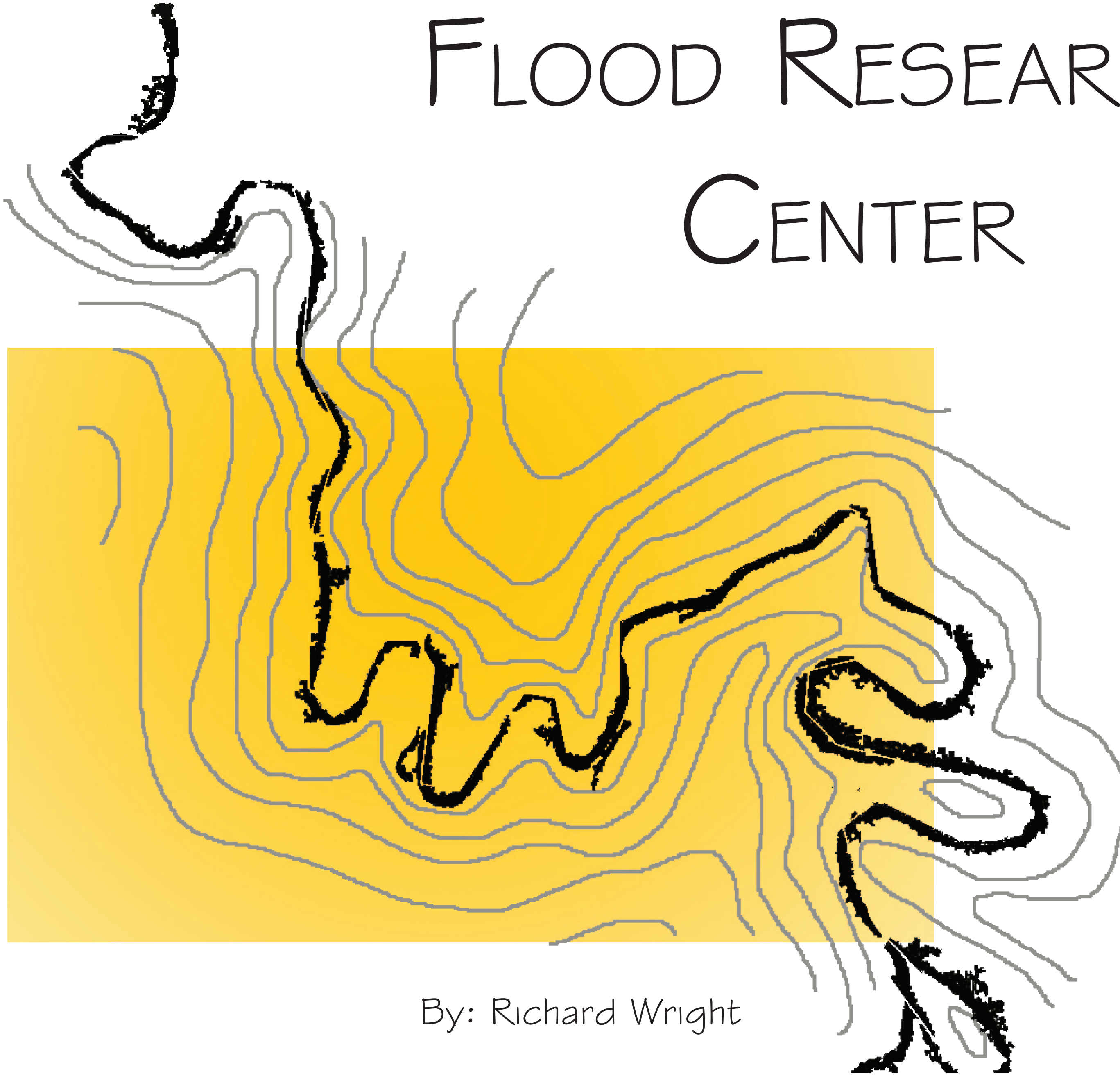
Flood Research Center



By: Richard Wright

FLOOD RESEARCH CENTER

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
of North Dakota State University

By

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In Partial Fulfillment of the Requirements
for the Degree of
Master of Architecture

Primary Thesis Advisor

5/4/12

Thesis Committee Chair

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Abstract

Abstract

This project will outline research into the flood prevention methods in nature and in the man-made world to translate into a new innovative inland flood research center design in Moorhead, Minnesota. This project was in response to the widespread flooding epidemic in the various regions of North Dakota. I hope to give dwellers in flood prone areas a chance to dwell in harmony with nature's natural events. The 8000 square foot research facility's main function is to re-establish the wetlands to allow water to have space to expand and retract. The expansion of wetlands will reduce the fast paced runoff from fields and concrete hardscapes of cities to safe manageable rates.

Key Words: Flooding, Research Center

Problem Statement

Problem Statement

How can architects respond to an inland flood research center in extreme flood plains through solutions in nature?

Statement of Intent

Project Typology

Flood Research Center

Claim

The **architect** will mitigate the effect of **flood** waters on an **inland flood reseach center** through **solutions found in nature**.

Theoretical Premise/Unifying Idea

Supporting Premise(s):
Actor(s): Hydrologist
Action: Flood
Object: Inland Flood Research Facility
Manner: Solutions in nature

The architect will design a solution to flooding in accordance with nature.

Flooding occurs in a variety of regions and climates and proves to still have a substantial impact on modern civilization.

Research facilities are a needed commodity in solving the struggles with massive flooding conditions in a variety of places around the world.

The ability to learn lessons from nature's solutions in the process of natural disasters proves a vital tool in our reaction with Mother Nature.

Final Theoretical Premise(Conclusion)

The natural environment will give rise to a solution in how to dwell in flood plains.

Project Justification

The flood plains of North Dakota have become scenes of recent and past disasters in North Dakota's many regions. The next step is rebuilding smarter and environmentally harmonious buildings and landscapes to overcome these events in the future.

The Proposal

The Proposal

The Narrative

The Narrative

How can architects respond to the built environment in extreme flood plains? This question has been asked by many people all over the world for centuries. Yet still to this day it serves as a pertinent question to many living along the water's edge. Lately the realm of flooding has been involved in multiple incidents of massive flooding in Minot, North Dakota, Devils Lake, and the many cities lying along the Red River. My goal is to make some of the massive flood plains an enjoyable and desired living experience year-round.

The architects in the past have taken flooding as a nuisance. The project will give the users of flood-prone buildings a chance to experience the flood as if living on the water like the inhabitants in the city of Venice. This brings people totally intune with their surroundings, like the farmer is to new rain. The connection makes such places special to all people.

The built environment of cities and small towns alike has always been in a direct line of flooding due to the settlement's wide disbursement along the waterfront. Some of the most sought-after land is river-and lakeside property. The views of the water make the building enjoyable and interactive with fishing, boating, swimming, and many other activities. This project will continue to create places like this without the struggles of rising water conditions that frequently cause significant loss and stress.

The project has great emphasis in creating a new flooding solution for buildings due to my past history of flooding efforts growing up in Fargo/Moorhead. Sandbagging as a ten-year-old in the 1997 flood gave lots of insight to the reality of how floods affect its nearby inhabitants. This translated into feelings of empathy to the recent victims of flooding in Minot, North Dakota. Now the project's plan is in taking this element of flooding and harmonizing it with the people of Fargo/Moorhead. The flooding of the Red River Valley shouldn't be seen as a threat, but as a way of life in the Valley, like the high and low tides of a bay.

User Client Description

User Client Description

The users of the building will be reseachers in inland flooding. The inhabitants will have a strong connection to the Red River during the adaptation the building incurs during the flooding months. The research center will give researchers a chance to work harmoniously with the nearby Red River. I hope to give researchers a chance to embrace the flood as a season such as fall, spring, and winter. During the flood months the employees will have to adjust to relocating parking and transportation to and from the research center.

Major Project Elements

Major Project Elements

Some of the main elements of my design will include all the basic programs of a home. However, priority will be given to making the space enjoyable during the flooding months and allowing for an adequate amount of space for circulation and dwelling.

Lobby	Offices
Lavatories	Kitchen
Cafeteria	Research Space
Meeting Spaces	Mechanical

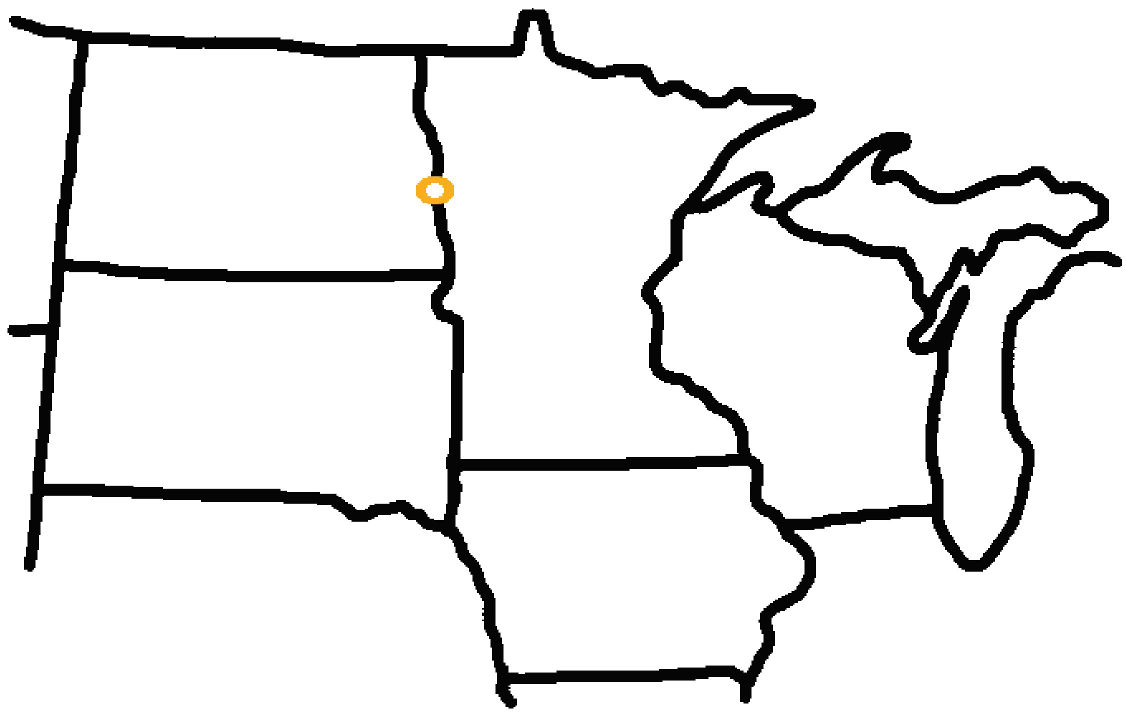
Other Elements:

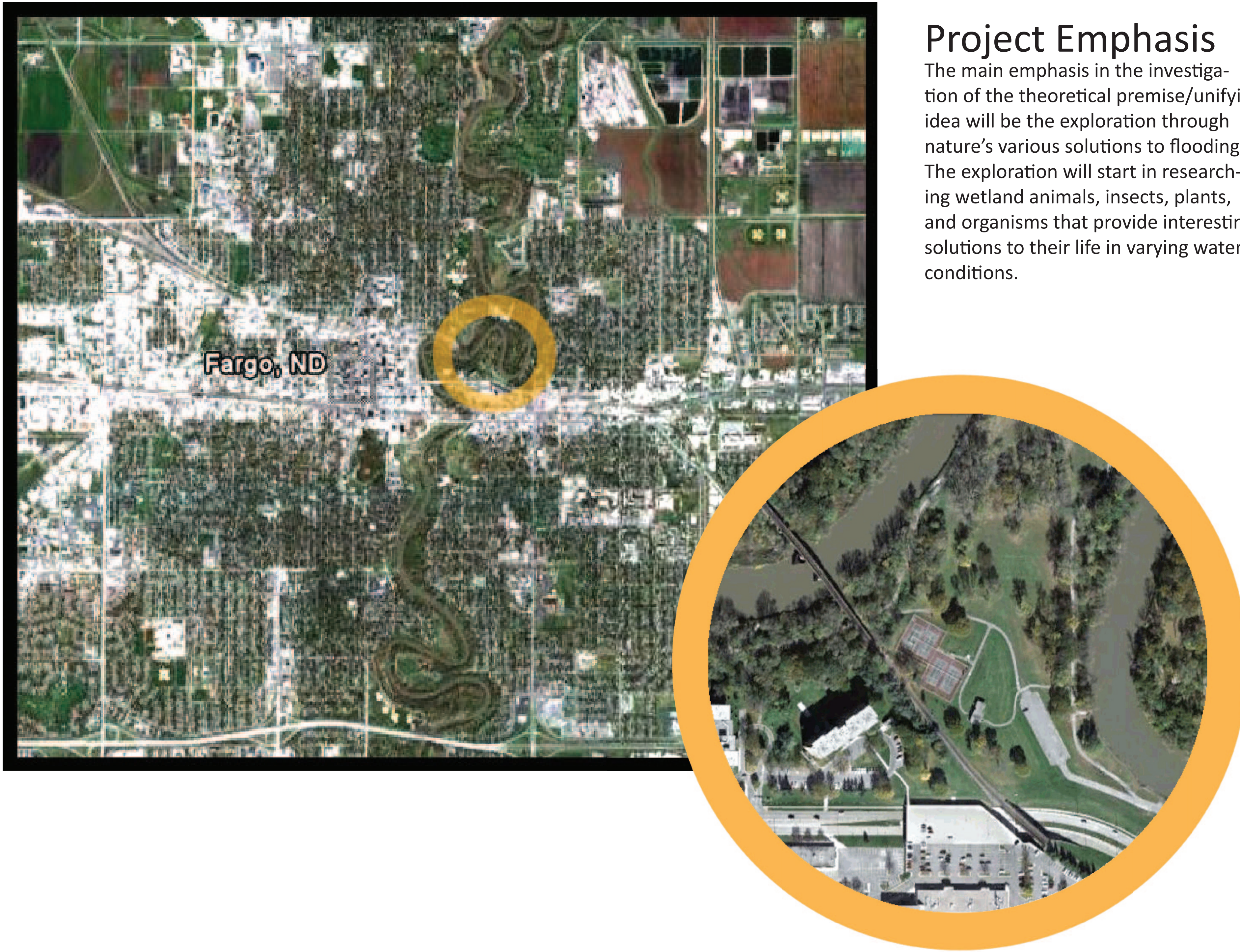
Public Displays	Social Space

Site Information

Site Information

The site is located in Moorhead, Minnesota, along the Red River near 1st Avenue North. This site has pertinence to the design in that the land was previously a city block and is currently perceived as having little to no use due to flooding of the nearby river. The facitlity building for picnic tables is in dismay after lack of upkeep and accessibility. The land's topography has a high elevation and a close proximity to the river to allow access and protection during the flooding months. The site is also in the heart of downtown Moorhead on a river peninsula. The peninsula allows for great views of the nearby Riverfront Park.





Project Emphasis

The main emphasis in the investigation of the theoretical premise/unifying idea will be the exploration through nature's various solutions to flooding. The exploration will start in researching wetland animals, insects, plants, and organisms that provide interesting solutions to their life in varying water conditions.

A Plan for Proceeding

Research Direction

The research will allocate a variable in nature conducive to finding a new innovative building technique. This will include a grid layout of a handful of different species living in such conditions. Each species will have a variety of boxes explaining their adaptation, re-use, migration, 12 month home, flood prevention, and working with/against the flood. The theoretical premise and unifying idea will be at the front of my mind in the selection and final decision to what species plays part as inspiration for the design strategy. I believe this process will give me great insight to nature for inspiration for my project.

A Plan for Proceeding

Design Methodology

I will assimilate my research with the aid of the mixed method, which will include graphic analysis, quantitative and qualitative analysis, 3D analysis, drawings, and sketches. The quantitative research will be gathered from sources processed and organized into graphics. The qualitative research will be assimilated during the site visit.

Documentation Techniques:

I plan on giving descriptions to the direction of ideas through drawings and graphics. I will scan and document much quantitative information with inspiring words or drawings to establish a path of information to my final findings on a subject. The information path will be elaborated with my thoughts and direction I want to take through a brief summary that will be gathered and evaluated biweekly. I hope to lead the trial and error process to my final product.

Previous Design Experience

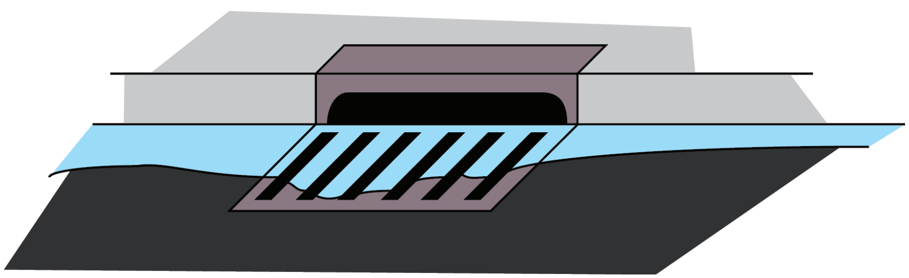
Previous
Design
Experience

- 1st Year
  - Spring 2007-Steven Wischer
    - Figure Ground
    - Cantilever
    - Column
    - Defining Space
    - Two vertical and two horizontal
- 2nd Year
  - Fall 2007-Darryl Booker
    - Tea House
    - Bio-Haus
    - Boathouse
  - Spring 2008-Mike Christenson
    - Solid Void
    - Community Complex
    - Plaster Castings
- 3rd Year
  - Fall 2008-Cindy Urness
    - Moorhead Library
    - Research Facility
  - Spring 2009-David Crutchfield
    - Spaceport Hotel
    - Concert Hall
- 4th Year
  - Fall 2009-Don Faulkner
    - High-Rise
  - Spring 2009-Paul Glye, Frank Kratky, Darryl Booker
    - Urban Re-Design
    - Re-Use

Research

Research

http://upload.wikimedia.org/wikipedia/commons/9/91/Cedar_Point_parking_lot.jpg



The Problem

As the rain and snow falls on the ground the question is, “Where does it all go?” Water has always had a way of naturally finding its way through the landscape and dispersing it to give life to plants, animals, and humans alike. Over time the human environment has drastically changed into concrete and asphalt landscapes of buildings, roads, and parking lots. These developments have made water an unwanted element tossed and drained into nearby bodies of water. It is said “Over 70 to 90 percent of water ends up as runoff” (Snoonian, 2001). This in turn increases our risk of flooding no matter how high we build our dams and dikes.

Inland flooding has been a major counterpart in the lives of people all around the world for centuries. The annual flood damages in America alone now are growing past $6 billion a year. As for the North Dakota region of the United States cities have been hit hard with massive in-land flooding. Minot, Devil’s Lake, Grand Forks, and Fargo are just some of the major urban centers within one state that have been devastated on multiple levels by river and lake flooding(Palmer, 2005).

Minot

The recent flood in Minot alone cost $500 million just to repair all of the public works in the city. Over 4000 homes were flooded, roughly 20% of Minot. The city was unprepared for a 500 year flood. (Minot Community Foundation) (ND flood’s taxpayer cost: $509M, 2011)

Devil’s Lake

The Devils Lake area needed roughly $900 million dollars from the federal government to fight the growing lake waters (Sen. Conrad in Devils Lake as Flood Costs Near $1 Billion, 2011). Much of the effort in Devils Lake is to raise dikes, roads, and buyout land for future dike developments. Devil’s lake alone has risen 16 feet over the last 3 years. (Fritz & Murphy)

Fargo

Fargo has been lucky, successfully fighting the major 1997, 2009, and 2010 floods. Fargo's 2009 flood crested at 41 feet (Jervis, 2009), while the 1997 flood crested at 39 ½ feet. The flood stage of the Red River being 18 feet leaves a gap between the two floods of 23 and 21 ½ feet respectively. The fighting efforts of the 2009 flood cost approximately 23 million dollars. Overall, Fargo has paid out nearly 74 million dollars since the 1997 flood ("Fargo Flood Costs staggering", 2010). Before the 1997 flood the only other major equivalent flooding incidents occurred in 1897 and 1979, which still were lower than the 97' and 09' flood. People might assume that flooding is as simple as that caused by heavy rains. This isn't the full story of why flooding occurs. Some major contributing factors to flooding include deep snow cover, frozen ground, wet or saturated soil, full reservoirs, high river and stream levels, ice-covered rivers, widespread rain, and increased water drainage. However, the main focus of the research is dedicated to the natural dispersion of water. As cities and towns develop and grow so does the concrete, roofs, ditches, parking lots, and the drainage of ponds, wetlands, and bogs. All of these factor into the current situation of higher consistent flooding. In fact, all of these situations would carry the natural events of heavy rain and snowfall to a whole new kind of massive flood for the main water dispersion points (Palmer, 2005).

