Designing for Loss

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April 24, 2009
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Floods are the number one most common natural disaster in the United States. Each year they kill hundreds of people and cause billions of dollars in damages to both the natural and the built environment. They are both unpredictable and unforgiving. They can be both swift and long-lasting. When they strike, whether we are prepared or not, they strike with full force. And as much as we try to prepare and protect ourselves, we’re fighting a fight against Nature; a fight that we are likely to lose. So what can we do to turn this loss into a victory? By finding the balance between the destructive forces of a flood and the valuable characteristics of water, we can use Nature to our advantage. By realizing that we are fighting a losing battle, we can design with priorities in mind, and take a vulnerable site and turn it into a beneficial one. This thesis intends on finding that balance, and using it to change the way we think about “controlling” floods.
Floods are the number one most common natural disaster in the United States. Each year they kill hundreds of people and cause billions of dollars in damages to both the natural and the built environment. They are both unpredictable and unforgiving. They can be both swift and long-lasting. When they strike, whether we are prepared or not, they strike with full force. And as much as we try to prepare and protect ourselves, we’re fighting a fight against Nature; a fight that we are likely to lose. So what can we do to turn this loss into a victory? Can we use Nature to our advantage and find a balance between the destructive forces of a flood and the valuable characteristics of water? This thesis intends on finding that balance, and using it to change the way we think about “controlling” floods.

Traditional methods of flood control include putting up walls and barriers, building on stilts, or manipulating the land around us. But what if we just let the flood happen? What if we designed a place knowing it’s going to get flooded? Is it possible to design a community or a campus that can get flooded, and still function like it’s supposed to? This thesis will explore that possibility.
In just the last few years we have seen how devastating floods can be to a community. In September of 2008 Hurricane Ike hit Texas, caused $22 billion in damages, and killed at least 35 people. More specifically, in Galveston, Texas the small campus of Texas A&M University at Galveston (TAMUG) was hit hard enough that it had to suspend all operations for this fall semester. It was the first time in the school’s history that it had to shut down all operations for an entire semester. With a location so close to the Gulf of Mexico, TAMUG is in a prime location for hurricane strikes. Because of this, it is a location that should be well suited to handle floods. This is also the reason that it is the perfect location to implement this thesis.

But what is there to gain from exploring this idea, at this specific site? If this campus is a place that is inevitably going to flood no matter what is done to protect it, why not leave it to get flooded? Shouldn’t we let Nature take its course? After all Nature is going to win the fight anyways right? This is the position that many professionals take. But why shouldn’t we protect ourselves? Why shouldn’t we fight for what we have built and developed? We have the ability to protect ourselves and at the same time let Nature take its course. The natural environment can be molded in a way that balances both aspects, and the built environment can also be designed to do so. By choosing a site that is in such a vulnerable location, the limits of these ideas can be tested to the fullest.

Flooding is unpredictable. While experts can guess when a flood may happen, the severity and effects are different each time. It’s easy to say that if you live below sea level or live near the coast or live downhill that you are more prone to floods. In these cases, Nature dictates where the flood waters are going to go. But if you dictate what is going to happen with the flood water and where it goes, you are one step ahead of Nature. If you plan for a flood by not trying to prevent the
water from entering the community, but instead using the water throughout the community, you control the first step of the process.

The next step is planning what to do with the water. Are there successful ways to utilize a water source that isn’t always around? And if the water source is around how long will it be around to use? When figuring out what to do with the water there are three factors to take into account: separation, intrusion, and interaction.

It’s rarely seen as a good thing when the built environment is completely separated from the natural environment. Architecture is intended to be an extension of the environment, a complement of the environment, or a part of the environment, but never separated from it. The key is to find a way to use the flood water which doesn’t separate the two environments, but instead brings them together in a positive manner. If done successfully people will see one environment instead of two separate ones.

When flooding occurs, people often look at the water as an intrusive element. An element that is new and probably harmful to them. But is the water really intruding upon us, or is the water simply doing what it is supposed to do, and we’re intruding upon its environment? The answer is going to vary depending on how you look at it, but if we intend on using the flood water to benefit us, we must find a balance in which neither side is seen as an intrusive element.

Those first two factors combine to make the third. The successful outcome of both factors is an interaction of the two sides. Whether it’s finding a way to combine environments so one isn’t separated from the other, or combine environments so one isn’t intruding upon the other, it’s the interaction of the two that is
important. How the water interacts with the building becomes an important factor of design, as well as how the water interacts with the natural environment that is already there. It may be most important that the strategies implemented to use the flood water, positively interact with the environment even if there is no flood water.

