Renovation of Water-related City Border
The TMC Green Transfer

STUDIO: Delta Intervention Studio P5
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# Table of Contents

Part 1  The Research for Houston  
1.1 Introduction  
1.2 3X3  
1.3 Research Question  
1.4 Research Method  

Part 2  Project Definition  
2.1 TMC  
2.2 Problem  
2.3 Project Strategy  

Part 3  Design  
3.1 Urban design  
3.2 Building concept  
3.3 Programme  
3.4 Accessibility  
3.5 Climate  
3.6 Structure  
3.7 Facade  
3.8 Drawings and Details  

Part 4  Reflection
Part 1 The research for Houston

1.1 Introduction

The Delta Intervention Studio Deals with the practical problem of the water-related architecture design and urban planning. It’s a combination of architecture, civil engineering and management which provide practical reference for the real project in Houston. Due to a changing climate and changing insights concerning sustainable relations between cities and water-landscapes, new interventions will be needed to create a new urban delta-landscape. The task of an architect in this studio is to develop an architectonical object in such a waterscape.

The left map shows the flood risk of Houston and Galveston area within the 100-year storm surge. The areas along Galveston Bay and some rivers have great risk of inundation. Based on the study of the Rice University, Houston, like Galveston, is also threatened by Flooding because of the sea-level rise Rising. Sea level will pose increased hazards to coastal cities in various ways, especially the magnification of inundating storm surges that accompany hurricanes and other tropical storms. From the map of “Current Rates of Sea-level Rise”, the sea-level rises 25 inches per 100 years in Galveston.

The Houston city suffered a lot from the flood and storm. In the hurricane Ike, the galvenston island was almost destroyed.
1.2 3X3 Analysis

The pre-analysis of Delta Intervention is undertaken on 3 different layers. First, the water condition. Second, the infrastructure level. Third, the Urban Fabric.

The changes of the Galveston Bay costal line between 1850 and 1968, tell how the development of Houston rely on the water. The industry and shipping contributed a lot to the city, but also changed the water-related condition. Ports, factories, channels are made on the water sides.

The Urban fabric developed around downtown and Galveston Island. Most urban area is far from the bay, but quiet closed to the different Bayous and branches of the rivers.
Personal Interest
During the research, I am interested in the relationship among the river, city and buildings. I focus on the water condition of the bayous in Houston.
City, Bayou and Flood

I found the missing link between the inner city and the water area. Some factories and ports located along the bayou separate the waterfront and the community. The green space near the water is in lack of connection and well organization. Also the conflict between the flood defense and the public waterfront reminds me to consider flood defense technology in my architecture design. It is hard for the people to benefit from the waterfront.
How to renovate the water-related city border into better public waterfront with strong link to the inner city, as well as promoting the flood safety?

1.3 Research Question

How to renovate the water-related city border into better public waterfront with strong link to the inner city, as well as promoting the flood safety?
1.4 Research Method

The research method is to define the question in three levels: the city level, landscape level and the architecture level.

As an architecture student, the design will mainly focus on the building, including the structure, material, interior, climate strategy. In order to answer the research question, and to make a continue logic for this whole design part. The urban planning and landscape for a larger area is also been developed. But the urban design will not go into a lot of detail or too large. It will mainly help to define the architecture project and to show the whole concept of the research.
Part 2 Project Definition
2.1 TMC

I choose the watersides of the Texas Medical Centre along Brays bayou to be the site.

The TMC is consisted of 4 parts in planning. Now, only the Main Campus is finished. The Rice University is just beside the Main Campus.

The Texas Medical Centre Located besides the Brays Bayou, 6 km from the Houston Downtown. The only metro connect them. It is a trend that the city center will expand along the line. The Midtown and museum district are between them.
In the visit to TMC, I noticed that the waterfront had great potential to be better and cleaner public space, as it is so closed to the TMC Transfer Centre and the inner green park. It also can be a connection between the Herman Park and the community in the west in a larger scale.
Programe missed

The most institutions in TMC is not open to the public. A public education centre is in need for the whole TMC and the district near it.
Public Transportation

The Metro connect the Downtown and TMC. It takes only 10mins. The Bus shuttle system also have a transfer centre there.