Contaminated Water

All the oils, grease, detergents, bleach, sewage, and variety of fertilizers and insecticides percolate into our drains, gutters, and ditches that flows into the lakes, streams, and rivers of the world's water source for animals and humans alike. Unfortunately, nature must deal with societies' self affliction. In the case of oil, even with the dispersion of one quart can contaminate over 2 million gallons of drinking water(Goo, 1991). These chemicals are producing toxic water that is to be expected during and after flooding season.

Solution

Water runoff must be seen in a new light. The solution lies within the dual supervision of flood dispersion by biologists and hydrologists. This team of experts will pull together to find solutions to flooding in nature. The combined knowledge of these two teams will increase the watershed into other wetlands, bogs, and other natural dispersions to help our decreasing natural ecosystems. The need to keep our wetlands safe is that they provide protection in multiple ways: water retention for prevent flooding and drought, water purification, shoreline stabilization, and wildlife preservation are just some of the main qualities of wetlands. Upon dealing with the watershed the ever-increasing need for dams and dikes will diminish (Ecology).

In the case of water retention and flood prevention, one acre of wetlands, at one foot deep, can hold up to 330,000 gallons of water(Wildlife, 2011). The ground matter of wetlands will act like a sponge and soak up much of the incoming water runoff, delaying water runoff through percolation through the soil. The percolation process can delay water from weeks to even years depending on the size of the wetland. The delay of water runoff will slow the water to bring balance to massive snow and rainfall conditions so the resulting water runoff has time to move and therefore reduce flooding in the main tributaries of lakes, streams, and rivers.

Water purification of wetlands can significantly reduce toxic elements to become nearly potable water, depending on the degree of toxicity. Wetlands will significantly reduce toxic levels of biochemical oxygen, suspended solid waste, and nitrogen by 70 to 90 percent. The treatment of phosphorus, metals, and organic compounds can vary from 20 to 90 percent (NCSU Water Quality Group, 1994). Every wetland has varying degrees of quality control. The quality of water purification process will depend on the water body's form, concentration of chemicals, substrate type, and water flow rates (Introduction to Treatment Wetlands).

Ecosystems

Types of Wetlands (Wildlife, 2011)

Wetland is a broad term to describe many specific types of ecosystems. To get a grasp of what wetlands are, here's a short summary of each. marshes, bogs, fens, and swamps.

Marshes -Marshes are bodies of water that are relatively shallow water levels and full of grassland type plants and no trees. The animals include a wide variety of mammals and birds. The water can be freshwater or saltwater, in each the seasons or tides can change the water levels.

Bogs - Bogs are water bodies that have had plant material (peat) cyclically grow and die from the outer edges to move inward over the water to create a thin layer. The thin layer then slowly fills till the entire body of water is filled with peat that can be 5 to 10 feet deep depending the age of the bog. In some bogs it can take up to 50 years to produce just one inch of peat(Refuge). This creates a unique environment for many plant materials, but is generally dangerous for most mammals due to drowning(Refuge).

Fens – Fens form from water has percolated through alkaline soils to create unique plant and animal environment.

Swamps - Swamps are forested bodies of water that are generally shallow in depth.

Vernal Pools- Vernal Pools are seasonal bodies of water that eventually dry up and re-form year to year. This ecosystem gives amphibians in particular a uniquely safe environment to survive from season to season (Basic Wetland

Facts, 2010)

Techniques

Flooding has occurred since the beginning of time. After years of planning and trial and error in our techniques, technology, and knowledge in civilizarion people now have varying conclusive results. The research will review current flooding techniques instituted for flood prevention in urban environments, such as dams, dikes, elevated structures, floating structures, and rain collection.

Dams:

The earliest account of a large scale man-made dam was by the ancient Egyptians in 2905 BC (Yang, Hayne, Winzenread, & Okada, 1999). But civilization aside, the beaver has been building dams since its existence as nature's engineer. Dams were and still are some the ways civilization has dealt with flooding and erosion. Today, dams create a controlled water environment that closes off a land depression to give humans control of the water levels behind the dam as well as the water going through it. This control allows us to stop or slow the movement of major water sources to prevent otherwise unanticipated flooding. There are four main types of dams: earth, arch, buttressed, embankment, and gravity dams(Hassam, 2009).

Images From: http://hopenchangecartoons.blogspot.com/2011_07_24_archive.html

Earth Dams

Hassam (2009) states that the construction of an earth dam is composed of water resistant clay, sand and soil. The water retaining side of the wall has erosion measures taken into consideration. The water, in this case, should be diverted around or through a separate connection to avoid erosion over and inside the structure.

Image from: http://www.drylandfarming.org/FB/Ethiopia%20photos/102s.jpg

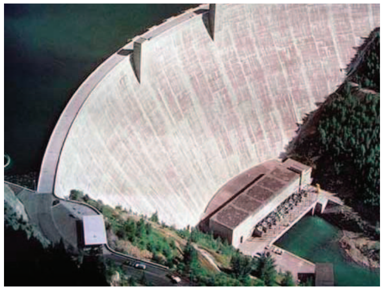


Image From: http://crunch.tec.army.mil/nidpublic/web-pages/USSD_Water_Dams/Images/History/arch_big.jpg

Arch Dams

Arch dams are built to push the water pressure into the two existing walls of a cavern or site features; this acts much like an arch doorway. The forces are transmitted to hold the structure in place while keeping a void from the massive forces. This style of construction requires less material than the average rock and soil and rock construction. The only drawback of this type of construction is dependent geology needed on the site (Hassam, 2009).

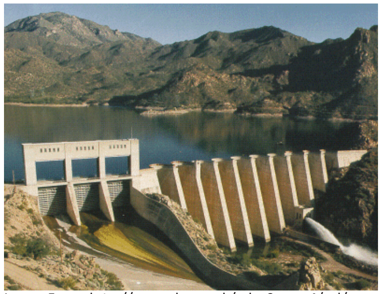


Image From: http://www.dur.ac.uk/~des0www4/cal/dams/conc/concf18.htm

Buttress Dams

The construction of a buttress dam consists of large angled vertical concrete reinforcing members to counteract the forces acting upon the retaining wall. This method is done to geologies that can't support the weight of a typical dam. In some cases the intervals between the buttresses can be arched to gain more strength than a flat retaining wall (Hassam, 2009).

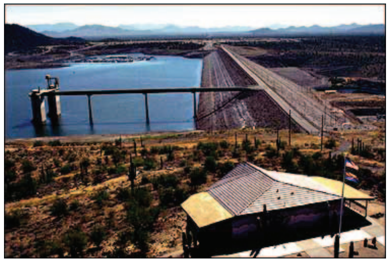


Image From: http://www.pbs.org/wgbh/buildingbig/images/dam/basics/embankment_dam_1.jpg

Embankment Dams

Embankment dams mainly use rock and soil to construct the structure of these projects. These dams are the most common considering the availability of rock materials. The rocks are normally spilled in loose, and the weight of the rocks are used to hold back the upstream waters (Hassam, 2009).


Image from: http://www.dur.ac.uk/~des0www4/cal/dams/conc/gappu.htm

Gravity Dams

The construction of a gravity dam utilizes one large mass of concrete. The base is wide at the bottom and smaller as it rises to the top to counter-act the heavy forces at the bottom. In many instances the water is allowed to move over the top of these dams to store excess water on the upstream side (Hassam, 2009).

Dikes

The construction of dikes consists of long earth-filled water barriers which cut off water from expanding across the land. Dikes can be constructed of a variety of materials but conventionally are made of sand and clay. Some new construction opportunities are being realized and utilized.

HESCO Collapsible Barrier

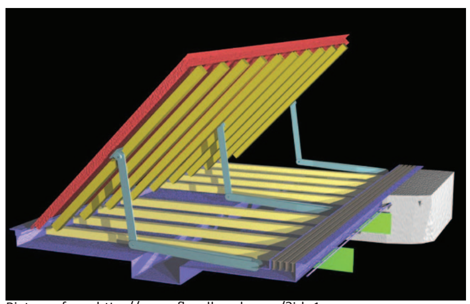
This new technique was invented to deploy temporary structures fast and efficiently. The collapsible wire containers can be deployed with a third of the normal man-power. The wire cages are tied together in a storage container so as a vehicle tow the container the modules self-deploy themselves one-by-one next to one another. Each container is lined with a durable fabric sack that can be filled with sand to act as a giant sandbag. HESCO barriers were used to fight the Fargo flood in 2009 (HESCO, 2011).

Pictures from http://www.boston.com/bigpicture/2009/03/red_river_flooding.html

http://northshorejournal.org/hesco-barriers-a-photo-primer

Flood Break

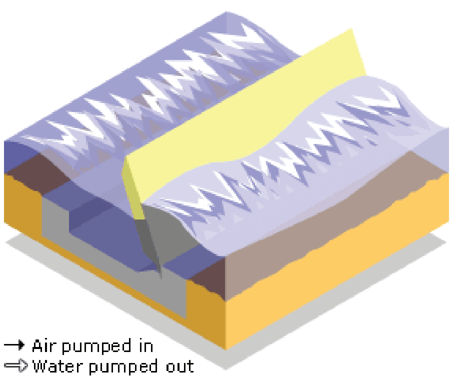
Flood Break is a new installation product that uses hydrostatic water pressure to self-deploy metal paneled dike structures without the use of electricity. The main application of this product is in doorways, gates, and roadway breaks of a flood dike. The application was designed to have nearly no maintenance or human intervention in the event of a flood (Flood Break, 2011).



Pictures from http://www.floodbreak.com/?id=1

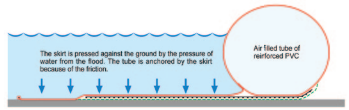
M.O.S.E.

Venice's new 4.5 billion euro flood protection system called M.O.S.E. has been under construction to control the city's ever rising risk of flooding. The system is equipped with over 3,500 reinforced concrete barriers that enclose the three inlets to Venice. The concrete barriers are submerged at the bottom of the sea-bed and are pumped with air to rise out of the water and hold back the increase in tides or increasing sea levels (Cecconi, 2007).



Picture from http://paratoie.intesesrl.com/en/mose-project.html

Picture from Goolge Earth- by RLW



Pictures from http://www.noaq.com/dokument/presentationsblad-en.pdf

NOAQ

This product utilizes long air-filled tube that is reinforced with PVC cylinder. The air filled cylinder is anchored t down to the ground with a long sheet on the water side of the dike. The pressure from the water to the sheet, on the ground, provides all the necessary force to keep the tube in place. This cuts down time and materials needed to build a conventional sand bag dike (NOAQ, 2011).

Pictures from http://www.usfloodcontrol.com/2009/applications.html

Water Tube Dikes

Water filled tubes dikes rely on the weight of the water to hold the pressure of the water back. In one design called, the Tiger Dam, composed of five stacked 50 foot long tubes that take roughly 1 hour to construct a 3 foot high and 50 foot long dike. Freezing temperatures and ground conditions play a factor in if the dikes will work. (U.S. Flood Control Corp., 2011)

Pictures from http://www.fema.gov/photolibrary/

Metal Dikes

Metal Dikes have been used in a variety of applications due to their inherent strength and solid nature against leaks. Sometimes removable metal sheets are used between structural columns to hold water back in entries and sometimes entire lengths of the dike. The main downfall is the price and corrosion water wreaks on exposed metal. However, if properly maintained they can prove successful.

Pictures from Pictures from http://www.fema.gov/photolibrary/

Sandbags

Sandbags are a traditional flooding countermeasure for communities. The heavey wieght of sand and small building units of the sand bag make it easy for anyone to build a dike with these small bags, sand, and metal twist-ties.



Images From: Hunter 1-9 & 1-13

Elevated Structures

These structures typically raise the dominant functions of the building one story high or to the specific flood-safe level for protection against future flooding. These have been built on water, near water, and other locations to avoid water encroachment. Building systems such as electrical, heating, and ventilation must be protected or above predicted flood levels. This feature can make elevating the mechanical space very useful in flood protection.


Image From: http://dornob.com/modern-houseboat-design-for-sea-worthy-luxury-living/?ref=search

Floating Structures

The Netherlands is one of the major innovators of water-mixed architecture. The architect, Marlies Rohmer, developed a community of 75 floating residential structures. These structures are permanently situated in a bay where docks and water is the community's playground. Each building is made up of an evenly balanced and watertight concrete foundation that is attached to metal piers for stabilization. However, in some other cases inland structures have been only made to float during the event of a flood (Ijburg).


Image From: http://www.earthtimes.org/going-green/roof-rainwater-runoff-collection-urged-experts/1542/

Rain Collection

Rain collection can play an active role in flood prevention. If all of the urban buildings had rain collection systems, it could prove vital in the event of heavy rainfall. This water in turn could be used to irrigate gardens, wash cars, and reduce the use of potable water.

Summary

Summary

I wanted to identify the problem and the places affected by inland flooding and present the true extent of the devastation flooding caused these areas. In turn, I will present what the inland flood research center will do to overcome these issues. These solutions will also continue into the research of water movement on various terrain and ecological environments such as CRP, bogs, and wetlands. The main goal is to give adequate reasons why this building's research is needed in today's environment. So as I move on I'd like to start research on the various devastating flood occurrences cities have faced in the in the last few decades. After, I will tie this information to the history of flooding in Fargo and present what has changed in the Red River Valley to create such a radical change in flooding. I'll finally tie all these disasters to their culprits. Then I will highlight the destruction of natural flood mitigation such as ponds, bogs, and wetlands. This correlation will tie the operations of the building to a driven goal of ending inland flooding.

In my research I found the devastation of inland flooding more catastrophic and complex than before. The implications of flooding are vast and to avoid such events is of great importance. I may want to list the consequences that flooding has after a city has been overcome by flood waters.

I will find a wide array of techniques in flood protection and find the qualities in each that make them work successfully against floods. The smaller qualities such as weight, supply, quick deployment, light and heavy, energy intensive, innovative, re-usability, and energy needed for deployment will all be in consideration. The qualities of each method will help find what makes flood protection efficient and reliable to collect and formulate a design solution that takes all the factors found into consideration.

History will provide documentation of past techniques used in the event of flooding. These results will prove themselves successes or failures. Many cities in world will also have lots of information to offer in the case of flooding. Amsterdam, Venice and Fargo are some of the major cities of interest. Their deep history of living near water will prove useful in learning from history's lessons. Fargo's unique geography and land-locked position makes the history of Fargo and its floods very important. The depth of Fargo's flooding crest history will provide frequency and levels of destruction that will present the need for flood design.

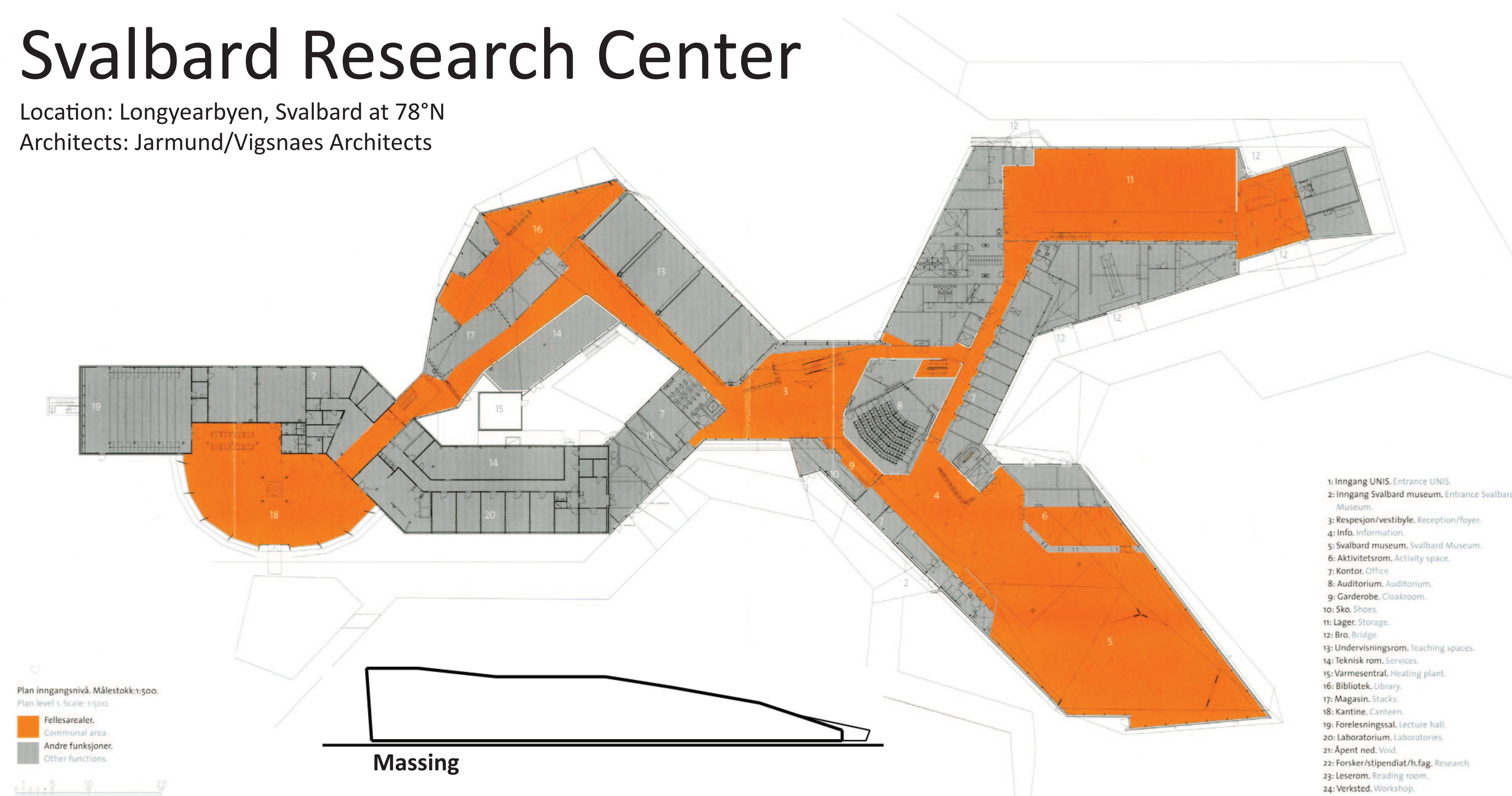
I also found that man-made flood protection must be researched to learn of various techniques to combine nature with technology into one new approach. Just dealing with nature will give rise to many solutions. The research created on 10 species native to water based ecologies will inspire new ideas to flood protection. The species characteristics will develop to a course of action in the design phase of the project.

Overall, I uncovered some of the hidden factors of dwelling near water. These factors will improve my knowledge in the category of how floods function in the natural habitat and built environment. The the natural world will give insight to how structures should be designed as to work with nature, rather than against it. Elements such as topography, trees, errosion, geology, and water currents should be considered in the the final design of the building. Our ability to foresee these elements will improve design in structures constructed near any water source.