The successful implementation of these three factors alone is not enough to save or protect a community from a massive flood. Quite frankly, nothing is going to be enough. If we provide protection for flood waters up to three feet, a hurricane will come around and dump four feet of water. If we design a campus to withstand 10 straight days of rain, it will eventually rain for 12 straight days. Then what do we do? It isn’t feasible to design everything for the worst possible disaster that may never happen. We design for really bad disasters that are probably going to happen. If something worse happens, we chalk it up as a victory for Mother Nature. So what more can we do to protect ourselves?

What if we designed a campus knowing it would one day be devastated by flooding? We know that all of the flood control methods in the world couldn’t save the entire campus. So what could be the next step? How could we “designing for loss?” Design the campus in a way that prioritizes the losses. Find out what can be “sacrificed” in order to save the rest of the campus. What if the first floor of every building could be used as a place to store flood water? You might be sacrificing the practicality of there being classrooms or dorm rooms on the first floor, but you’re gaining a place for the flood waters to go and possibly an un-tapped water source. If designed properly, the flood could benefit the campus just as much as it harms it. And if not, at least you were in control of what the flood ruined first.
Overall, the intention of this thesis is to redevelop a community, in this case a campus, into one that is ready to understand, utilize, and survive a massive flood. By finding a balance of separation, intrusion, and interaction, and by “designing for loss,” a community can go beyond protecting itself from flooding. If done correctly the strategies used to implement this thesis will not be a solution which would be completely feasible for this site. Instead it is intended to educate people about flood control and flood management in a more creative and thoughtful way. Let’s face it; we’re living in a world where the natural disasters are only getting worse so we need to find ways that go beyond simple methods of protection.
Project

Flood mitigation system at University of Texas Health Science Center at Houston

Project team

Prime consultant: Walter P Moore, Infrastructure Division
Structural engineer: Walter P Moore, Structural Diagnostics Division
Architects: P&W Architects and Gensler
Landscape architect: Clark Condon
Surveyor: C.L. Davis
MEP engineer: E&C Engineers and Consultants, Inc.

Project summary

Redundant systems, including a perimeter berm, floodwalls, drains, and building improvements, provide 500-year flood protection to a medical center campus.
In June of 2001 Tropical Storm Allison dropped a record amount of rainfall across the greater Houston area. After the flood waters receded, the University of Texas Health Science Center at Houston (UTHSCH) found that the campus in the Texas Medical Center (TMC) was devastated. The basement and ground floor of the Medical School Building (MSB) were flooded and all contents destroyed. The damages exceeded $205 billion.

After the disaster UTHSCH sought to develop a flood hazard mitigation program to reduce the potential of future flooding. UTHSCH hired Walter P Moore to lead a project team to develop the program. They first decided to establish the ‘flood elevation level’ which was determined to be 47 feet, corresponding to a 500-year return period flood. During the schematic design phase the team decided to design a redundant system with three layers of independent protection: perimeter berm, integral floodwall, and interior floodwalls.

**Perimeter Berm**

The primary protection system consists of an earthen berm and structural concrete floodwall around the perimeter of the campus. The berm meanders
through the existing landscape and roadways on along the east and west sides of campus and ties into the secondary protection system on the north and south sides. The campus public area, Webber Plaza, is protected from flooding by the construction of the earthen berm and a structural concrete flood wall around the east side of the complex. The landscape architect directed placement of new trees, plantings, and other landscape elements to integrate with the existing landscaping. Since UTHSC has a strong green building tradition, the protection of existing oak trees along Fannin Street was designed into the system. By incorporation existing elements of the campus where possible, the berm creates unobtrusive protection that enhances the aesthetics and landscaped character of the campus.

**Integral Floodwall**

The Secondary protection system is a structural floodwall incorporated into
the perimeter columns of the MSB building. This system is designed to only be functional in the event of a failure of the primary protection system (perimeter berm). The floodwall extends the full perimeter of the MSB and provides full flood protection on 100 percent of the MSB perimeter. The owner also required that this system be integrated architecturally into the building in such a way that the wall appeared to be part of the original structure. The wall provides protection to an elevation of approximately seven feet above the ground floor, contains nine flood gates, and includes submarine glazing in some locations to allow light into the ground floor and minimize the aesthetic impact of the flood wall.

**Interior Floodwalls**

The final protection system consists of interior protection of critical areas within the MSB. This system is designed to only be functional in the event of a failure of both the primary and secondary protection systems. The floodwalls in both the basement and ground level divide the building into two sections, preventing the complete flooding of the building. There is also an additional protection wall...
constructed around the ground level of the mechanical, electrical, and plumbing (MEP) room to prevent power loss.