Pedestrian and Bike Trail

The pedestrian and bike trail seems popular for the people in the community. But the environment seems not so good. Waste can be found everywhere.
2.2 Problem

Drains
The existing drains along the bayou exhaust waste water directly to the river, which cause the pollution and increase the water speed at the same time.
Flood

After the Storm Alison, the TMC was promoted in flood defense. By adding flood gates, wider the Brays Bayou. The Rice University developed advanced features for a real-time flood alert system for the TMC.
It's better to relocate the power machine out of the 100 year flood area.
2.3 Project Strategy

Create a better green waterfront for Brays bayou, enhance the link between the community and Herman Park, connect the inner city to the waterfront. Get use of the Central Park and Transfer center to make a great access for people to the Brays Bayou.
Concept | What’s missing in the TMC water-related area?

Function: Public Education
Commercial
Open Public Square
Access to the waterfront

Key: The idea to value the bayou environment and water condition

Concept | What’s the answer of the project?

Make people realize the value of Brays Bayou, the importance to protect the waterfront.

Program: Education center for medical and water environment.
Part 3 DESIGN
3.1 Urban Design

Urban Strategy
The Urban Strategy is to create a better green waterfront for Brays Bayou, enhance the link between the community and Herman Park, connect the inner city to the waterfront.

Several possible research has been made for the Brays Bayou renovation.
Renovation | Brays Bayou

Possible method to renovate the Brays Bayou

Widen the river directly

Problem: no interaction space on the bank, people cannot touch the water. No purification.

Create delta islands

Problem: People cannot use the islands. The bank area is not enough.

Widen the river / slow the bank / Vegetation cover

Advantages: Vegetation slow and purify the water. People can touch the water. People can experience the waterfront according to different water levels.
Widen the Brays Bayou, change the concrete bank into vegetation bank, which will slow down the water and purify it. Pedestrian and bike route on different levels will make the waterfront more public and active.
Platforms

Platforms on different levels will provide accessible space for visitors while the water on different levels.
Master Plan

Relocate the Parking Space, integrate the Green Park and the waterfront. Create more pedestrian and view connection between the Transfer Center, the Green Park and the Waterfront.
Sketch for the landscape
3.2 Building Concept

Building Strategy

The building will perform as an motivator, to connect the TMC Campus and the waterfront. It will invite the people in the transfer center to the waterfront. It will reorganise the circulation to connect the tram, bus and bike route. It will also act as a bridge to connect the north and south campus of TMC, as it is hard to cross the Bayou and the busy road in Huston.

In a larger aspect, the building will also supplement the landscape for the Brays Bayou.
Site Reorganise

Relocate the Parking Space, integrate the Green Park and the waterfront. Create more pedestrian and view connection between the Transfer Center, the Green Park and the Waterfront.
Possible Building Type

The new building should connect the park to the waterfront. It should keep the view connection as well as keeping green elements. It should be a nice access for the people from the transfer center to go to the waterfront.
A floating strategy is chosen for the building. It keeps the view connection, create nice waterfront access and good flood safety for itself. It is also a common building language in Houston.
How to construct such a huge floating roof is a question for the building.

It is a good way to divide it into main structure and secondary structure.

The main structure can lead the movement of people.
A bridge form is a continue of the urban context, as there are a lot of bridges of connecting the huge buildings in Houston, as it is too hard to use the pedestrian system on ground. The building actually functions as a bridge to cross the Brays Bayou.
4.3 Program

Program required
A lot of programs is missed or less in TMC. In order to achieve the project goal. Several programs are selected for this building.

The main program is defined as a public education center, open to the visitors, nearby neighbors and the people who work for TMC.
All the program is designed to make the building more public and suitable for the this area. It will provide enough attractive points and make the waterfront interesting.

On the other hand, it will be flexible to transformed into office to serve the TMC.
Program Layout

Bridge level

- Studio
- Restaurant/coffee
- Exhibit
- Public Library: +/- 300m²
- Bridge: +/- 1000m²
- Public Education Facility: +/- 7000m²

Ground level

- Commercial: +/- 100m²
- Bike Station: +/- 200m²
- Restaurant/coffee: +/- 100m²
- Playground
- Summer Theater: +/- 400m²
- Playground: +/- 2000m²
Programme Flexibility

Office  Meeting  Lecture  Studio  Library

Exhibition  Study Room  Balcony  Equipment  Bridge

Restaurant  WC  Entrance  Coffee/Dine
Programe Equipment

Office
Meeting
Lecture
Studio
Library

Exhibition
Study Room
Balcony
Equipment
Bridge

Restaurant
WC
Entrance
Coffee/Drink

Extra Equipment Required
Basic Equipment Required
<table>
<thead>
<tr>
<th>Public</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>WC</td>
</tr>
<tr>
<td>Meeting</td>
<td>Entrance</td>
</tr>
<tr>
<td>Lecture</td>
<td>Coffee/Drink</td>
</tr>
<tr>
<td>Studio</td>
<td>Bridge</td>
</tr>
<tr>
<td>Library</td>
<td></td>
</tr>
<tr>
<td>Exhibition</td>
<td>Study Room</td>
</tr>
</tbody>
</table>
Programme Light Need