Case Studies

Svalbard Research Center

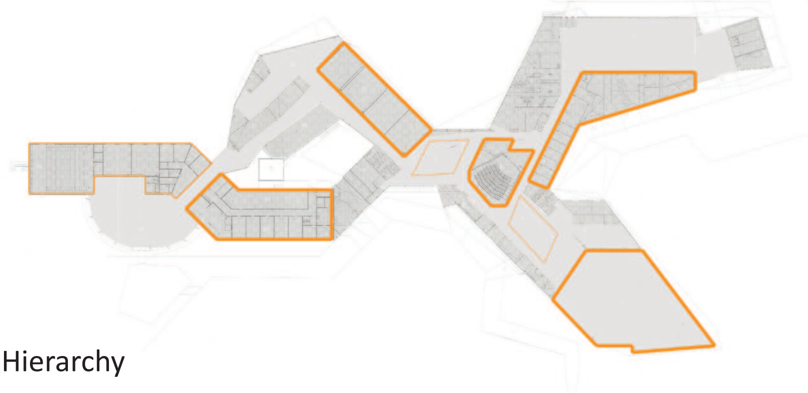
Location: Longyearbyen, Svalbard at 78°N
Architects: Jarmund/Vigsnaes Architects



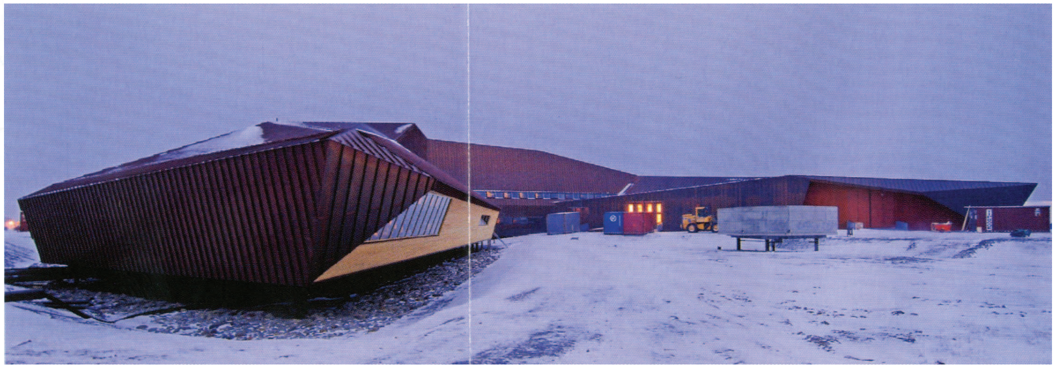
Massing

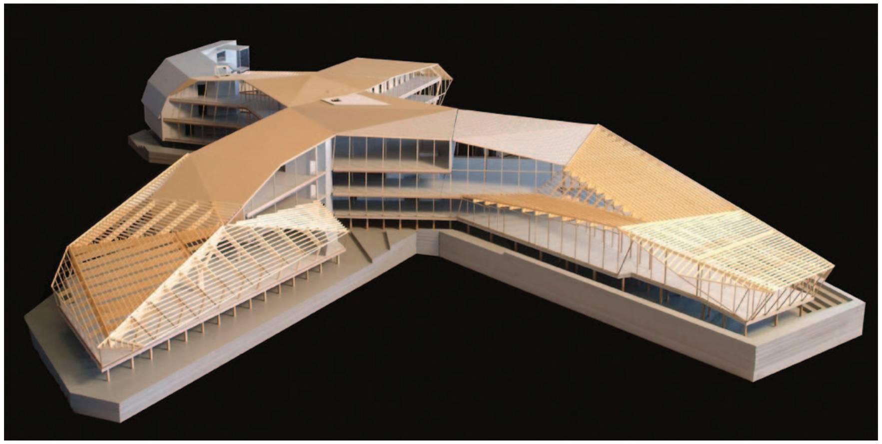
Introduction
"In old Norse, Svalbard means the land of the cold coasts" (MacKeith, 2006). This building was designed in a frigid region of arctic Norway. The research center acts as an undergraduate and graduate studies program on Arctic Biology, Arctic Geology, Arctic Geophysics and Arctic Technology. The region's temperature gets to a high of 49 degrees Fahrenheit and a low of -6 degrees Fahrenheit. However, most of the season has relatively low temperatures and can change drastically in a matter of minutes. The location of the site on Spitsbergen Island makes weather change quickly. The stark and raw nature of the building to its environment has built a great connection to the two. The barren landscape to the flat, blank, copper façade moving up and down as if it were rocks of the landscape itself as one. The building is made to the specific site's topography and climate. The 91,500 square foot complex produces ample space for the new laboratories, museum, and cafeteria to allow for expansion of the student body. The outward glass windows gives fine views of the rugged scenery. The interior is laid with spruce panels up and down walls and ceilings alike. The spruce panels give a warm feeling to the interior from the cold exterior. The thermal qualities of the building were of top importance to the overall design (MacKeith, 2006).

Case Study #1: Svalbard Research Center

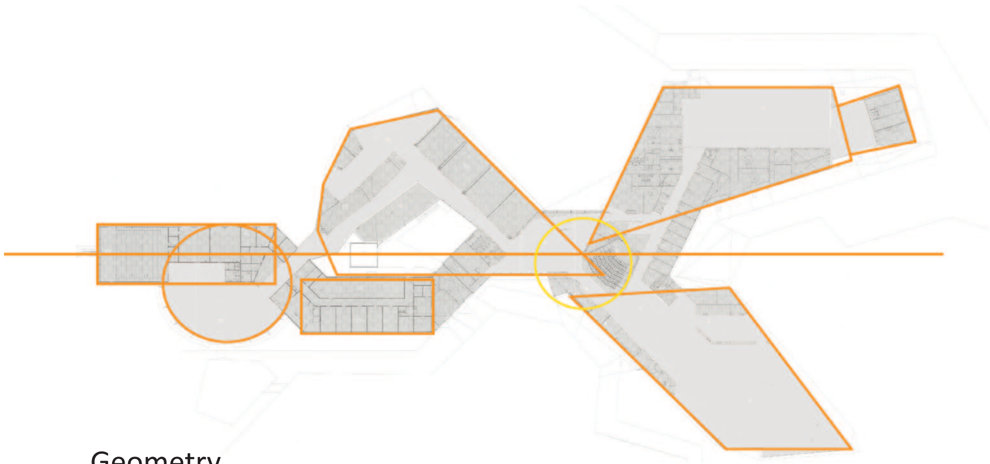


Hierarchy





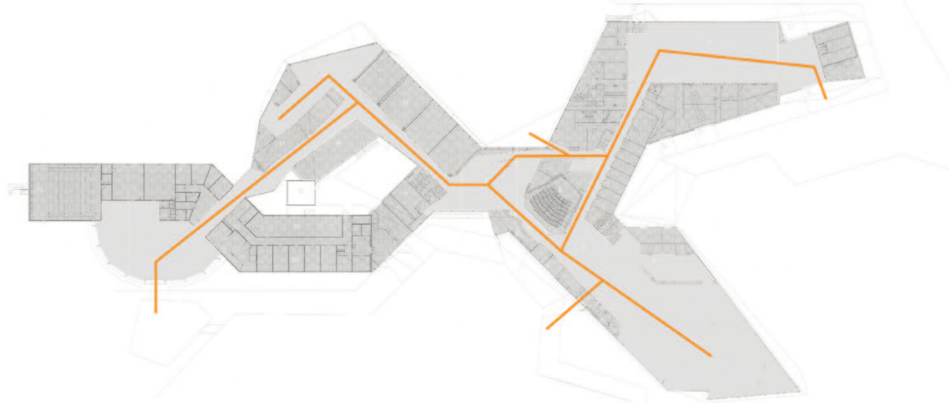
Hierarchy
As seen in the upper-left corner image, the central auditorium, cafeteria, and museum space are some of the hub locations that are of prime importance to the design of the building. Some smaller breathing spaces are located between the pinched circulation spaces to break-up and become important in the transition of space.



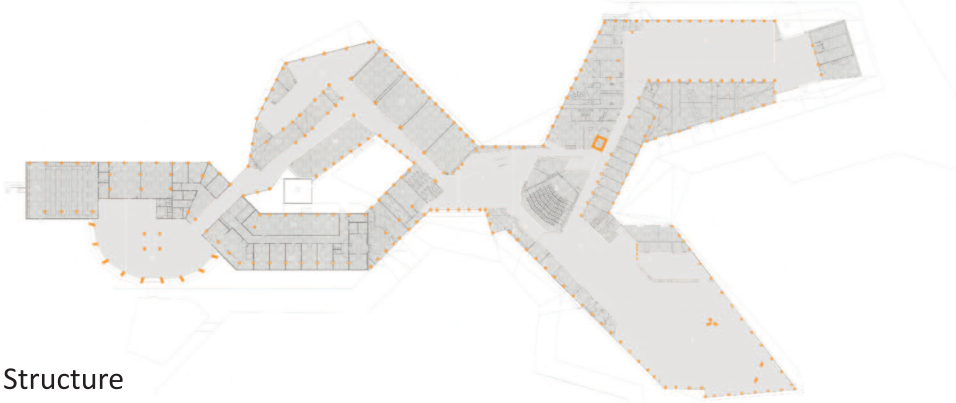
Geometry

Geometry
The overall geometry of Svalbard Research Center utilizes jagged forms to unite in the center near the auditorium and between the offices and laboratories with the cafeteria. The conglomeration moves along the central axis as seen in the lower left image.

Case Study #1: Svalbard Research Center



Circulation of Space



Structure

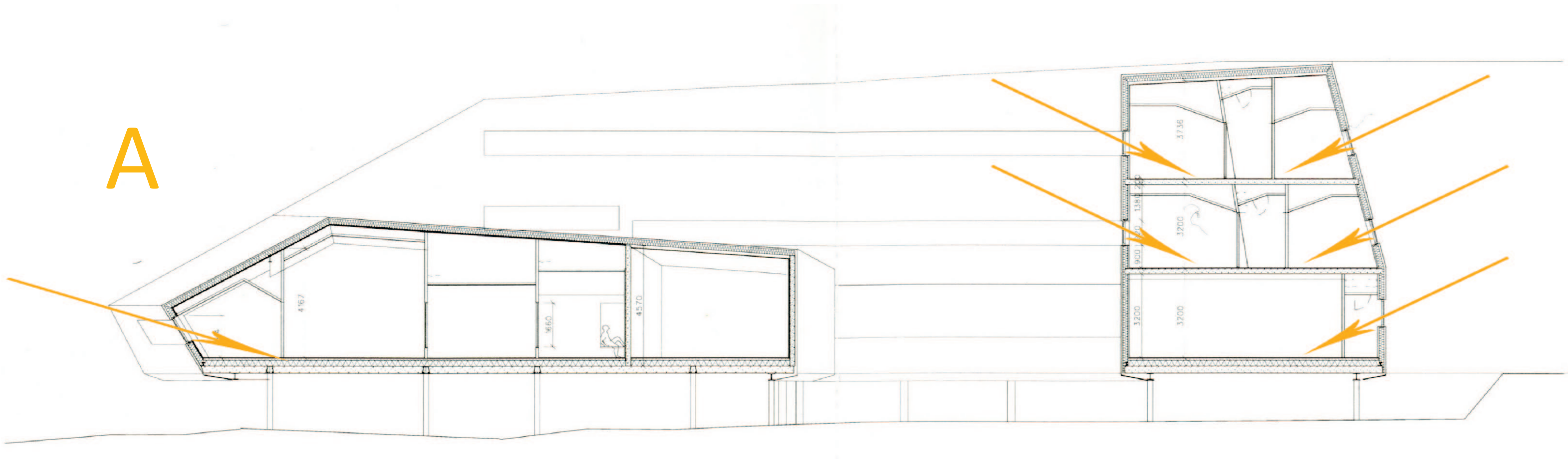
Circulation of Space

The movement through the facility is very unique and spread out like fingers over the landscape. At the end of every journey through the building the designer has created prime public spaces with vistas of the surrounding landscape. The original design has made the building very interesting to work in and visit.

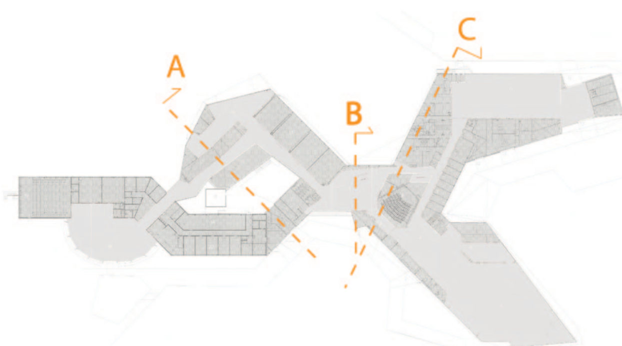
Structure

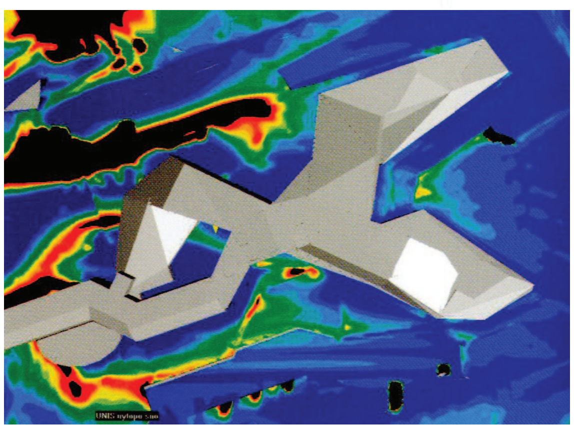
The structure of the building was made to be elevated off the freezing-cold tundra on top of many wooden posts. The ground would otherwise be too cold to excavate. The use of posts also played a part in reducing the building's impact on the natural landscape. The wood posts eliminate thermal bridging between the extreme cold landscape. The entire structural shape was designed to cut through the extreme freezing winds, ice, and snow. The weather can change drastically and the need for adequate interior spaces was critical for this center to develop further. The walls and roof all connect as one and the same. The corners of the top of the building point outward to cut through the weather.

Case Study #1: Svalbard Research Center



Plan to Section Light Study





Plan to Section

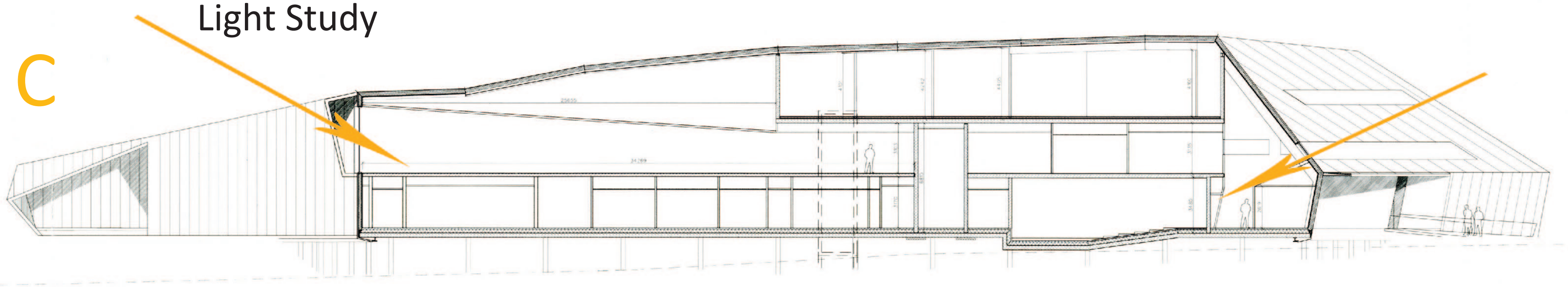
As seen in section, the building's shape has taken on a streamlined shape. The exterior gradual slope allows snow to blow off and away to prevent snow buildup. The streamlined shape makes use of little glass and more protective material to trap heat inside the structure. The plan's interesting shape comes directly from the topography contours. This makes the gradual rising of the site allow the two to work together in movement of wind and visual connectivity to the landscape.

Section B and C also demonstrates the post-suspended structure system the building utilizes, considering its arctic grounds stay frozen nearly all year. The post structure allows the building to support the complex angled structure. The posts support the inner floors and roof. However, the building's pitched roof actually supports itself from the edge running up the side of the roof from the ground cohesively.

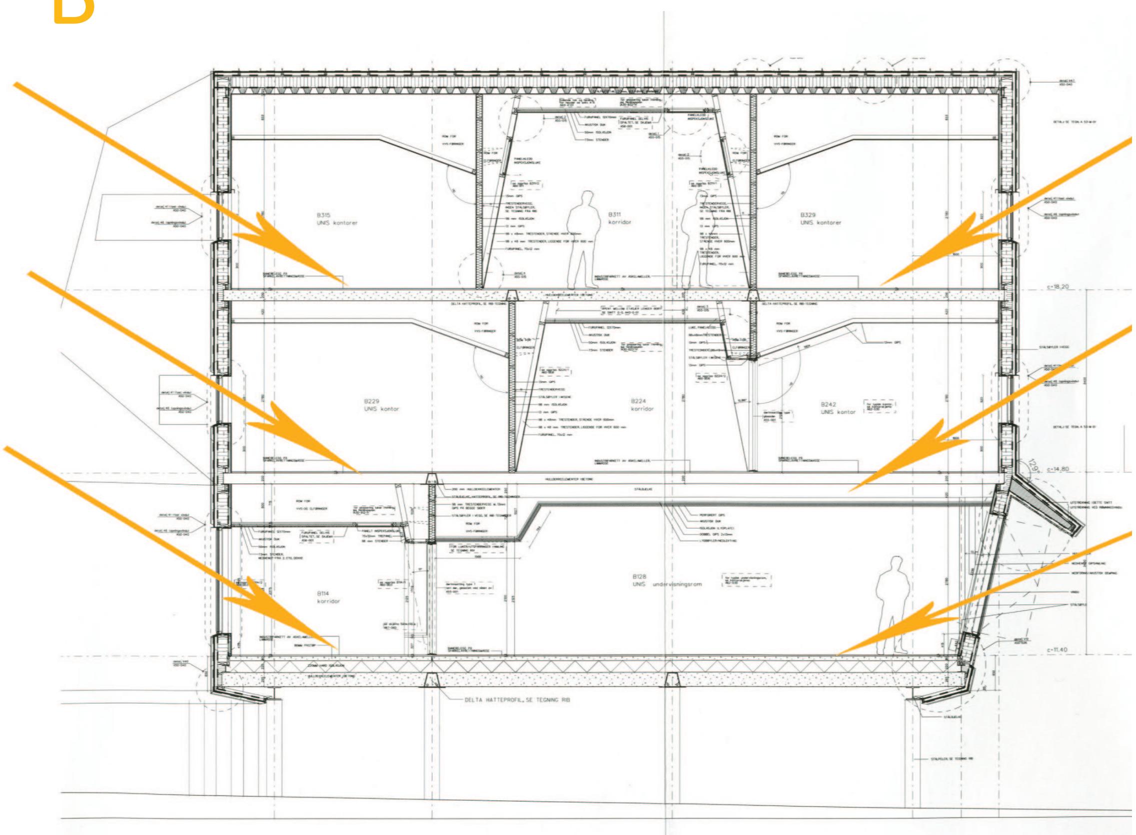
Case Study #1: Svalbard Research Center

Light Study

C

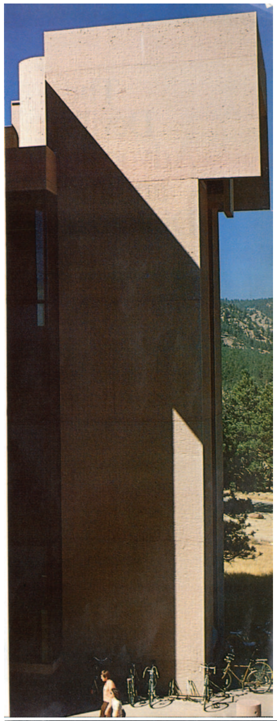


B



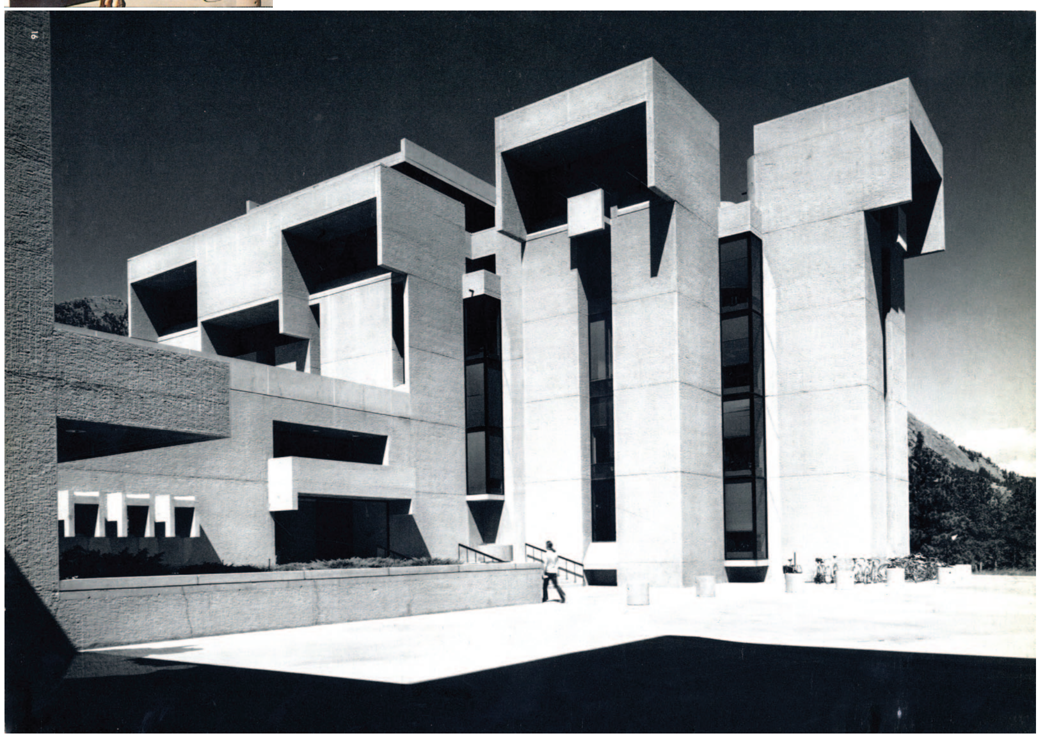
Light Study

As the two diagrams illustrate, the light allowed into the building was done sparingly. The small narrow windows in the structure allow for maximum views as well as heat retention. In section B the material qualities present itself. The thick thermal barrier was a large issue in this northern remote region. The highly efficient thermal retention of heat and the ability of the narrow windows to not have any awnings brings some needed heat in the summer, as it will still be around a high of 40 degrees Fahrenheit. The lower large windows of the building do utilize an awning to protect from overheating. The steep angle of the wall with the large window also limits sunlight on the south side of the facade.



