The infraplus floor type cover the whole area of the building including both inside and outside.

6. Staircase
Because of the stairs on both edge of the building. Part of the beams are canceled to ensure the accessibility of the stairs.
Three Layers of Beams
The steel frame applies unified I-beam as the load-bearing elements. The longitude direction is regarded as the main direction, so the longitude beam is the main load bearing beams. The short direction beams are only acting as connections. However, the middle beams on the longitude direction are not fixed to the columns, so they are different from others. Because the best span of the infrasplus vloer is 3 to 4 meters, so the middle beams are to support floors. They are like a third level of load bearing elements, they deliver load to the short side beams and then, the short side beams deliver load to the other longitude beams.
1. Architectural Aspect

We want to create a pure interior longitudinal space without the block of ceilings. We aim to expose the main beams of the steel frame in order to make the construction logic transparent.

2. Construction Aspect

Lighter weight. The integrated solution can speed up the integration of construction and all climatic installation. Infraplus vloer can save floor height compared with traditional floor.

3. Climate Aspect

We want to hide all air duct under floor to create a pure interior perspective and also a better acoustic environment. Double thermal activation, especially ceiling thermal activation play an important role in thermal environment design. Which requires no ceiling blocking the cooling process. We aim to expose the main beams of the steel frame in order to make the construction logic transparent.
3. DELTA INTERVENTION
IDES FLOOR and INFRA+ FLOOR are two types of overhead floor which can put HVAC system installations in the interlayers. They have different construction logic and different properties we list a pro and con to evaluate which type works better in our design.

**IDES FLOOR**

**PRO**
1. Save floor space
2. Precast concrete floor slab, lower cost.

**CON**
1. The main beams block the expansion crosswide of the installation pipes, they can only be installed freely along one direction.
2. Lack of integrity, cause every floor slab is fixed to the main beams independently.

**INFRA+ FLOOR**

**PRO:**
1. The steel cassette embedded in the concrete floor, better stability.
2. The cassettes are possessed lengthways, and the holes on the cassettes enable installation pipes penetrate both crosswide and lengthways.
3. Still space beneath floors for ceiling.

**CON**
1. The total height of the system is more than the IDELS system, so it will take more floor space.
3. DELTA INTERVENTION

Delta Intervention Studio

[Diagram showing various architectural details and specifications]

- 22 mm stone cladding
- 15 mm timber paving
- 70 mm corrugated steel decking
- 350 mm Surge Protection
- 30 mm stone cladding
- 10 mm plasterboard
- 120 mm insulation
- Beam fire protection

[Image of wall details]
When it comes to the ventilation system, more attention should be paid when dealing with health care building than other normal buildings. Cause health care buildings require a higher air condition than other buildings, the requirement of ventilation installations are also different from other buildings.

HVAC system are regularly applied into health care buildings, which means Heating, Ventilation, Air Conditioning system. There are various types of installations of HVAC systems. Decision should be made carefully based on the specific program.

**Constant Air Volume System or Variable Air Volume System?**

Constant Air Volume System

Pro:
1. Centralized layout, easy to maintain.
2. Lower initial investment and maintenance cost.

Con:
1. Higher energy cost compared with variable air volume system because of a constant flow rate all the time.

Variable Air Volume System

Pro:
- Smaller dimension of fan. Reduce energy cost by turning down flow during off-peak period.
- Better thermal control
- Better humidity control
- Fit for both Constant Air Volume System and Variable Constant Air Volume System.

Con:
- Higher initial investment.
- More installation space required.

Double Duct System

Pro:
- Better thermal control
- Better humidity control
- Fit for both Constant Air Volume System and Variable Constant Air Volume System.

Con:
- Higher initial investment.
- More installation space required.

Single duct system

Pro:
- Fewer flexibility on temperature and humidity.

Con:
- Easy maintenance.

Therefore after such an evoluation process it seems clear a variable air volume, single duct system is more fit for our project.
We decide to apply lower air supply method in each room, it can supply fresh air to the patients more efficiently. The main ducts distribution are shown on the image. The vertical ducts are positioned in each concrete core, what’s more, an extra room for air handler is arranged on each floor and the volume of the air handler will be calculated next page, the dimension of the ducts are also calculated according to an reliable discipline.
Which type of installation is needed in which room?[Technical program for each room/function]

I already started doing research on the indoor climate and relevant installations including thermal environment/indoor condition/sound/light. These four aspects will connect to the infraplus vloer technique as we discussed before. So first we go into the indoor condition aspect.

1. Air Condition
   The principles of indoor air circulation especially in the health-care buildings are,
   A. **Zoning the interior space, follow different air condition standards due to different zones**
   B. Determine the air inlet location in each room
   C. Determine the new air volume, the dimension of supply duct.