Office  Meeting  Lecture  Studio

Exhibition  Study Room  Balcony  Equipment

Restaurant  WC  Entrance  Coffee/Drink

More Light Required

Less Light Required
Programme Zone

Office
Lecture
Meeting
WC
+/- 2000m²
Max 200 People

Studio
Study Room
Coffee/ Drink
Exhibition
+/- 3000m²
Max 100 People

WC
Entrance
Exhibition
+/- 1000m²
Max 100 People

Coffee/ Drink
Balcony
+/- 1000m²
Max 50 People

WC
Library
Bridge
+/- 1300m²
Max 150 People
The east sides of the building will not take too much sunlight, only in the early morning. But the west side will bear the hot sunlight for almost 10 hours, which means the shading for the west facade is quite important.
Shading for the west sides

It is better to hange the shading system ouside.
5.4 First Floor Program

Most fixed space that gathering people is located in the mainstructure. The hanging program is quite flexible and transparent.
Courtyards
6 courtyards provide the natural light and green view to the interior. Each courtyard focuses on different type of inner space.
View to the Courtyards

First Floor Plan 1:200
Interior Material

Wood floor + Glass facade + Aluminum frame + Steel columns + Wood Shadings
Exhibition Space and Sky windows
Roof

The combination of Solar Panel and the Green roof will make the energy system work better.
Ground level Landscape
Ground level Materials

Concrete walls + Steel Columns + Glass Windows + Concrete Pavement + Grass land + Vegetation Purify Poor
Summer Theater

Open Style

Closed by curtains
Continuity of the main street facade

Aluminum Cladding
Aluminum Window Frame
Fiber cement Cladding
Steel Truss
Different Facade Options
Different Facade Options
Preferred Facade

Identity between the transparent part and the solid part.
Hanging parts facade
Long facade
Wood Shading
Aluminum Window Frame
Steel Truss
Concrete walls on ground level
Short facade
Wood Shading
Aluminum Window Frame
Steel Truss
3.4 Accessibility

1. Ramp from the Transfer Station/ Park
2. Disabled Elevators
3. Main Stairs and Elevators from ground
4. Access to the South Campus
5. Ramp in Courtyards, directly into the education center
6. Serve people who work in the Education center or know it well
7. Emergency exit from the theater
8. Transparent Staircase on water
Central Courtyard
Access from the Station Side
3.5 Climate Strategy

The climate strategy is going to get use of the sunlight and wind in Houston to achieve better natural ventilation.

A additional ventilation tower is designed to heat the top air. Open windows is going to invite the cool air from the bayou.

Heat pump system is also suitable for this project.
Heat pump

The average ground water temperature in Houston is 20°C, which makes the heat pump system work very efficiently.
Heat pump

The stabilized sand in the wood box provide enough thermal mass for the building.

The equipment will located in three place.
Suny with wind
Winter
Cloudy with no wind
Summer
Afternoon
Cloudy with no wind
Summer
Afternoon
<table>
<thead>
<tr>
<th>Program</th>
<th>Total Area (m²)</th>
<th>Light (W/m²)</th>
<th>Equipment</th>
<th>Open hours per day</th>
<th>Energy</th>
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</thead>
<tbody>
<tr>
<td>Office lecture</td>
<td>314</td>
<td>15</td>
<td>10</td>
<td>6</td>
<td>6kwh</td>
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<tr>
<td>Lobby</td>
<td>310</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Studio</td>
<td>600</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Restaurant</td>
<td>330</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Shop + coffee</td>
<td>126</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Study room</td>
<td>244</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
</tr>
<tr>
<td>WC</td>
<td>160</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
</tr>
<tr>
<td>Library</td>
<td>520</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Exhibition</td>
<td>641</td>
<td>10</td>
<td>5</td>
<td>12</td>
<td>117kwh</td>
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<tr>
<td>Office relaxing area</td>
<td>200</td>
<td>10</td>
<td>7</td>
<td>12</td>
<td>12kwh</td>
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<tr>
<td>Storage</td>
<td>100</td>
<td>10</td>
<td>3</td>
<td>12</td>
<td>12kwh</td>
</tr>
<tr>
<td>Out coffee</td>
<td>140</td>
<td>15</td>
<td>5</td>
<td>14</td>
<td>739kwh</td>
</tr>
<tr>
<td>Bridge library</td>
<td>1130</td>
<td>15</td>
<td>5</td>
<td>14</td>
<td>739kwh</td>
</tr>
<tr>
<td>Piano</td>
<td>145</td>
<td>15</td>
<td>5</td>
<td>14</td>
<td>739kwh</td>
</tr>
<tr>
<td>Circulation space</td>
<td>2550</td>
<td>15</td>
<td>5</td>
<td>14</td>
<td>739kwh</td>
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<tr>
<td>Out door</td>
<td>300</td>
<td>15 only at night</td>
<td>0</td>
<td>14 2h lighting at night</td>
<td>9kwh</td>
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<tr>
<td>Summer theater</td>
<td>236</td>
<td>5 only at night</td>
<td>0</td>
<td>24 4h lighting at night</td>
<td>163kwh</td>
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<tr>
<td>Ground ceiling</td>
<td>8170</td>
<td>5 only at night</td>
<td>0</td>
<td>24 4h lighting at night</td>
<td>163kwh</td>
</tr>
</tbody>
</table>