National Center of Atmospheric Research

Located near Boulder, Colorado
Designed by I. M. Pei & Partners

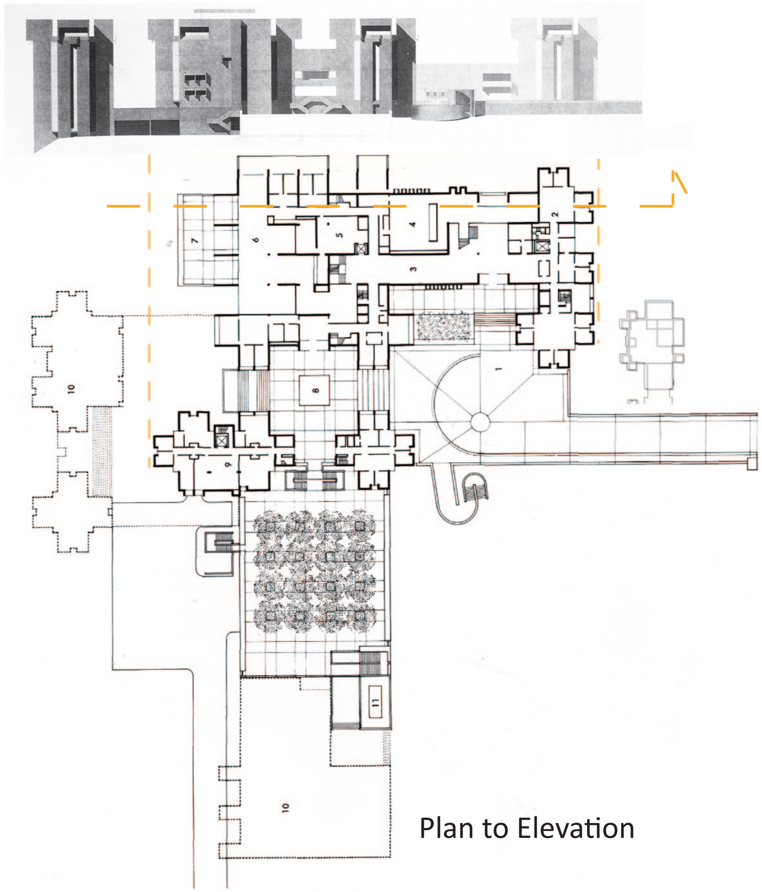


Introduction

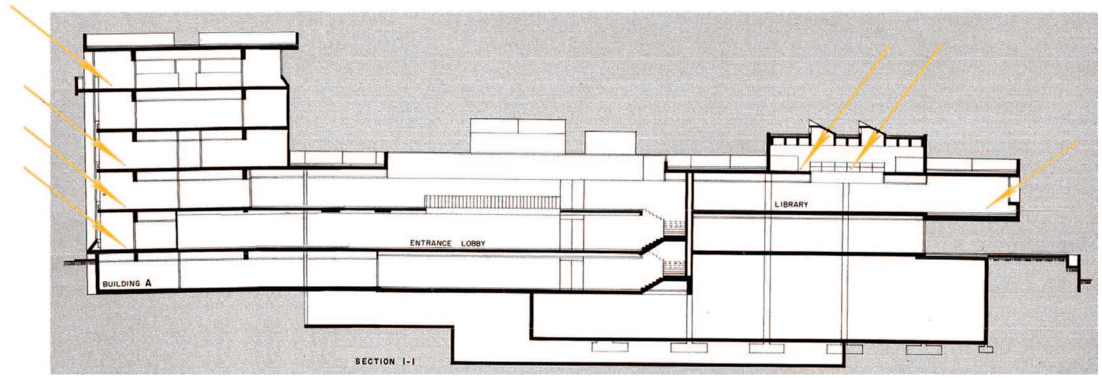
The National Center for Atmospheric Research (NCAR) is located at the bottom of the eastern side of the Rocky Mountains near the city of Boulder, Colorado. The vast scenic landscape is virtually untouched and full of natural beauty. The NCAR was a massive undertaking with a program exceeding 153,000 square feet. That's over 2 ½ football fields worth of space to design. The blank vastness of nature made the thought of scale for the project very difficult in the beginning stages of design for I. M. Pei & Partners. Some of the preliminary ideas behind the design were to design the building through the use of a castle arrangement of spaces and forms. The large mass of a castle was to blend with the masses of the surrounding Rocky Mountains and give the structure a chance to rise out of the landscape. The large blank facades of native stone aggregate towers give a sense of protruding rock. These combinations made the building stand out from conventional modern architecture of that time. The mixture of nature, modernism, and philosophy brought this design to life.

This particular project was interesting in its integration with the natural landscape. At first glance the structure looks more like a mammoth rock with deviating windows of shadows. The use of nature and quality work environment was intertwined and meshed together to produce the final product of the NCAR. The qualities of nature and the site's surroundings brings this project to the forefront of projects to be analyzed and researched for the production of the flood research center (Pei & Partners, 1967).

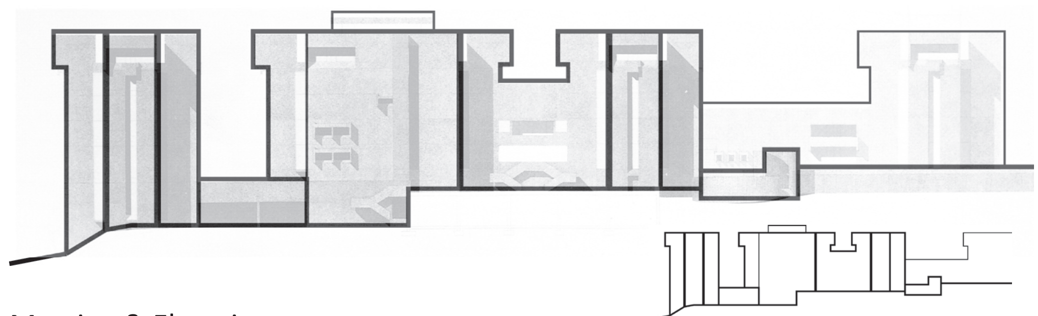
Case Study #2: National Atmospheric Research Center



Plan to Elevation



Natural Light



Massing & Elevation

Natural Light

The natural light diagram above provides graphical information about light that was to be avoided in the laboratory sections of the building to sustain stable temperature levels for testing. However, the offices and library portion of the building receive most of the sun exposure. The building has six levels, each with long slits of light coming from the inner corners and long thin windows to the top of the towers.

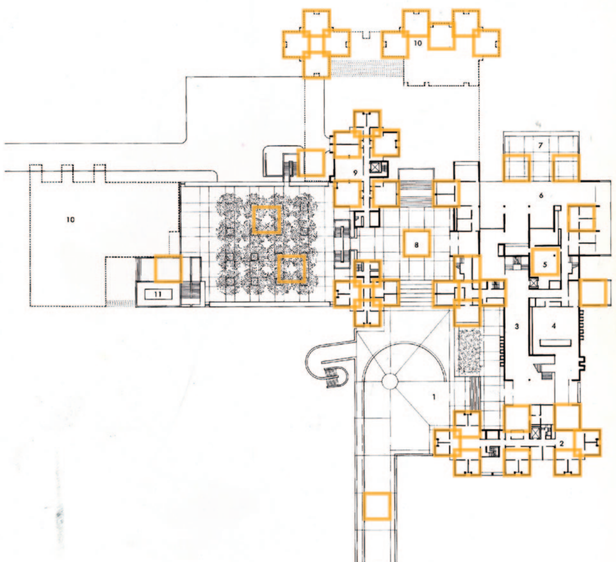
Plan to Elevation

The elevation and plan gives insight into the true scale and massive size of this project. The elevation illustrates the vertical windows in the towers, which presents itself with a vertical orientation to give it more size visually. All except the top windows does the building present a visual human scale of the floors.

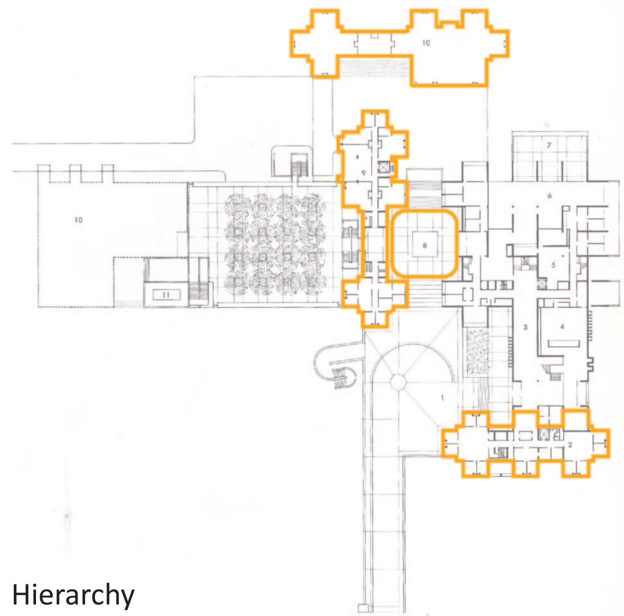
Massing

The massing clearly illustrates the use of towering shapes. The small, cantilevered concrete panels make the building stand out as it's true unique characteristic in the entire composition. What the massing diagram unveils clearly about the National Atmospheric Research Center is its ability to work with the gradual slope to provide a high end of the topography with an entrance yet gradually increase the size of the building to the west while not changing the view heights throughout the structure.

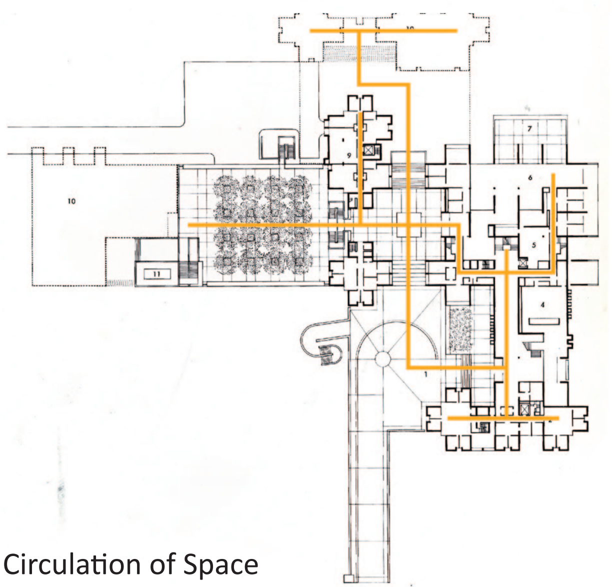
Case Study #2: National Atmospheric Research Center



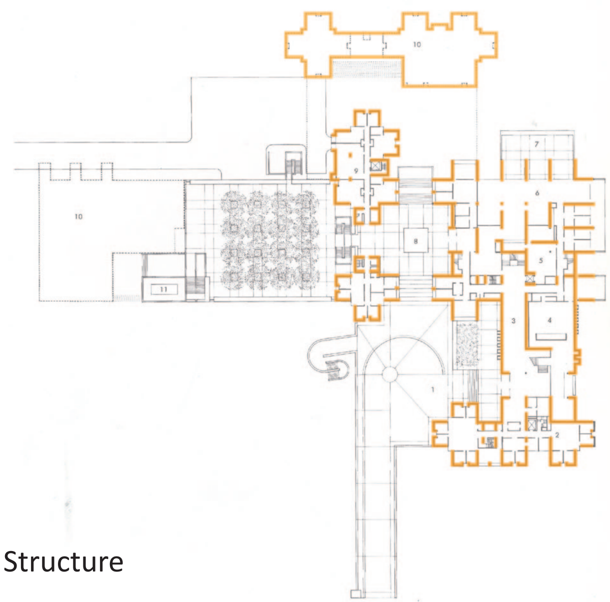
Geometry



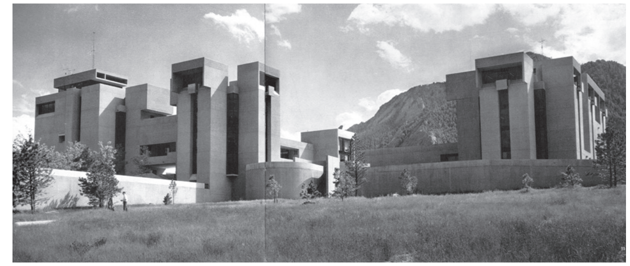
Hierarchy



Circulation of Space



Structure



Movement

The movement through the building relates fairly well to that of a castle. The main entrance and courtyard make the space open to the rest of the buildings from the center. The high buildings become that of castle towers.

Geometry

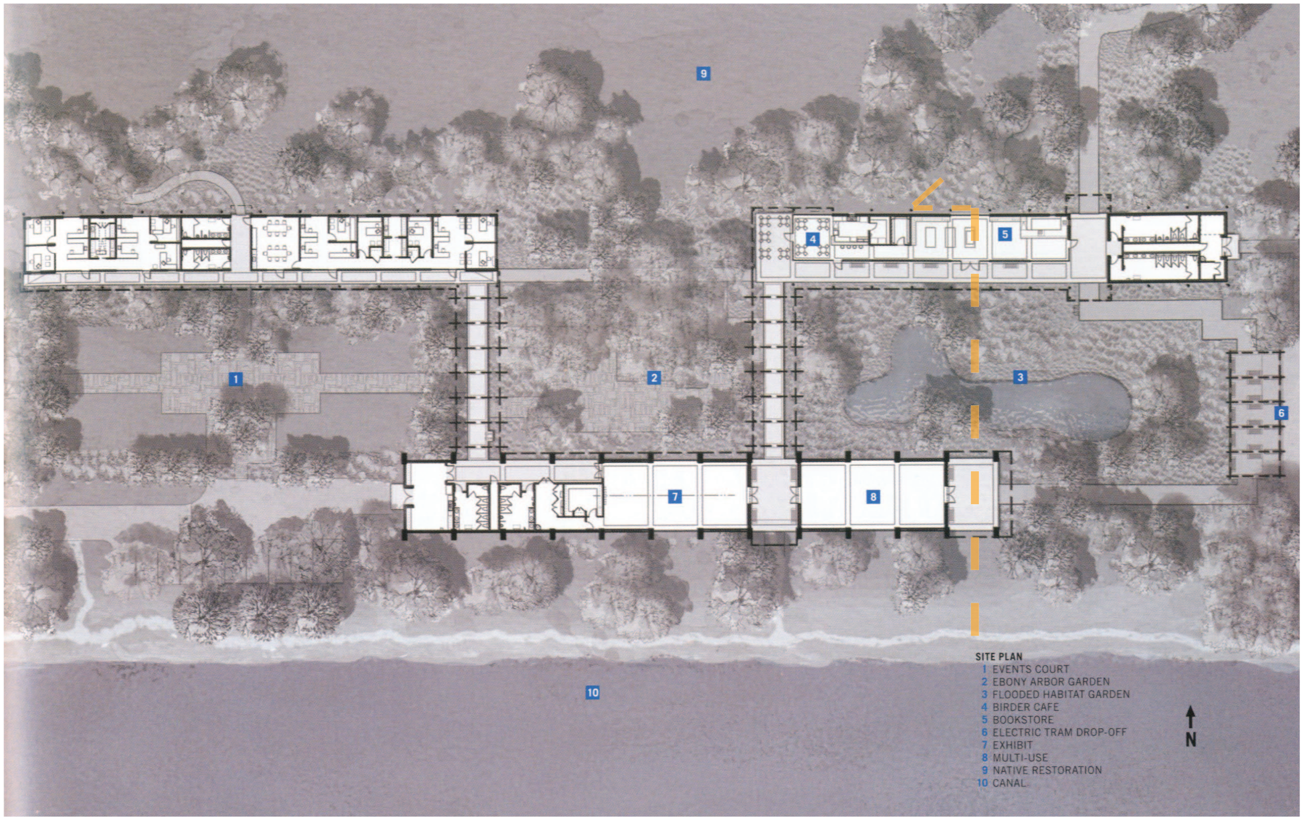
Through the use of a structural analysis, the National Atmospheric Research Center(NARC) has unveiled the use and re-use of the square. The towers all jutout with specific dimensions that are used throughout the design of the NARC. As seen in the diagram the orange highlighted squares relate to the geometry of the square and where signs of the geometry occur through the building and site.

Structure

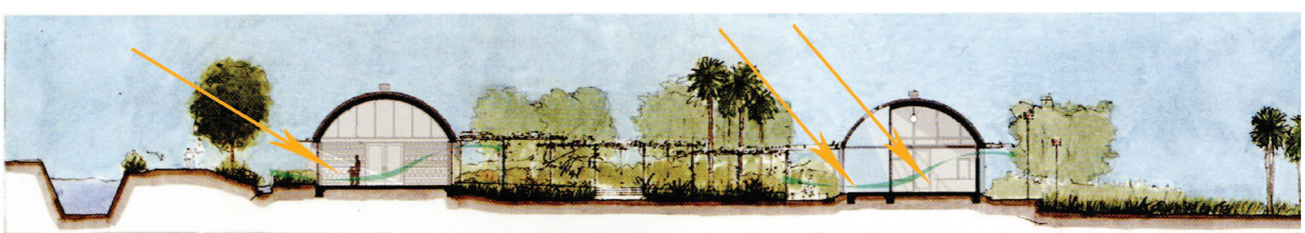
The structure is composed of reinforced concrete walls and columns. The walls of concrete were designed to hide the floor-to-floor relationship from the exterior view. The lack of floors creates a lack of human scale that makes the structure monolithic in view. I. M. Pei used less glass throughout the building to create better thermal environment for the labs and research facilities that require strict temperatures for research.

World Birding Center

Plan



Massing



Plan to Section & Natural Lighting

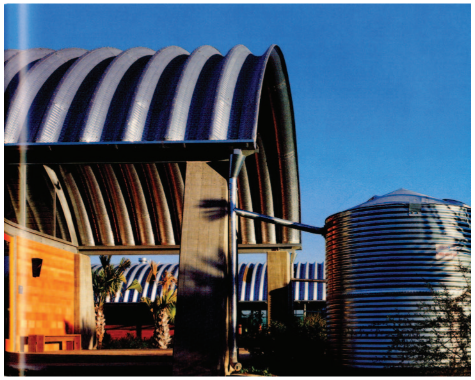
Introduction

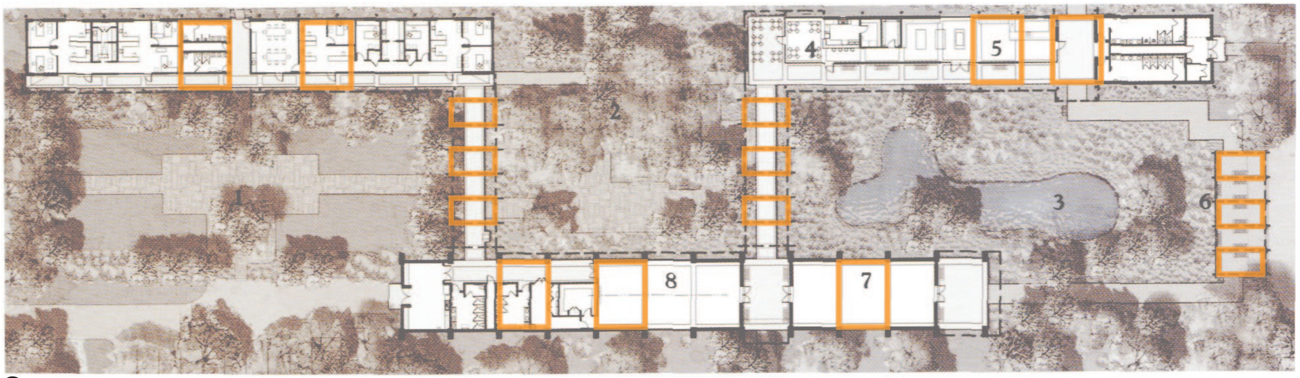
The World Birding Center takes the natural surroundings into account for its shape and use in the Rio Grande Valley of Texas. The building was designed solely to invite and teach the visitors about the natural environment. The staggered arrangement of the buildings and paths truly connects this building to its surroundings. The buildings are set close to a train stop to allow for an interesting natural environment. Every time visitors move from one building to the next they are presented open views of vegetation on both sides of the structure.