Why it’s relevant

This project, led by Walter P Moore, is a perfect example of how to incorporate flood protection throughout a campus without compromising the aesthetics or functionality of it. By incorporating so much of the new systems into the existing elements of the campus, the design team was able to provide a level of protection that is practically naked to the human eye. One of the main goals of this thesis will be to provide a level of flood protection to the Texas A&M University at Galveston (TAMUG) campus without being obtrusive to the campus. By incorporating some of the similar ideas that Walter P Moore’s team was able to incorporate, this goal can be reached.
Precedent Two
Coastal Protection

Types

Sea Wall
Groyne Pool
Detached Breakwaters
Submerged Reefs
Sea walls are a very common method of coastal protection. They are mainly intrusive elements added to an environment and used mainly to protect against storm surges. Once the water reaches a level above the wall, it stops being effective.
Detached breakwaters are structures built a few hundred feet offshore. They are built in groups that run parallel to the shore. After time, the water brings sediment along the shore which builds up and forms an extra barrier between the shore and the breakwater. They’re main job is to slow down waves before they hit the surface.
Groyne pools are structures similar to detached breakwaters, except they run perpendicular to the shore. They extend out into the water and catch the sediment that runs along shore. They do not provide much protection until they get enough sediment built up to extend the shoreline.
Submerged reefs are structures built offshore, but built on the ocean floor. They work by slowing the waves down before they reach the shore. The attraction of the submerged reefs comes from the fact that they do not intrude upon the shoreline. They are hidden beneath the surface and still provide a level of protection.

images of submerged reefs courtesy of google images
In September of 2008 Hurricane Ike ripped through the Gulf Coast as a category 3 hurricane. It caused more than $22 billion in damages, and killed at least 35 people. More specifically in Galveston, Texas (which was one of the hardest hit cities) the small campus of Texas A&M University at Galveston (TAMUG) was flooded so severely it was forced to suspend all operations on campus for the entire semester. It was the first time in the history of the campus this had happened.

Texas A&M University at Galveston is a 130-acre campus located on Pelican Island approximately 45 miles southeast of Houston. The small island is in the southern part of Galveston Bay right off the Gulf of Mexico. The campus is an ocean-oriented campus offering four-year courses with excellence in business, oceanographic and physical sciences, biological sciences, engineering and transportation and liberal arts. There were over 1,650 students enrolled in 2007. It also houses the Texas Maritime Academy, which is one of six maritime academies in the U.S. preparing graduates for licensing as officers in the American Merchant Marine. There are 21 buildings on campus including dorms, classrooms, labs, and research facilities.
Conditions that Affect Flooding

When looking at the entire campus many conditions can be examined when it comes to flooding. The first is topography. Throughout the campus there is little change in the topography. The highest point is only 20’ above sea level. This point is on the south side of campus along with a few other smaller ‘hills’. Because of these ‘hills’ there are a few places on campus where most of the water drains towards. The north and northeast corners of campus are relatively flat and collect most of the runoff water. This causes the parking lots and roads to be the biggest flood problem on campus.

The majority of the campus lies within the 100-year flood plain. This means that in any given year there is a 1% chance of flooding. If someone wants to build within the 100-year flood plain, a permit must be applied for. Within the 100-year
flood plain most structures are general required to be elevated above the base flood elevation. The high parts of the campus lie within the 500-year flood plain and have a .2% chance of flooding. Building within the 500-year flood plain is typically not an issue because this land is elevated above the 100-year flood elevation.

The last condition is soil analysis. Different soil types alter building design and construction. They also affect how much water the soil can hold. Each soil has a specific “depth to restrictive surface” which is the distance to a solid layer which impedes the flow of water.

The majority of the campus is built on Francitas Soils. This is a typical soil found near the ocean and is somewhat poorly drained. Other soils found on the campus include Mustang Fine Sand, Mustang Fine Sand Saline, and Ijam clay, which are all also poorly drained.
Other Campus Conditions

The campus itself has very little organization, with the only guiding principle being 3 general areas of interest: the waterfront, the academic core, and the residential area. The buildings are rather scattered around campus with green spaces not planned as much as they are just leftover spaces. There was a little bit of thought when it came to the heights of the buildings, as the heights increase the further away from the water to increase views. Most of the parking is on the exterior of the campus but there are some lots on placed in between buildings. It only takes about six minutes to walk from one side of the campus to the other.