<p>| Total                   | 8170           | 5 only at night | 0     | 24 4h lighting at night | 2062kwh |</p>
<table>
<thead>
<tr>
<th>Area</th>
<th>P</th>
<th>Time</th>
<th>Energy</th>
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</thead>
<tbody>
<tr>
<td>5710m²</td>
<td>100W/m²</td>
<td>8~10h</td>
<td>4568~5710kwh X70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70% efficient</td>
<td>=3197kwh~3997kwh</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;3093kwh</td>
</tr>
</tbody>
</table>

Conclusion

The Solar Panel System can provide enough energy for the artificial light and basic equipment power, in good days. Consider the weather in Houston, it is supposed to work well.
## Water circulation

<table>
<thead>
<tr>
<th>Max People</th>
<th>Average Time</th>
<th>Black water Producing</th>
<th>Gray water Producing</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>6~8h/day</td>
<td>Toilet 5L/flush</td>
<td>Wash room 2L/flush</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resturant 5L/person/meal</td>
<td>Resturant 15L/person/meal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Max</td>
<td>Total Max</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600x5x4+600x5x2=10800L/day</td>
<td>600x2x4+600x15x2=22800L/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Efficence</th>
<th>Maximum Wetland Need</th>
<th>Wetland in Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000L/15m²/day</td>
<td>22800/1000x15 = 342m²</td>
<td>1000m²</td>
</tr>
<tr>
<td>(water quality level 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500L/15m²/day</td>
<td>22800/500x15 = 684m²</td>
<td></td>
</tr>
<tr>
<td>(water quality level 5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**

The artificial wetland is enough to purify the gray water and recycle it to wash the toilet. In this way, it can reduce the need of the fresh water for the building.
How Green the Building is

- Solar Energy: 70%
- Heat Pump: 20%
- Electricity: 10%
- Fresh Water: 35%
- Gray water Recycle: 65%
- Waste black water: 35%

Exhaust to Brays Bayou
City seweage treatment work
3.6 Structure

The structure is designed as the concept "Main ans Secondary", "Stand and Hanging".

This concept goes deep in to the whole system as well as the details.
Explore the trusses
Explore the trusses
Explore the trusses

The supporting structure ranges according to the height. The H-beam will be covered to leave space for pipe and wires.
Hanging System

Second Structure
Quick Idea

Shading for Hanging parts

Shading for Main Structure
Joints of the beams
Joints of the facade
Adjust the Joints
Combination
Fire protection

Combine the Board fire protection and the intumescent coatings.
Building Process
Tower and Balcony

Detail 6
Create sustainable safe waterfront and new building to show people the value of green bayou.
Part 4 Reflection

The project tries to answer the question that public water-related building can contribute to the circulation between the inner city and the waterfront as well as promoting flood risk management. The project also shows the concept that ecological aspect is significant for the water-related design. It is a good continue of the group research of the Delta Intervention subject.

As an architecture students, I mainly focus on the building, including the structure, material, interior, climate strategy. In order to answer the research question, and to make a continue logic for this whole design part. The urban planning and landscape for a larger area is also been developed. But the urban design will not go into a lot of detail or too large. It will mainly help to define the architecture project and to show the whole concept of the research.

At last, when I look back, the Delta Intervention Studio really give a nice and wide topic to me. The research method helps me to get my interest and develop it into a project. The lecture courses improve my skills and knowledge to deal with the water-related topics. The final project is a good practical exercise for me to learn it.
Thank you for listening.