People enter this complex to park their cars and venture through the site to the train station. The train station will pick the visitors up and transport them into the park. The building and environment is made to attract birds and butterflies. The Rio Grand Valley is surrounded by farming in a dry climate. The World Birding Center acts as an oasis for travelling birds and butterflies, and therefore also for bird watchers and other spectators alike. Passive systems are in place throughout the design. The core theme of the building frames the environment in all aspects of the building and site. The rain is responded to in the design with an aluminum arced roof made to shed water as 18 massive rain collection towers collect the water for the gardens. Sunlight is vital to the functions of the interior day lighting. Skylights are located vertically situated on the roof to light some of the hallways.

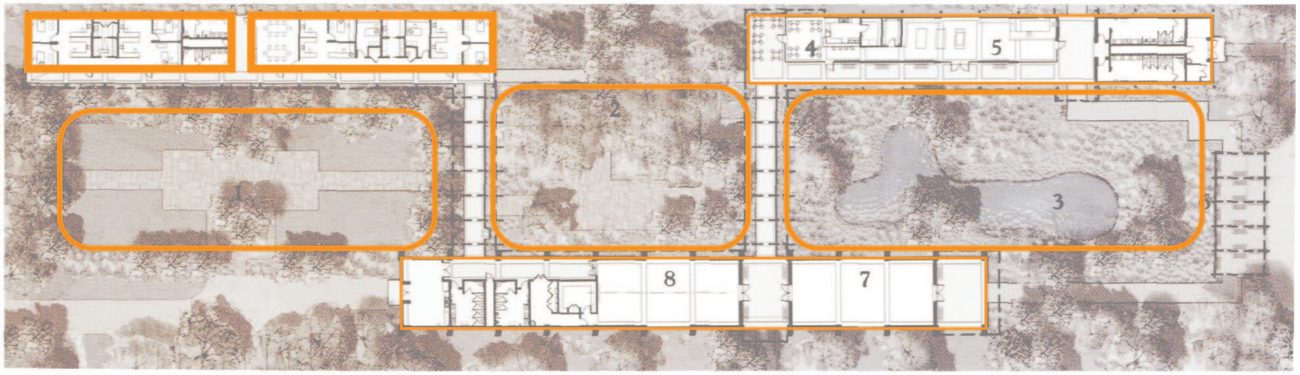
This project relates directly to the flood research design in that the building

Case Study #3: World Birding Center





Geometry



Hierarchy

drastically emphasizes its surroundings. The focus on the environment and enhancing that experience is key to the success of this building. The quality of taking an observer and highlighting information is what will be translated from this project into the flood research center. The way the architect takes a traveler into a train station in a whole new way to experience to learn about nature in a visual environmentally conscious setting makes this project stand out as an influential project (Bahamon, 2008).

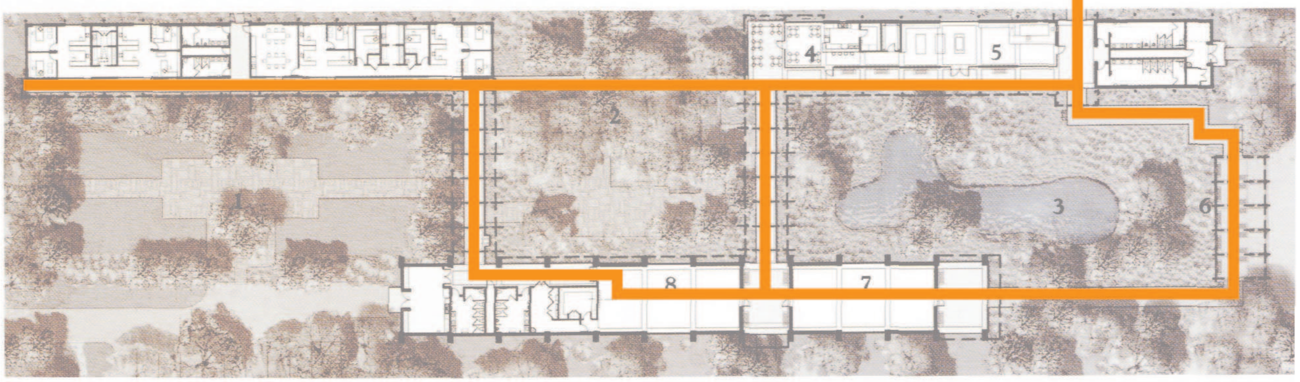
Geometry

The geometry of the World Birding Center is interesting in that the design uses long building layouts split into similar geometrical rectangles. This orientation allows maximum views to the surrounding site and the exterior elements of fresh air and sun. Due to its hot climate, the open shaded spaces create a great environment with the cooling from the nearby pond and cool winds.

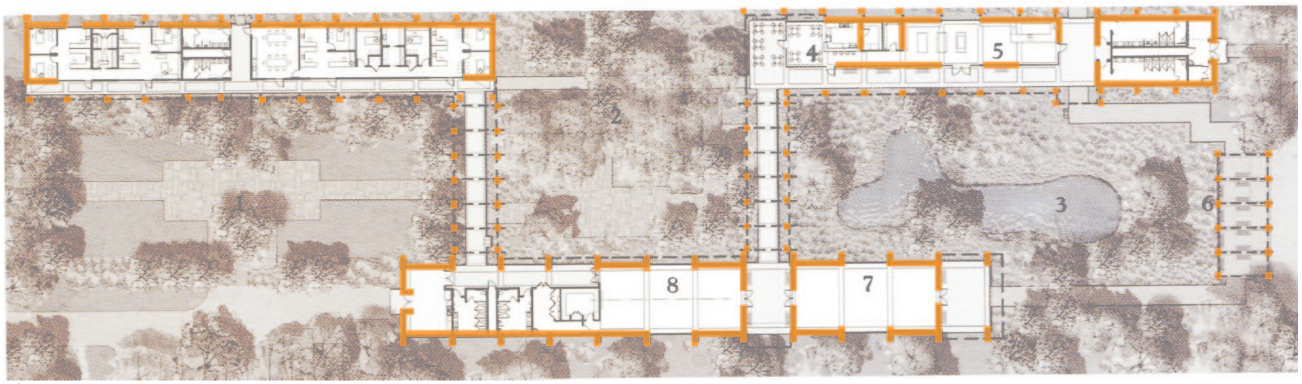
Hierarchy

The interior courtyards are the main focus of the building. The structures and paths create enclosed environments that are always seen in any part of the building. The exterior paths guide along the interior giving views as well as the interior spaces. The single floor-length orientation caps the height near the vegetation. Out of the three buildings, the office building is the only building that is utilized as a private space, while the other spaces are used by the public. The other two separate buildings

Case Study: World Birding Center



Circulation of Space



Structure

hold other functions for the public. One space is open for presentations and other multi-use space. The last building has a public cafe and bookstore. The layout of the buildings frame the important spaces of the project. That being the natural habitat between the structures as the main focus.

Circulation of Space

The buildings are oriented lengthwise east and west along the banks of a small waterway. The landscape is key to how the visitor moves through the site. The small one-story building is careful not to overbear itself over the landscape. The long fields and open gaps between the structures give adequate distance between the buildings to make the central gardens the focus of moving from space to space. The large plants and vegetation transform the building into a covered walkway. The slender, long buildings still act as hallways, and movement spaces are all located outside as the roof protects them from the intense sunlight and rain.

Structure

The structure mainly consists of large concrete columns that tie down the arched corrugated roof. The larger waved aluminum roof makes the roof self-reliant on its material structurally. The roof also allowed for the use of less steel normally needed to support a roof. Steel columns and girders mixed with wood serve as trellised walkways between the north and south buildings.

Summary

Summary

After reviewing all three case studies I've found that all have a deep connection to its natural surroundings. The site and nature is highlighted and celebrated with the use of views and framing of environments through architecture. The architecture should react to the environment to the varying conditions. These qualities are essential to the feature in the future design of the Flood Research Center. Some of the main focuses of design were on the site, materials, orientation, and exterior form to react to nature.

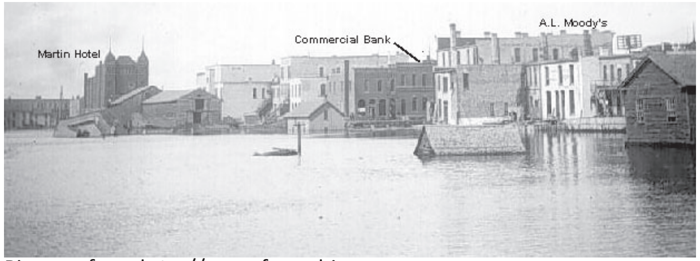
The site has many elements that a design will respond to. One is the topography of the site in which tells a story about the water movement around the site and the watershed of that particular area. The second major feature being, trees and other major vegetative features of the site that allow for natural sun and wind protection. Trees can also allow for debris protection during a flood depending on the degree of density of the forest. Natural openings in a site can allow for views and potential for public use. The third element is water, large bodies of water will need to be studied and understood before any building placement can be decided. The water's flood levels, flow rate, and flow direction can have devastating effects if not totally understood and utilized. Considering in the World Birding Center utilized the water from its roofs to create an oasis for birds, butterflies, and bees to use the elaborate vegetation and stagnate water to their advantage.

Materiality was a major factor in how the buildings sat in its surroundings. The Svalbard Center was a great use of wood and its limited scaring of the rock site. Materials in some of the case studies also reacted to the intense situations of the site to resist weathering and structural failure. However, materials should tangibility to the site as in National Atmospheric Research Center's concrete exterior was mixed with local aggregate to bring out some color to the large structure.

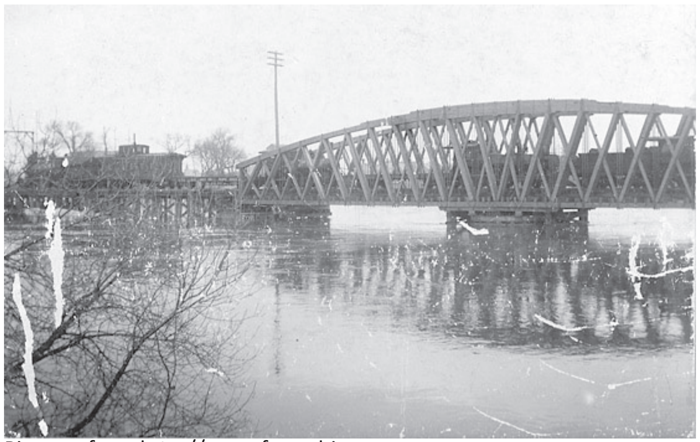
Orientation of glass, walls, and general building form was best utilized in the Svalbard Research Center. The designers used extensive wind tests and sun analyses to develop the exterior form of the building to work with the elements of sun, wind, and water. Through this great example I hope to utilize extensive sun, wind, and water analysis to develop the design.

Historical Context

History: Fargo and The Flood of 1897



Pictures from http://www.fargo-history.com


Pictures from http://www.fargo-history.com


Pictures from http://www.fargo-history.com

Fargo

The city of Fargo/Moorhead was first developed in the 1870s when boats travelled up and down the Red River to move shipments and supplies. The city was first named "Centralia" but as the Northern Pacific Railroad Company finished th,e train-line from Minneapolis to Centralia, the name was altered to Fargo after the director of the train company, William Fargo. William Fargo also became the founder of the Wells Fargo Express Company. Fargo soon gained a college named North Dakota State Agricultural College in 1890 but by 1960 the name changed to North Dakota State University (Caron, 2004). All of these developments brought more people to the city. The city of Fargo soon became a transportation hub of the West and began to grow faster and faster. The population boomed, nearly doubling from 5,664 in 1890 to 9,589 people in 1900. By 1930 the city was nearly 30,000 people and grew nearly 10 to 30 percent every decade after 1930 (U.S. Census Bureau, 2010).

Flood of 1897

Fargo was unprepared for the devastation the Red River brought on April 7th, 1897. The city of Fargo was only populated with about 8,000 people(census.gov). The lack of time and resources created massive flooding with a crest of 39.1 feet. Water from the river filled the streets. People used canoes and small boats to travel through the city to dry land.

The city of Fargo had always had problems with erosion and mud on the streets. The city decided to make use of small horizontally-cut tree chucks as road pavers in the 1890's. This worked until the Flood of 1897 came through the streets and forced the wood pavers out of the ground by their buoyancy. The roads of Fargo never again used wood as road pavers and looked to new materials (Caron, 2004).

Pictures from www.ndsu.edu/fargoflood/

Fargo Flood of 1997

The Flood of 1997 all started on March 24th when massive snow coverage of the winter started to melt. The long winter actually moved through the thawing months of the flood up to May 15th. The prolonged winter, along with the accumulation of a total of 8 blizzards, proved to bring 10 feet of snowfall. All of this, along with continued snowfall and frigid temperatures, brought on one of the worst floods the FM area had ever endured since the flood of 1897. The weather conditions actually brought on freezing that led to two sustaining crests. The first crest peaked on April 12th at 37.61 feet; the second and final crest, three days later on April 15th, peaked at 38.3 feet. The effects of the flood were catastrophic with Grand Forks of North Dakota completely overrun by the Red River on April 17th. Adal, a town of Minnesota, also was flooded in multiple directions by the Wild Rice River and massive overland flooding. The evacuation of thousands and rescues of hundreds occurred throughout the region with large loaders, trucks, boats and helicopters. The freezing temperatures produced ice storms that took down over 1500 power lines. The loss of power proved disastrous for some people without power, heat, or transportation links to evacuate. When water reached the sewer levels of the city soon people's homes were backing up with sewage water. Some people used nerf balls to keep their toilets from flooding their house. Another key issue was that the flat geology of the Red River Valley started to move across the land and turn fields into lakes, which washed out roads and bridges that cut people off from help and supplies. However, Fargo had successfully protected itself from flooding. The Red River had by early May receded back into its original banks. (Red River Flood of 1997)

History: Fargo Flood of 2009

Picture from www.ndsu.edu/fargoflood/ - by Larry Hanson

Picture from www.ndsu.edu/fargoflood/ - by Donald P. Schwert

Fargo Flood of 2009

The Flood of 2009 was one of the worst floods Fargo has ever endeavored in its recorded history, with a height of 40.82 feet, or an elevation of 902.62 feet above sea level, at 12:15 a.m. on March 28th. The Army Corps of Engineers spent $12.4 million in contracts for dike construction (Jervis, 2009). It took nearly 3 million sandbags and 100,000 tons of sand to finish the 8.2 mile dike. The city of Fargo/Moorhead produced over 90,000 civilian volunteers and 2,100 National Guard troops to get the dike construction finished in 12 days. The warnings of the flood came on March 9th, however construction of the dike didn't begin till March 16th. As the crest of the Red River was approaching, the predicted water levels kept rising as days drew on. As changes in the final crest continued, ongoing additional dike construction was underway.

History: Fargo's Flood Recod Crests

Year	River Level (ft)
1897	39.1
1907	29.8
1965	30.5
1966	30.16
1969	37.34
1975	33.26
1978	34.41
1979	34.93
1989	35.39
1997	39.72
2001	36.69
2006	37.13
2007	30.88
2009	40.84
2010	36.99

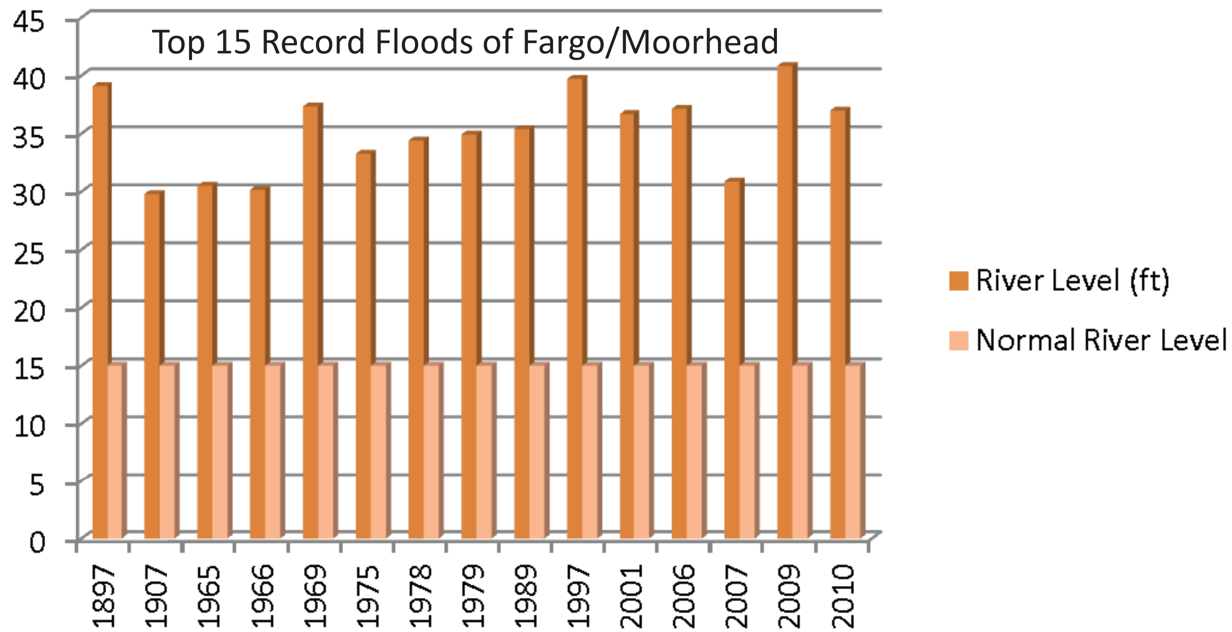
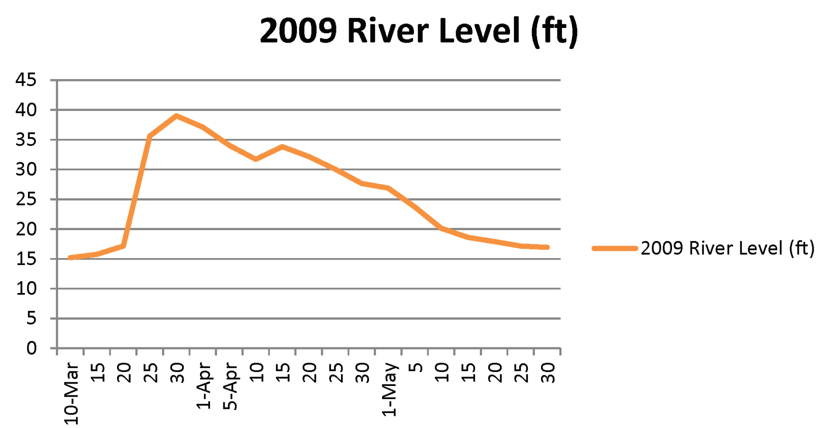


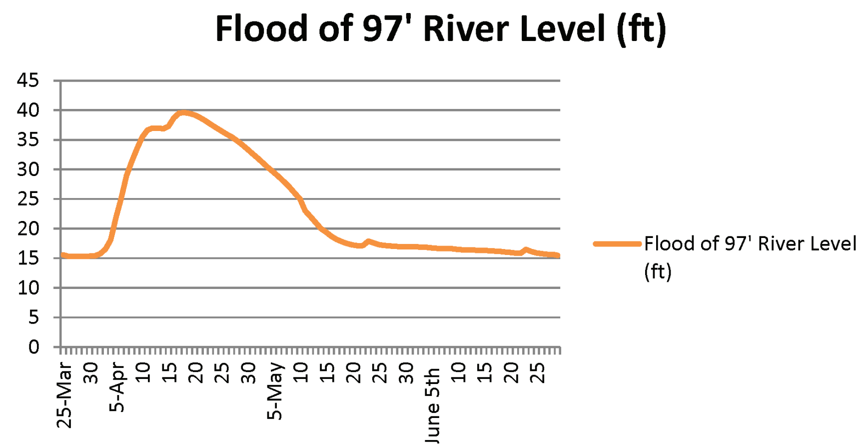
Table & Graph by Richard Wright - Data from minnesota.publicradio.org

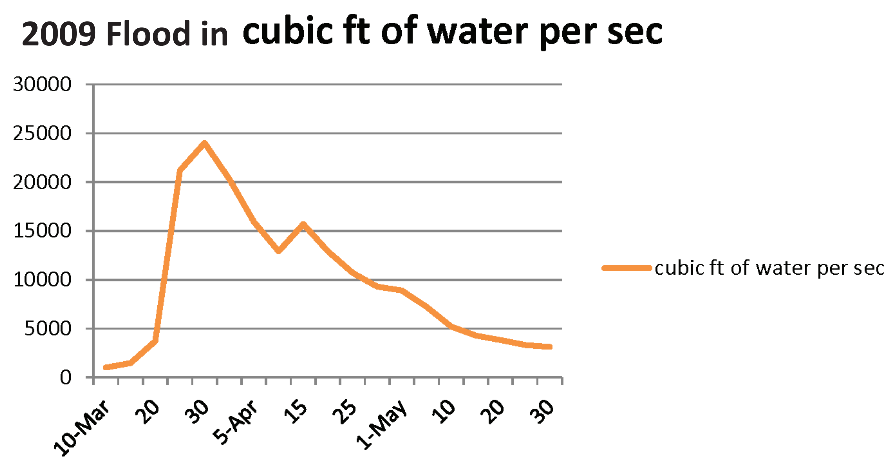
Cumulative Flood History

In the above table are the top 15 record floods of the FM area. The data displays that Fargo has experienced nearly 6 of the top 15 floods within last 14 years. All floods of the FM area have been observed during the process of the thaw cycle of the spring months. This seasonal thaw-out has always brought a rise in water levels, but never in such a short span of time. The past 10 years of flooding has well exceeded the normal standards of flooding (Huttner, 2011).