What Can be Done at this Site

The campus of Texas A&M University at Galveston provides a great opportunity to accomplish the goals of this thesis. Since the site is located in the direct path of hurricanes each year, it is in a flood-prone location. This provides adequate opportunities to accomplish the goals of the thesis related to flooding. Since the campus itself is unorganized, it also provides a chance to improve the overall layout of the campus in order to make it a more functional learning environment. There is also plenty of extra room on the campus which provides space to design a new flood research and education facility.
Project Program
Layered Protection

Wetland
Parking Lot
Courtyard
Platform
Surrounding
Building
These areas in the program are intended to be constructed wetland spaces. They are the closest spaces to the existing sea level of all the spaces. The wetland spaces are all connected to each other, weaving either under paths or through paths. These spaces are connected to both the surrounding wetlands to the north and the open water to the south, via a drainage system under the surrounding road. Since they are the first of the spaces above sea level, they are the largest spaces and take up the most area on campus.

A sub-category of space within the wetlands would be natural paths and courtyards which connect some of the areas on campus which wouldn’t otherwise be connected. These surfaces would be a permeable and almost temporary type of surface and are intended to be nothing more than a path.
Parking Lot

These areas in the program are intended to be parking lots. A few feet above the level of the wetland, the parking lots are located around the exterior of the campus. The surfaces of the parking lots are permeable and drain into the surround wetland spaces.

A sub-category of spaces within the parking lots are the paths from the lots to the interior of the campus where the buildings are located. These paths, like the parking lots, are only a few feet above the wetland and have a soft edge which allows people to walk down from the path into the wetland.
These areas in the program are intended to be courtyards. These spaces are a few feet higher than the parking lots and make up a majority of the interior spaces within the campus. The courtyard spaces are intended to be developed into the places on campus where the students hang out. They are located primarily in spaces which lie in between the buildings on the interior giving importance to the center of the campus. Each of the courtyards has a drainage system allowing them to drain into the wetlands.

A sub-category of spaces within the courtyards are the paths that surround and intersect the courtyards, as well as connect the buildings to each other. These paths are hard surfaced paths with hard edges that do not allow people to move from the path into the wetland.
These areas in the program are intended to be platforms around the buildings. Each building is surrounded by a platform which extends at least 40’ from the edge of the building. These platforms are at the same level as the original ground level of the buildings. They are intended to be a ‘buffer’ space between the buildings and either the courtyards or the wetlands. A sub-category of spaces within the platforms around the buildings are the docks. Being so close to the ocean, Texas A&M University at Galveston has a couple of academic programs that require docks for large ships. There are two of these docks on the shore of the campus and they are at the same level as the platforms around the building.
The purpose of this study was to explore the relationship between protection and separation. Most traditional flood protection methods involve putting up obtrusive barriers; barriers which separate a building from the surrounding environment. When a barrier is at its best it completely protects a building. However, how much does it sacrifice in order to achieve that level of protection? How much do you separate a building from its environment? Generally speaking, when the level of protection goes up, so does the amount of separation. Likewise, the less separation, the less protection. In this study different levels of protection were compared to their levels of separation.
showing that having no protection (below) doesn't separate the building from its surroundings (above)

showing that having some protection (below) partially separates the building from its surroundings (above)
showing that having some protection (below) partially separates the building from its surroundings (above)

showing that having full protection (below) completely separates the building from its surroundings (above)
Sketch Problems
Separation and Intrusion