A-- Zoning is quite important in the ventilation design especially in the health-care building. Each floor should be divided into several zones according to the hygiene level in order to keep high efficiency and prevent cross infection. There is a rigid rule about ventilation zoning and pressure gradient in infectious hospitals. Considering our project is a general rehabilitation center having nothing to do with infectious disease. I made a general partition based on the main function of each part.
Actually zoning method is practical in a typical hospital buildings, especially a hospital with infection ward, it require a stabel air pressure to keep a constant air circulation. Here without a infection ward it is no necessary to set multiple zones, a set of unify air supliment will be more efficient except the fitness rooms. It require a cooler environment and more fresh air, which can be solved merely by floor thermal activation and variable air volume system.
B-- Determine the air inlet location in each room.
C-- Determine the new air volume, the dimension of supply duct.
I search on ventilation manual and find the calculation method of the dimension.

Duct Cross-Sectional
\[ \text{Area} = \frac{\text{Air Volume}}{\text{Air Speed}} \]
\[ \text{Air Volume} = \text{Room Volume} \times \text{Ventilation Rate} \]

Ventilation Rate means How many times do we renew the indoor air per hour. And there are existed routine of ventilation rate for different functional rooms.
The normal ventilation rate is 1 t/h, For some odor-causing rooms such as toilets (5-15t/h), printing rooms (5 t/h), dressing rooms (5 t/h), the ventilation rate is higher than normal rooms.
Generally, offices ventilation rate is 2-5 t/h; patient rooms ventilation rate is 2-4 t/h; seminar rooms ventilation rate is 3-8 t/h, infection rooms is more than 6 t/h.

Here we take one of the patient rooms as an example. The area is 26m², room height is 4.2m.
\[ \text{Room Volume} = \text{Area} \times \text{Height} = 26 \text{ m}^2 \times 4.2 \text{ m} = 109.2 \text{m}^2 \]

We set the ventilation rate as 4 t/h, so
\[ \text{Air Volume} = \text{Room Volume} \times \text{Ventilation Rate} = 109.2 \text{m}^2 \times 4 \text{ t/h} = 436.8 \text{ m}^3 \]

Here the air speed is also based on the experience (secondary duct in public building 4-6 m/s), so
\[ \text{Duct Cross-Sectional Area} = \frac{436.8 \text{ m}^3}{4 \text{ m/s}} / 3600 = 0.03 \text{ m}^2 \]

All available dimension of duct included 675*150; 550*175; 450*200; 400*225; 350*250; 300*300
Here I choose 550*175 one, it fit for the size of the infraplus vloer.
The Calculation of the Section Area of Air Handler

Estimated 75 people staying on the 1st floor. Comfortable air supplement is 10 liter/per person.

\[ 75 \times 10 = 0.75 \text{ m}^3/\text{s} \]

\[ 0.75 \text{ m}^3/\text{s} \times 3600 \text{ s/h} = 2.7 \text{ m}^3/\text{h} \]

\[ 2.7 \text{ m}^3/\text{h} / 2 \text{ m/s} = 1.35 \text{ m}^2 \]

The section area of air handler is 1.35 m².

The infraplus vloer cooperate with HVAC system, the height of the subfloor’s height should ensure the installation of ventilation ducts. The supply duct and return duct should prevent interference. All the attached installations such as air inlet pump, cooling towers will be positioned on the roof.
Removable Facade
The foundation of the city named San-Houston

The Houston was granted incorporation and selected first mayor.

The Galveston city was incorporated by the congress of the Republic of Texas.

Delta Intervention Studio
3. DELTA INTERVENTION

Delta Intervention Studio

The foundation of the city named San Houston was granted incorporation and selected first mayor. Houston had emerged as a commercial and railroad hub for the export of cotton. The Galveston city was incorporated by the congress of the Republic of Texas. City Expansion Reconstruction after American civil war. Hurricane and Reconstruction

The development of tourism. The economy enter into a stagnant because of disruption of gambling and prostitution.

Galveston Historical Foundation began its efforts to preserve historical buildings. Development of Higher education in Galveston.

Development of the Strand Historic District.


The Brown Shipbuilding Company start to build ship for U.S Navy.

The foundation of Texas Medical Center.

The establishment of NASA. Development of Aero

The population boom because of petroleum industry.

Tropical Storm Alison. Tropical Storm Katriona.

1940s -- 1950s 1957 1966 1960s 2008

The economy enter into disrupion of gambling and prostitution.

Galveston Historical Foundation began its efforts to preserve historical buildings.

Development of Higher education in Galveston.

Hurricane Ike.

Development of the Strand Historic District.
How it is related to program of similar building? Please reflect on your design.
How it is related to program of similar building? Please reflect on your design.

Here I take one of my references as an example. Okinawa Nursing Training Center. I learn from this building how to organize functional program as a medical training center. This building is a small scale complex with functions of a head office for nursing association and also nurses training and other practical techniques training, quite similar to my project.

The seminar rooms seem to be the core function for the aspect of training, and also several offices, consulting rooms and nursing station. Therefore I reorganize my project’s 3rd floor in order to make it fit for the practical use.