History: Fargo’s Flood Recod Crests of 09’ and 97

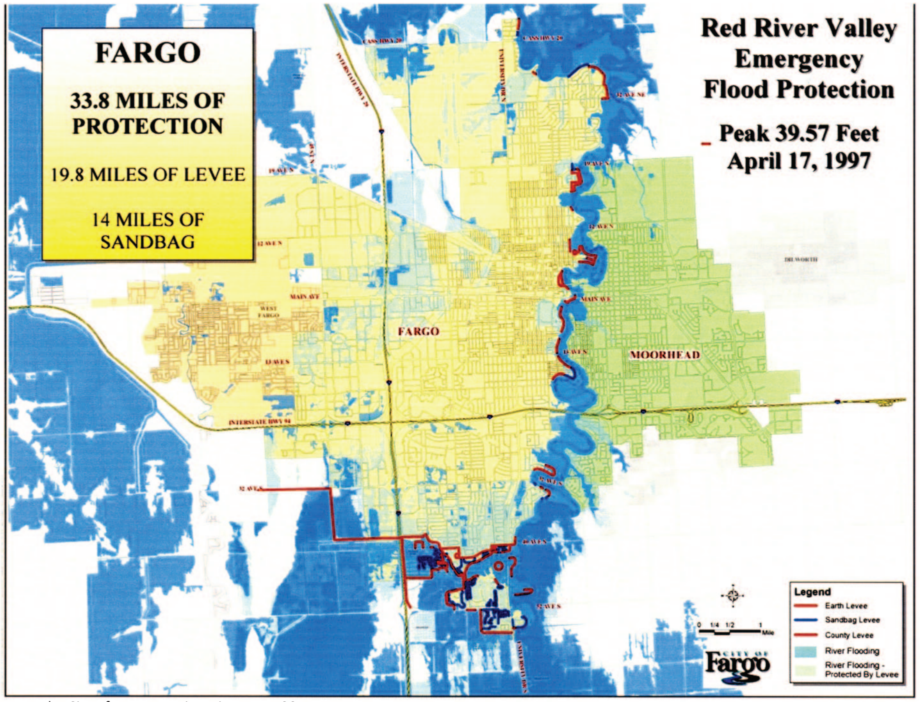




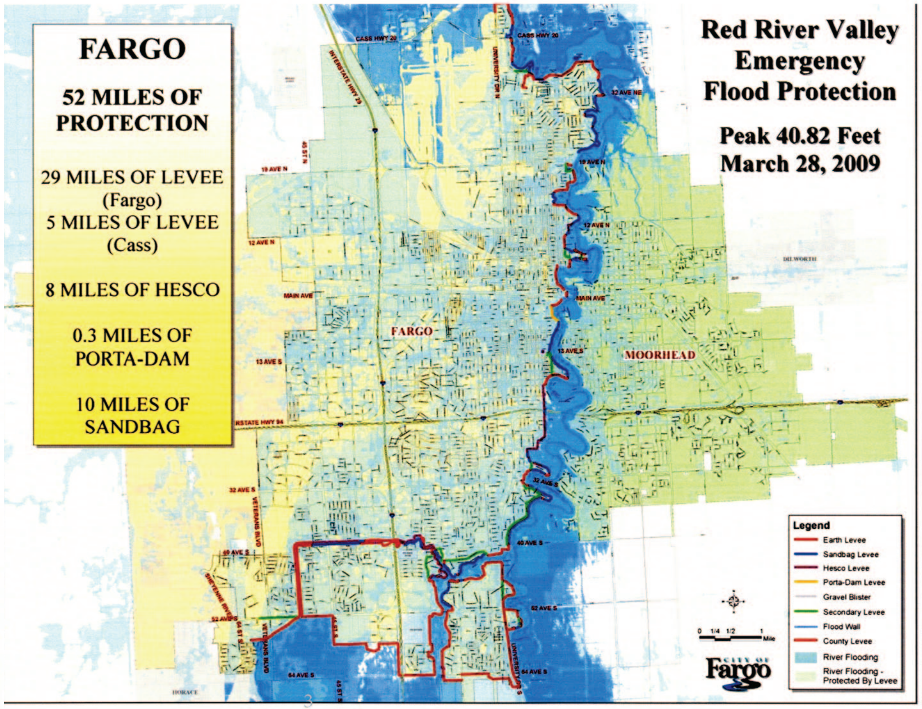


Graphs by Richard Wright - Data from www.ndsu.edu/fargoflood/

History: Fargo's Dike Construction Locations

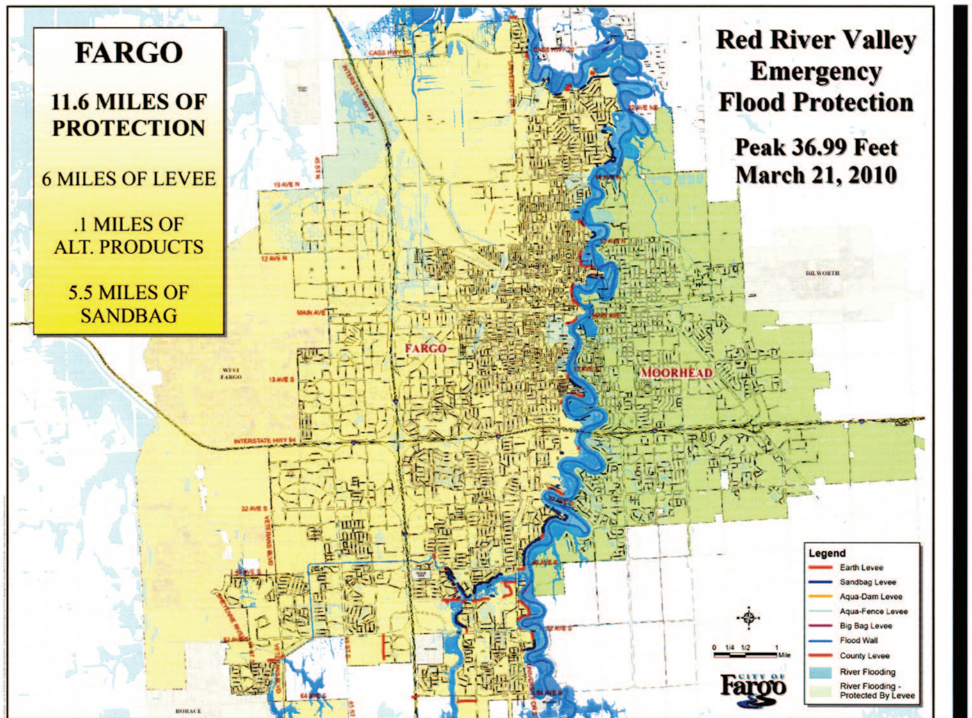


From the City of Fargo - Engineering Dept. 2011



From the City of Fargo - Engineering Dept. 2011

History: Fargo's Dike Construction Locations



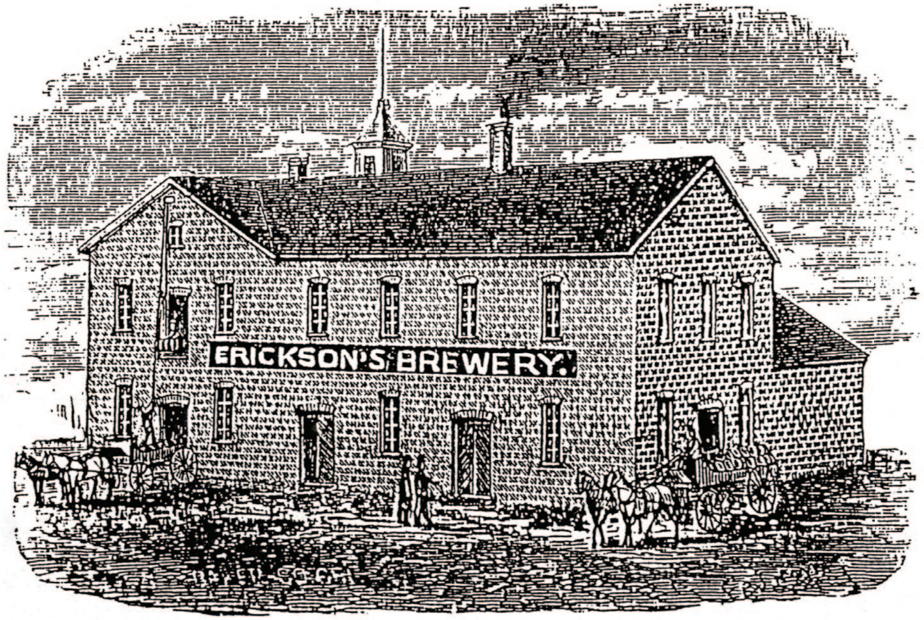
From the City of Fargo - Engineering Dept. 2011

Protection Plan - 2011 (Updated 4-18)

	(Constructed Levees)	
Primary Levees	***Miles***	***Feet***
Earth	7.44	39,263
Earth (Corps)	5.00	26,388
Sandbag	2.85	15,059
Hesco	0.18	936
Aqua Dam	0.00	0
Trapbag (4 ft tall)	2.06	10,869
Trapbag (6 ft tall)	1.55	8,185
Aqua Fence	0.28	1,499
WIPP	0.19	1,012
Big Bag	0.06	340
Gravel Blister	0.02	100
Total Primary Levees	**19.63**	**103,651**

From the City of Fargo - Engineering Dept. 2011

History: Site



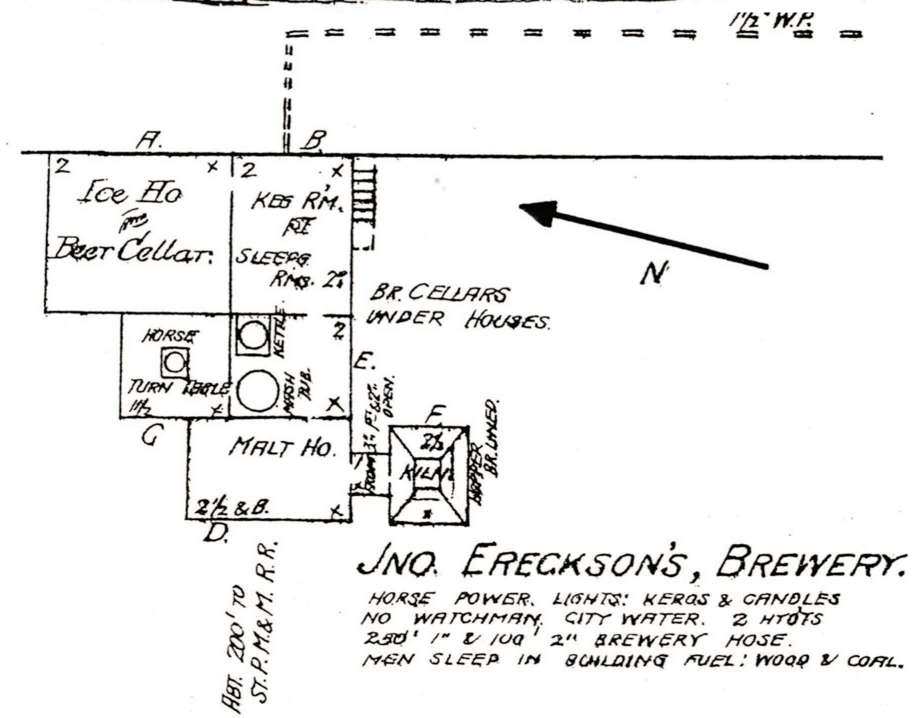


Image from the Moorhead Historical Society

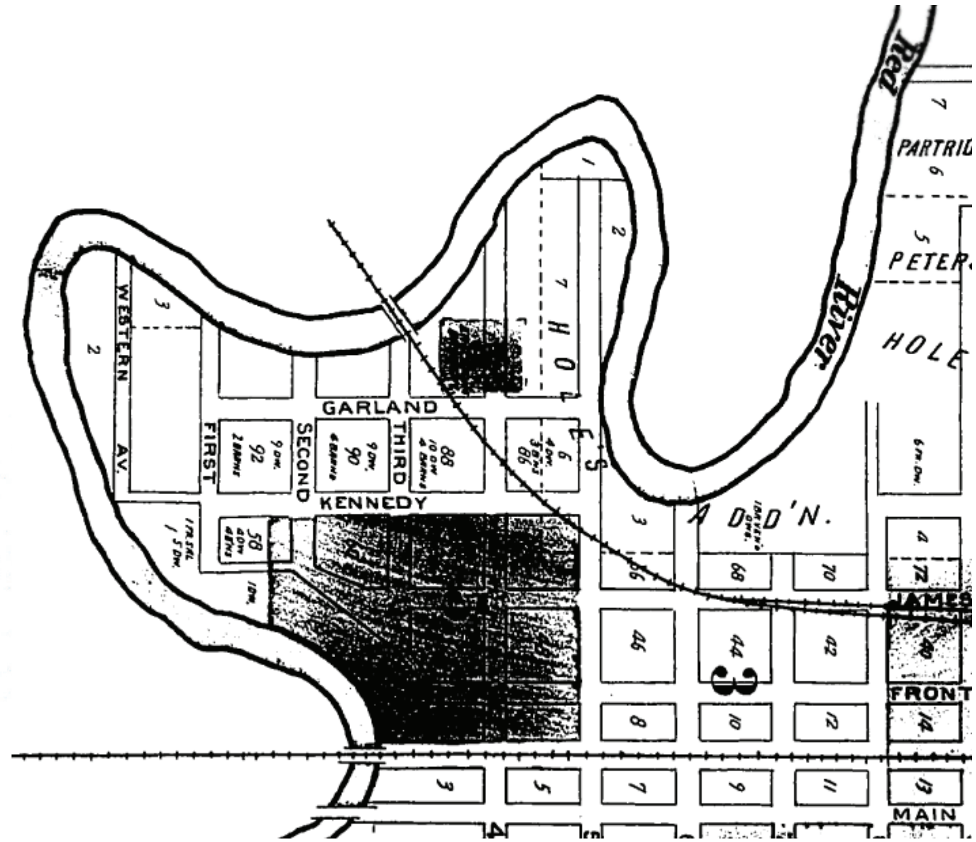
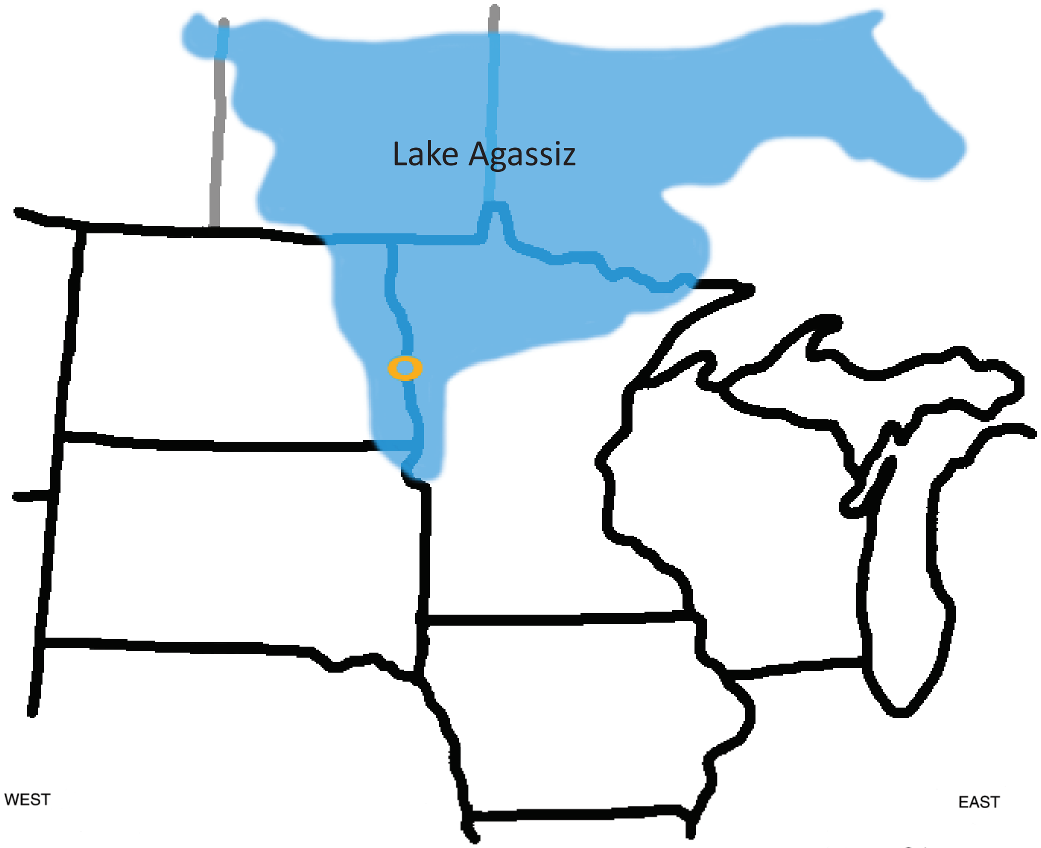


Image from the Moorhead Historical Society

Directly over the site there once was Moorhead's first brewery in 1875. In the above map there was a brewery in in large black shaded region. The site still has some reminates of the old site being the flat graded portion of the site used to be the foundations of the building. In some areas there are still foundations left from the old houses that wrapped up along the river.

The brewery's location along the river was to allow for easy transport connection with Winnipeg's ferry boats on the Red River. The city of Fargo/Moorhead thrived on the local brewery. They kept brewing until August 30th 1901 when the brewery was lost in a fire. The owner after soon retired with what money he recieved from the insurance company and brewing in Moorhead ended for the time being.

History: Lake Agassiz



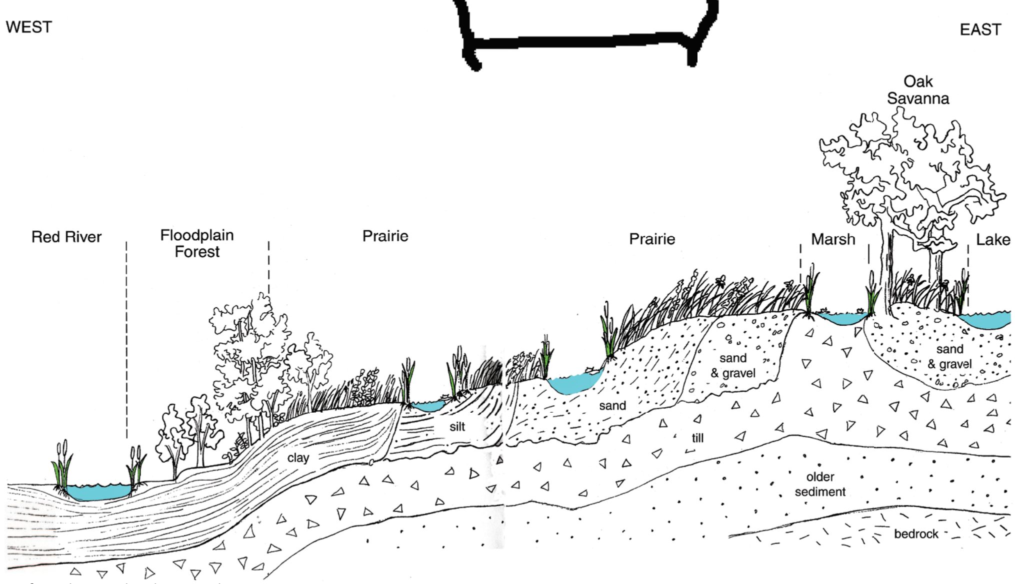


Image from the Moorhead Historical Society

The Red River Valley was first formed by large glaciers that melted into a large lake basin called Lake Agassiz. This lake, over time, receded its banks to what is now the Red River. As seen on the left the location of Moorhead, Minnesota was once inside the bottom of this lake. As the lake receded marshes, swamps, lakes, rivers, streams, and wetlands were created to the topography change and watershed change. The watershed with all these water bodies created places for water to charge the area with water and slowly release the water to the river. These water bodies have since been majorly altered or destroyed causing water to reach the Red River at an ever increasing rate.