The purpose of this sketch problem was to look at a larger scale of protection. Instead of just protecting a building, this study explored how to protect an entire area, and in this case a campus. The study explored how much protection can separate a campus from the environment, as well how much protection can intrude on a campus. It showed different examples of how you can approach protecting an area. It explored two ways in which the protection could separate a campus: complete separation and isolated separation. There were also two ways explored in which the protection could intrude upon a campus: conscious intrusion and thoughtless intrusion.
showing conscious intrusion (above) and thoughtless intrusion (below)
showing complete separation (above) and isolated separation (below)
The design process began with the idea that by incorporating water features into the campus, it would allow for a positive use of the flood as well as provide a level of protection to the campus. I started by drawing a few diagrams of possible layouts for where I felt the features should go, as well as how the water moves throughout the campus to get to the features.
The first layout had the water running from the existing harbor, though the campus, and draining into the wetlands to the north and into the wetland on the southwest corner of campus. There were two planned water features, two new courtyards, and a few new buildings.
The second layout had the water running from the existing harbor, up the east side of the campus, and draining into the wetlands to the north. There were four planned water features and two new buildings.
The third layout had the water entering the site by the dock, running through campus, and draining into the wetlands to the north. There were three planned water features and three new courtyards.
Ultimately the layout I decided to go with was a combination of the first and the third. I wanted to incorporate the existing wetland in the southwest corner of the campus, so the water begins there, flows through campus, and drains into the wetland to the north. I decided to add three different water features along with expanding the existing wetland. Each of the features had a few distinct design characteristics.
The feature located on the north side of campus is the smallest of the three features. It was designed to be a fountain inside a newly developed courtyard. It’s located within the residential area of the campus near the dormitories and P.E. Facility, as well as near the existing swimming pool and volleyball court. It was intended to be a more subtle feature that blended well within the residential area of campus.
The feature located in the center of campus is located within the main academic area of the campus. It is a reflecting pool with four different tiers. This area of campus has the most foot traffic due to the movement from building to building and the addition of this feature completes a central courtyard space for students to stop and hang out.
The feature located on the south side of campus is the largest of the three features. It is located near the water front so it was intended to be a very open feature where students could sit and get pleasure from being near the open water. The feature includes a floating pavilion on one side and an open pool on the other, with a walkway that crosses the entire thing.
The intention of adding these features was not just to enhance the campus, but also to provide a level of flood protection. The idea was that during normal, non-flood conditions the wetland would be fairly dry and the features would run normally as a fountain, pool, etc... As soon as there was warning of a flood, the water in the features would be pumped either into the wetland to the south or to the wetlands located north of the campus. This would leave the features and the channels throughout the campus empty, which would give the flood water a place to go, instead of causing a flood.
If the empty area wasn’t enough to handle all of the flood water, it was intended that the areas around the features would be the first areas to flood. By having control over what floods first, the architect is able to plan which areas of the campus have a higher priority over the others, and which areas can be sacrificed.

Unfortunately, I was naïve to speculate that this passive of an approach was enough to handle the flooding for the entire site. These features may do what they are intended to do, but at such a small scale, they would not do enough to protect the site.
Since I had been taking too passive of an approach up until this point, for the final design I decided to take the site, and start from scratch. I looked at the site and took the entire thing down to the level of the water except for the buildings. This basically gave me an empty canvas to work on in order to properly incorporate my flood management system.
Starting with just the buildings, the next step was adding platforms around the building extending no less than 40’ from the exterior of the building. After refining the platforms, the next step was to connect them all through a series of paths. It was my intention to identify the center the campus as an area of higher importance. I did this by locating all of the parking for the campus around the exterior, and develop the spaces between the buildings as courtyards.
Having laid out the plan for the campus the next step was how to incorporate the flood management system. The design of the system began with having four tiers of protection. The four tiers would vary in height giving different layers of protection. The lowest tier would be an area of constructed wetlands. The next tier up would be the parking lots. The layer after that would be the courtyards. And the top layer would be the platforms around the buildings. The tiers (which are explained in more depth in the project program) are connected by intermediate levels of paths and platforms. The intention of having different tiers stems from the idea that the architect can decide the order in which areas of a site are flooded and damaged.
showing campus not flooded at all

showing campus flooded above wetlands

showing campus flooded above wetlands

showing campus flooded above wetlands

showing campus flooded above wetlands
section study showing courtyard flowing into wetland
Each of the tiers is connected so that water is able to drain from the top tiers all the way down to the wetland tier. A series of section studies taken in two different places shows the interaction of the tiers and what each condition looks like at different stages of flood.
Throughout each tier there are also one or two sub-tiers which were developed in more detail.
The last study is a diagram showing the movement of water throughout the campus. The water in the wetlands flows freely throughout the lowest tier, moving either underneath paths or through paths. Each of the parking lots drains into the wetland as do each of the courtyards. The wetlands are then able to drain from my site out into the open water to the south or into the wetlands to the north and west of the campus.
Conclusion

Something for architects to think about

As a flood management system, this plan was intended to give the architect control of the flood. By setting up these different tiers of protection, the architect is in control of what gets lost first. It allows the architect to prioritize the different areas of a site. In this case, the wetlands have the lease priority, followed by the parking lot, the courtyards, and then the buildings themselves. In this regard, the thesis was implemented successfully. The general plan allows for a level of protection which both prioritizes the losses, and integrates the flood within the campus.

This thesis can also be seen as unsuccessful on a couple of levels. The first being the fact that it was not explored to the proper level of detail. In order for this to have been completely successful, it would have needed to be developed in much more detail. It also could have been more successful if there was more integration of the site and the flood water.

Looking back the most successful part is the idea that us as architects can’t control everything throughout the design process. There are factors, such as flooding, that we don’t usually account for. The exploration of this thesis, if nothing else,
Annotated Bibliography


Texas A&M University at Galveston’s main website  
[http://www.tamug.edu/](http://www.tamug.edu/)