History: Venice, Italy

Venice, Italy

Venice is a truly remarkable city that has been around since the early 5th century as a city on water. The beginning of Venice is said to have started from St. Mark, who was sailing to Rome to be blown away by a storm to a marsh island where he had a dream that an angel came to him and said: "Peace be to you, Mark, my Evangelist, and know that one day your bones will rest here. You have had a long life ahead of you, Evangelist of God, and many trials to bear in Christ's name. But after your death the faithful people of this land will build a wonderful city here and will prove worthy to possess your body. You will be venerated honorably." The city was later created as the angel had said when Venetians used the islands to escape the dangers of the invading Goths in the 5th century. Over time the city grew larger, full of fisherman, salt farmers, and traders to become a valuable trading hub with routes only known by Venetians due to the labyrinth of islands and low spots leading to the city of Venice. The naval power of Venice grew to the point of superiority in the early 8th century. The secure isolation of Venice proved quite valuable, so that art and architecture soon blossomed.

The city's structural foundations started on the series of 117 small islands of dirt, to gradually have trees driven into the earth to build larger structures such as churches and large buildings. Some of the trees were driven so close together they nearly touched each other. The bases of all the structures were made to withstand the natural high and low tide that keeps the nearby lagoon in ecological balance. The current city of Venice has grown to its current population of 270,000 people. The dense nature of construction along with the canal infrastructure of transportation has made the city very unique to any other city in the world (Mosto, 2004).

Goals of the Thesis Project

Thesis Project Goals

Thesis Project Goals

Academic Goals

Through the utilization of research and application I will learn the current and past flood techniques that man and nature have provided. The gathering of all this information will give me insight to just how a flood occurs and how to prevent such an event in the future through design. The early ways of flood prevention found in history will prove insightful to our present high-tech to low-tech techniques. This research will become an aid to my understanding of floods and flood design for projects with similar conditions.

Professional

After years of flooding, I wanted to research and discover new ways to avoid inundation. The years of experience have taught me that flooding has countless factors to consider before designing can take place. Some main elements to observe and evaluate are: sewers, ice dams, floating debris, mechanical, electrical, transportation links, overland flooding, and many other implications that may occur to be prepared for in the future. Many of these issues have never been explicitly been addressed to me at one single time for a design. After a thorough review of these elements, I will bring insight to any design project dealing with inundation.

The aquatic behavior of lakes, rivers, and streams has always been of extreme importance throughout my project. The understanding of how the watershed works in a region in accordance with its geography has never been as vital as it has in this project. The understanding that water from the Red River is a collection of water from three different rivers across the valley to finally run through Fargo/Moorhead is vital to truly see the magnitude of what excess water to a region can do. Water speeds and typical flooding periods are vital knowledge as to the length of time the site will be flooded.

Flooding has become such an issue in the United States in the last ten to twenty years that I believe the act of individually improving your home to avoid loss of property and heartache is inevitable. Personal safety is always top priority in everyone's minds. Soon, people realizing their home or property is too close to the water to be safe will need to find alternatives. This extensive research will aid me in the architectural field to assess the client's options to live safely near water for years to come.

Drainage in urban and rural environments was interesting in how the man-made landscape has evolved to the point of destruction. The natural world has ways of dealing with rapid water expanse in cases such as wetlands and vegetation. Man has destroyed many of these features naively to the point that we continue with man-made procedures until we someday understand our first mistake. Nature is a force that should be worked with, not against. Our dams and dikes will hold but our greed for land will topple nature's balance. I now see the world of sea of black asphalt parking lots draining the water quickly to the nearest sewer just to flood ourselves near the river. The multitude of actions does create risk and someday our actions must change to prevent the repeated outcomes.

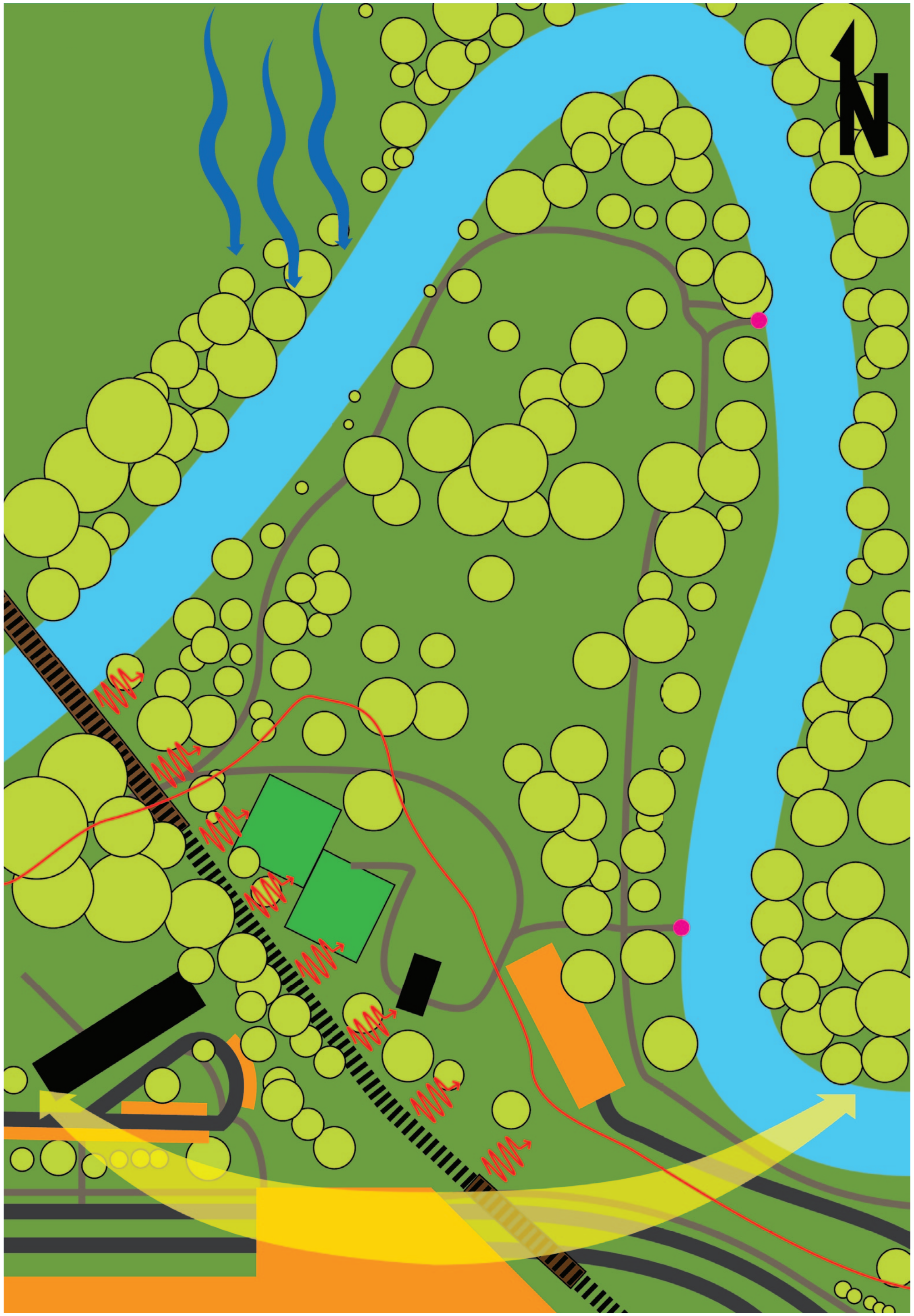
Personal Goals

After experiencing the post-flood effects of losing entire schools, towns, and homes to inundation, I've wanted to fulfill solutions to these problems utilizing my architectural talents rather than my sandbagging and dike-building skills. I figured if people were totally prepared architecturally, floods should come and go without major complications. Our lives would go on uninterrupted and with a feeling of security in one's home. I couldn't believe the re-occurrence of the massive floods in the region of North Dakota. The need for design solutions couldn't be at a better time than now.

Nature has been a great source of inspiration in design. Some of the ways nature has acted during and after catastrophic events tells a bigger story than that of just loss and ruin. The process is life. The time is to work with life and understand the long-run outcome of flooding and just how most plants and animals react in such conditions. The results will give designers a deeper awareness of what flooding is and how to design in conjunction with it.

The city of Fargo/Moorhead receives millions of dollars of our taxes to build temporary dikes against the flood. I hope to understand their views and techniques to critique their measures and possibly find alternate solutions. The expensive act of placing temporary dikes just to put them up again year after year seems irresponsible. I hope to locate prices on current measures and see if our cities aren't wasting public funds and improving the city from future floods.

Site Analysis



Site Analysis

The site is located on the east side of the Red River, in Moorhead, Minnesota of approximately 38,000 people. Across the Red River lies Fargo, North Dakota, with nearly 100,000 people. The site is very interesting in that in such a flat landscape it is relatively a high elevation to be found near the river.

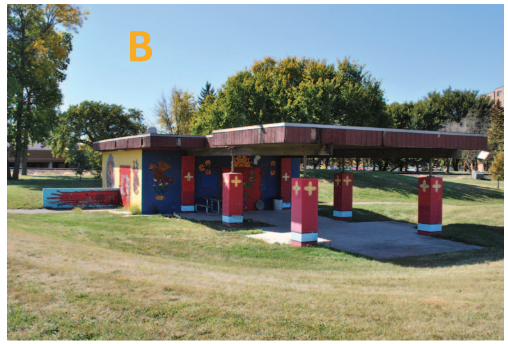
Geology

Fargo/ Moorhead (FM) is located at the bottom of a large valley called the Red River Valley. This valley is mostly flat, but gradually runs north into Canada. The downward slope creates the unique south to north flow of the Red River. In the valley, land will rise in elevation at a rate of .5 to 1.5 feet per mile. This gradual flat slope allows over-land flooding with even the slightest overflow of water on the banks of rivers, streams, and lakes. The spanning out of water can therefore flood buildings miles away and prevent the flow of water downstream. The prevention of flow will keep levels higher for longer and in the case of Fargo can take up to three months to recede back into its banks. Before the Red River moves through Fargo, its waters come from a major flow of three rivers: the Wild Rice, Otter-tail, and the Bois de Sioux Rivers. The three rivers absorb the water-shed and moves it downstream to the FM area. This large conjunc-tion of rivers can produce above-average water levels. However, after Fargo to Grand Forks nearly 80 miles away, has an additional 7 rivers bringing the Red River's water up to it's banks.

- Sidewalk
- Roads
- Parking
- Bridges
- 09' Flood level
- Train Trax
- Trees
- River Balcony
- Tennis Courts
- Existing Structures
- Noise
- Wind
- Sun Pattern

Site Analysis

Views of the Site



Ice Dams

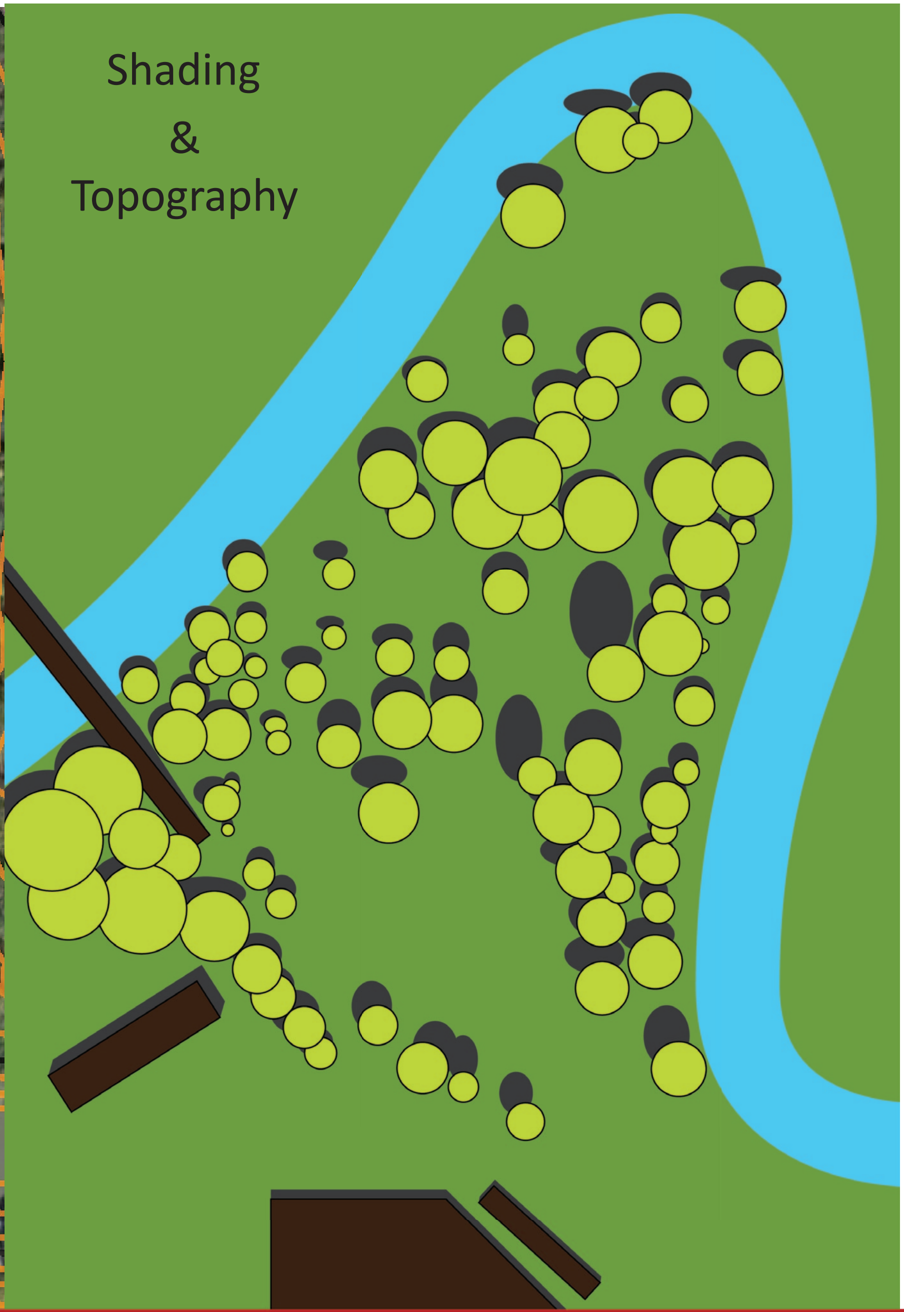
The north flow of the Red River also creates a dilemma of the natural freeze-thaw cycle. The south part of the Red will thaw while the northern region is still in the state of freezing. The result is ice dams. Ice dams are when rising waters carry ice debris downstream and dams up on solid frozen ice and any other objects in its way. This action can demolish entire houses and bridges with build-up(USGS, 2011).

100 Year Flood

The meaning of a 100-year flood isn't that a flood will occur every 100 years. The term 100-year flood actually means that a flood has a one percent chance of occurring a year. This term and water level derives from statistical data of water levels of a river and the occurrence of floods during that time. The only problem many regions face is that over time and observation the statistics change, whether higher or lower. However, as Fargo has experienced two 100-year floods along with consecutive 6 major record-breaking floods in the last 15 years means that odds have indeed changed(International Joint Commission 20).

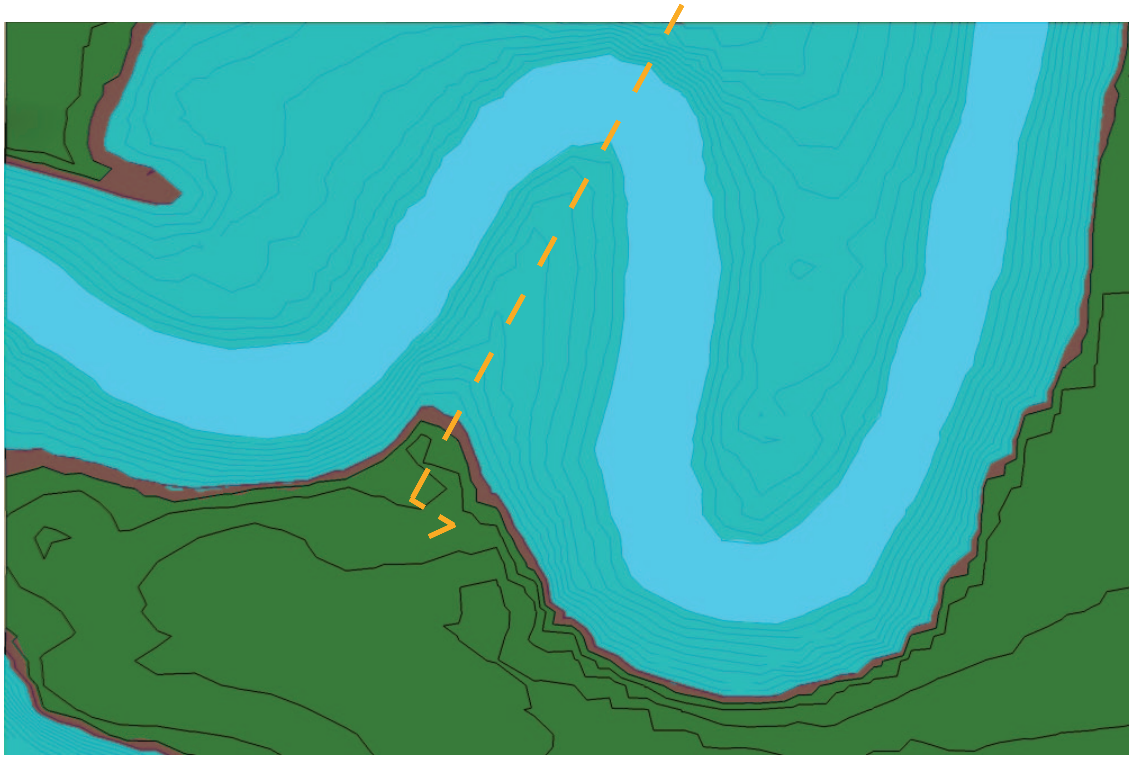
Views

The views of the site in picture A show the views to the north at the top of the hill. The large, open, flat landscape with some large tree coverage creates a great view of the land peninsula. Picture B and C illustrates the existing structures on the site, including 4 handball courts and a small public restroom and picnic area. The picnic structure has been worn down and heavily corroded from rain and weather damage. View D shows the existing parking lot that floods nearly every year and the degree of slope the site has running up to the site.


Shading
&
Topography

Site Analysis

Highest Flood Levels on Site



Normal   100 Year Flood Plain   500 Year Flood Plain

Topography

The flood map to the left displays the highest recorded levels of flooding for the FM area. The section highlighted in red is the 500-year flood elevation of 902 feet. The light blue is the intermediary flooding limits of the site. A 500 year flood has a .02% chance of happening any year, but is considered very rare.

Soils

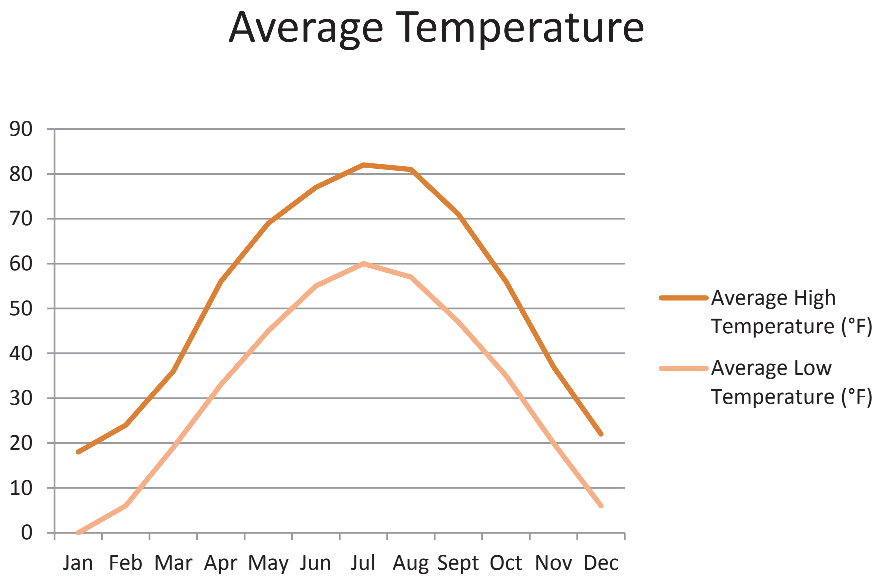
The soils of the site are lacustrine sediment left behind by the glacial lake called Lake Agassiz. Over years of plant and organic material accumulating on the base of the lake made the rare soils that lie there today. The soils on the site are close to the river which is mostly composed of silty clay.

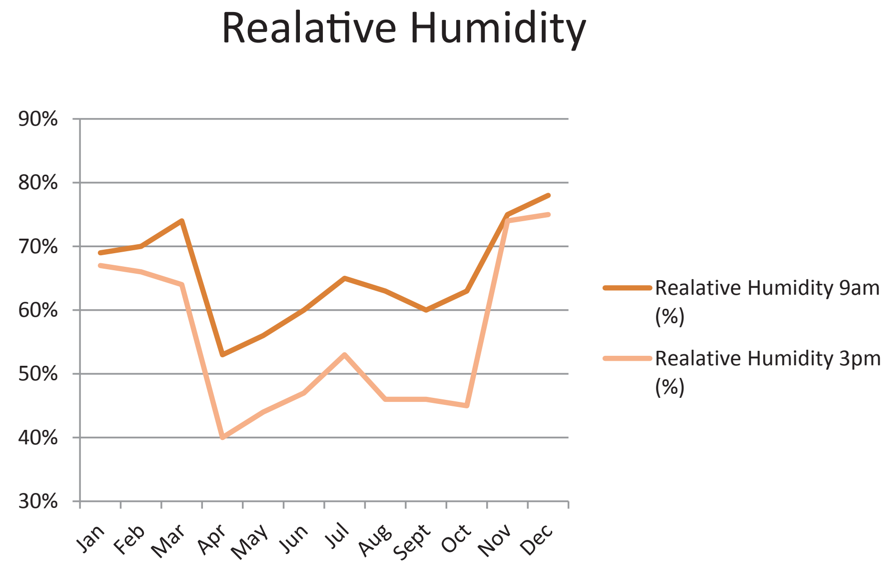
Information from http://websoilsurvey.nrcs.usda.gov/app/Web-

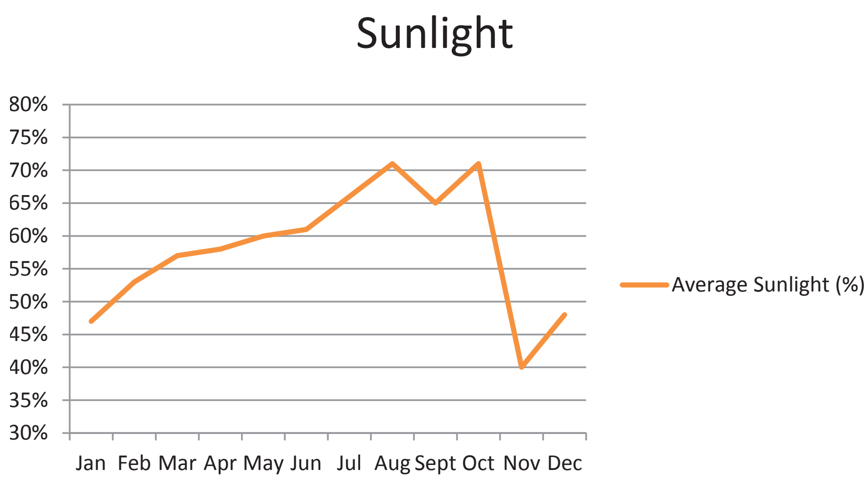
Silty Clay and Loam   Silty Clay 0 to 6% Sand   Silty Clay 0 to 2% Sand   Water

Highest Flood Levels in Section

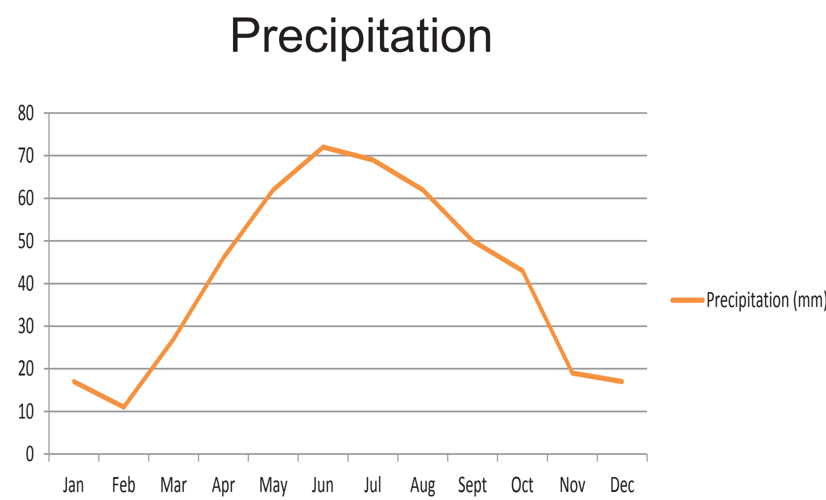
Site Analysis



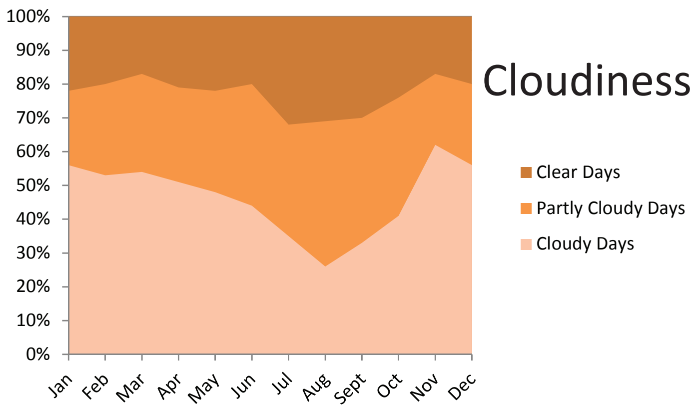


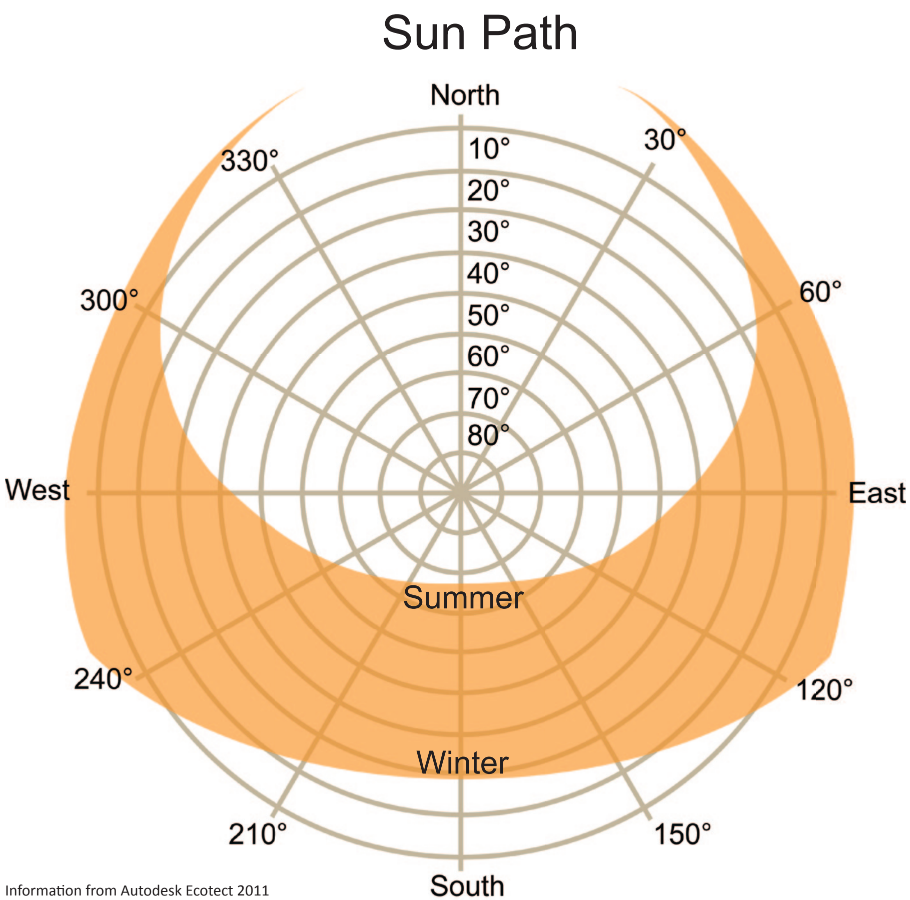


Information from Autodesk Ecotect 2011



Site Analysis





Information from Autodesk Ecotect 2011

Site Analysis Summary

The light quality of the site is very clear with great degrees of change from winter to summer. During the winter months the site will get nearly 40% less sunlight than in the summer months. The sun path daigram displays the sun's azimuth and path through the sky. The summer months also prove to have less cloud coverage than in the winter months.

Wind

The wind on the site comes predominately from the north at 10 miles an hour. The wind does increase slightly in the evening compared to the mornings. The residing trees provide lots of coverage to protect from strong winds.

Human Characteristics

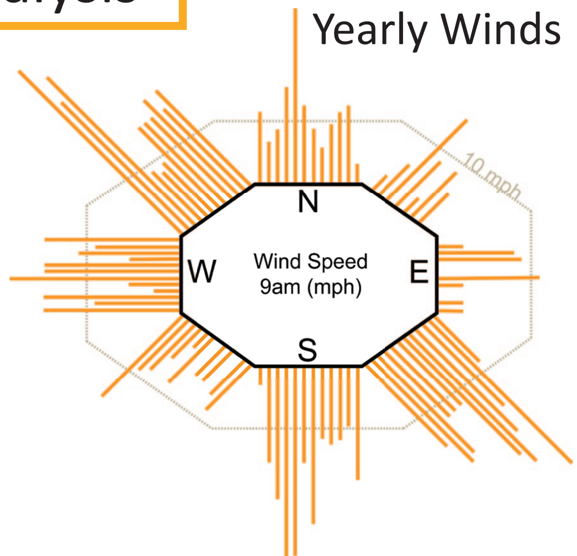
People intermittently pass through the site. Most visitors are joggers and bikers along the river paths made of tar. The picnic structure is rarely used and in bad shape. Train tracks run directly through the site causing some noise and small tremors. A highway is also located directly south of the site with a 80 by 50 foot parking lot, which is rarely used due to the steep road link often being hard to view.

Site Conditions

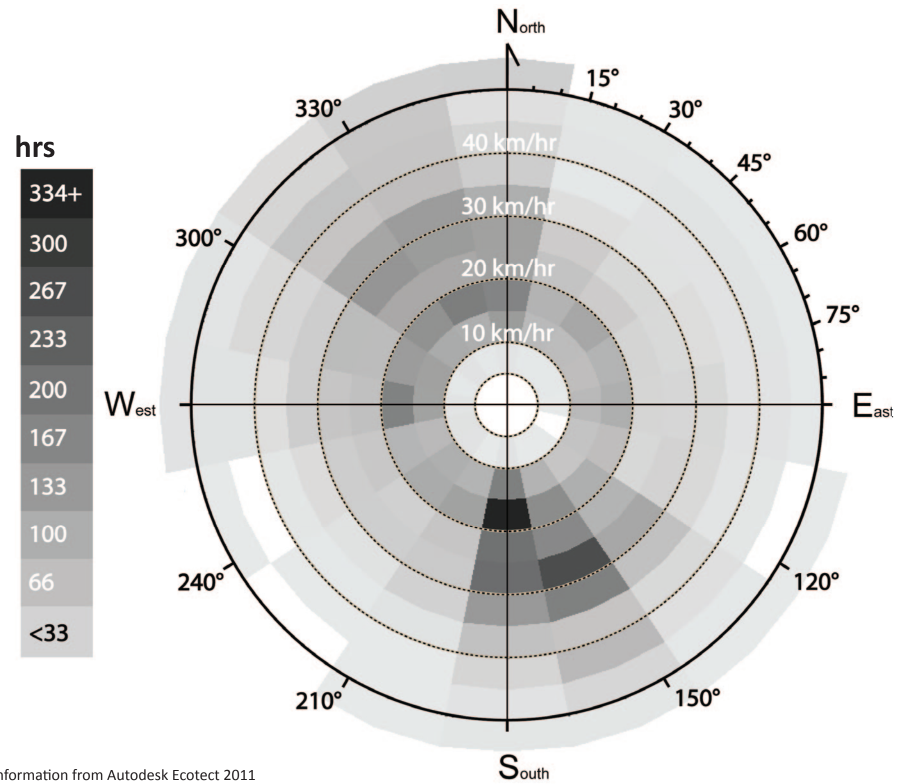
Erosion occurs during the spring flooding season and dispurses clay and debris deposits over the site. However, most debris will be deposited on the other side of the river considering the bend. Grass and tree roots provide retention of most of the soil. The nearby parking lot needs to be cleaned of dirt seasonally.

Site Analysis

Yearly Winds



Wind Direction & Speed



Information from Autodesk Ecotect 2011

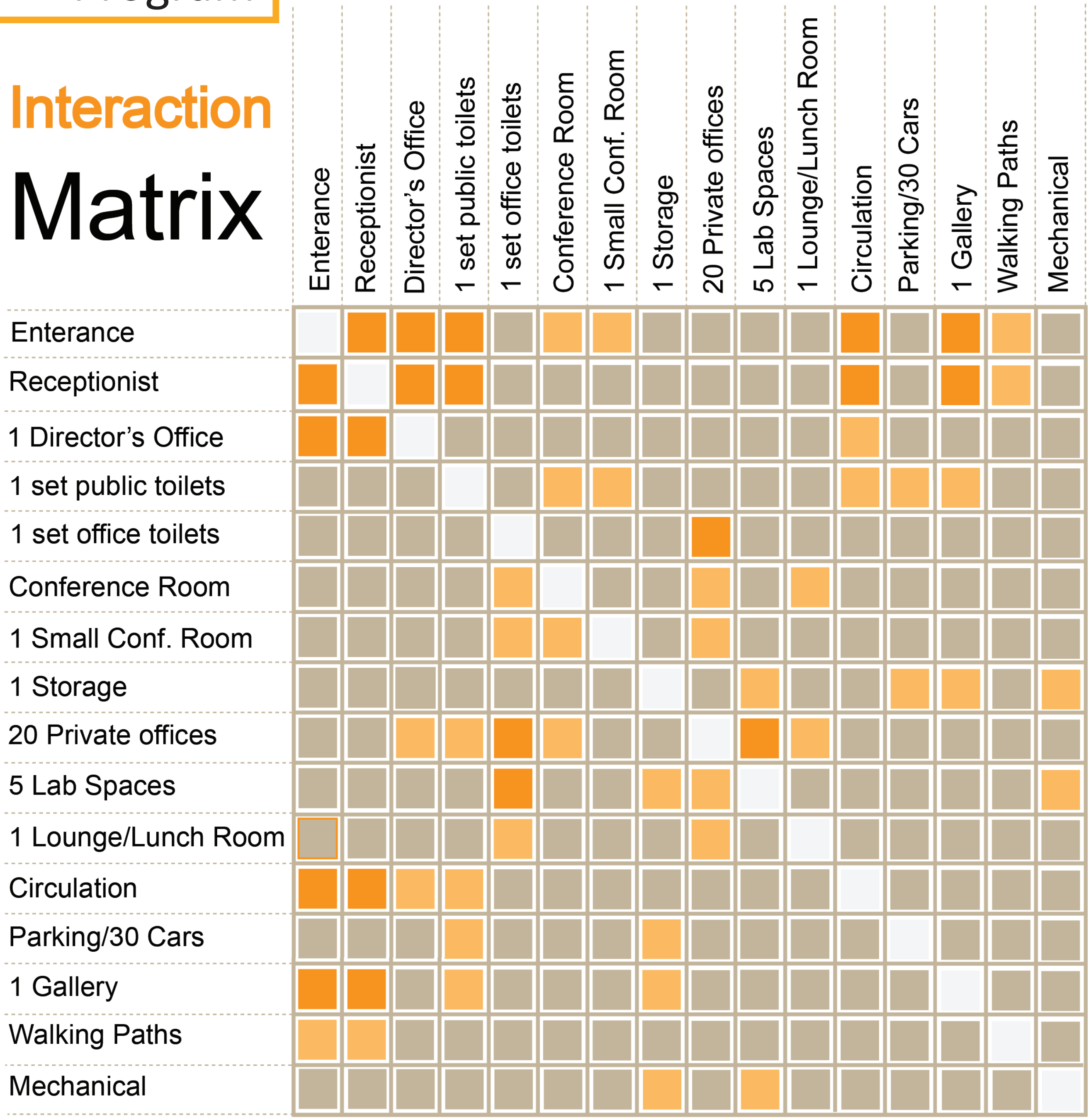
Program

Program

Column1	Square footage
Entrance	1200
Receptionist	300
1 Director's Office	400
1 set of Public Toilets	300
1 set of Office Toilets	300
Conference Room	800
1 Small Conference Room	500
1 Storage Room	1000
20 Private Offices	3000
5 Lab Spaces	750
1 Lounge/Lunch Room	600
Circulation	3000
Parking/30 Cars	4000
1 Gallery	1500
Walking Paths	3000
Mechanical	1000
Total	20650

Program

Interaction Matrix



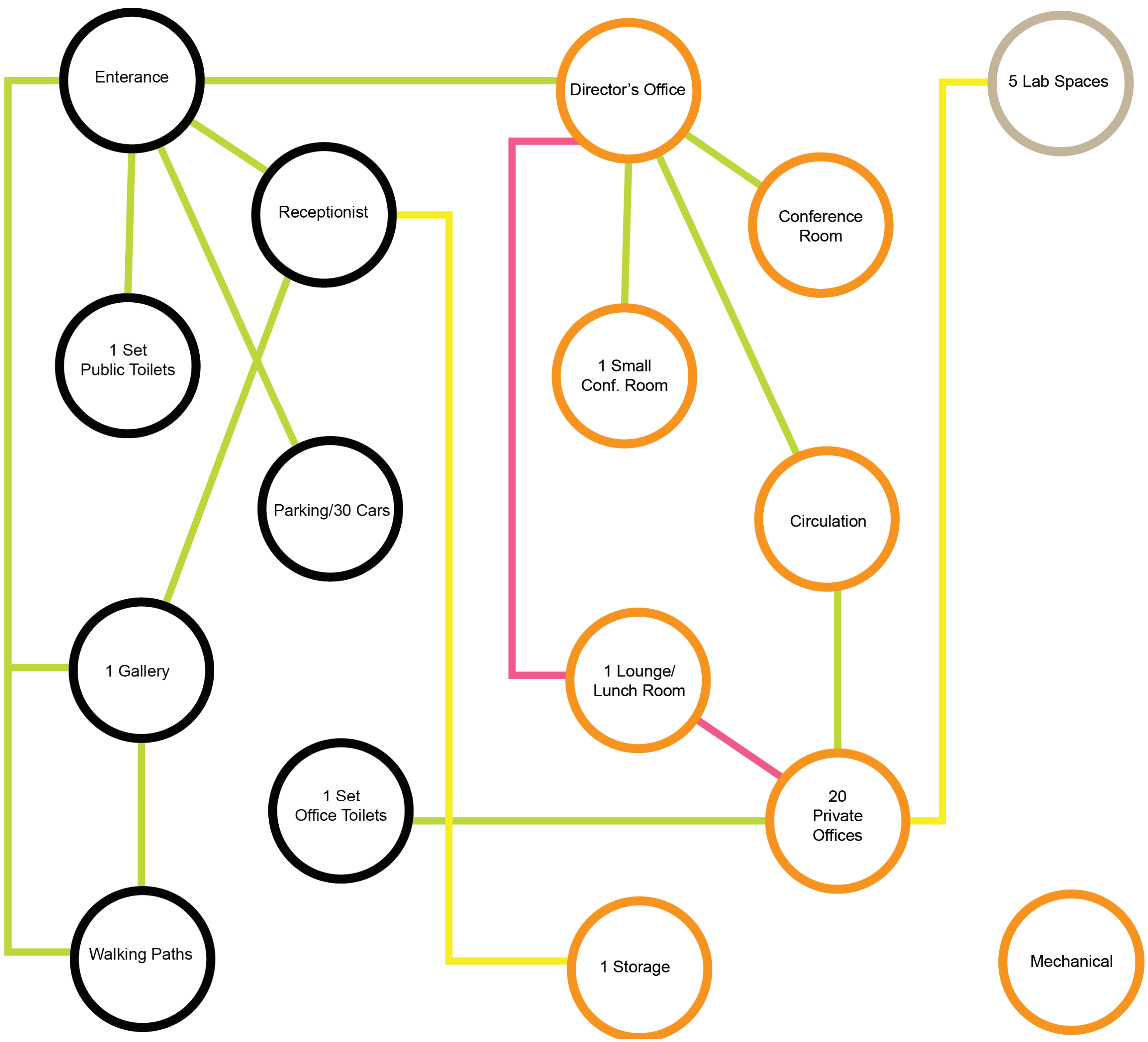
The interaction matrix describes the degree of connection between spaces in the program. This makes it possible for the designer to be aware of strong relationships to improve the design of a large program. The larger the program, the harder it becomes to adequately evaluate all the spaces in the process of joining and connecting spaces. Diagrams such as the interaction matrix improve designs for the user to live and work with ease.

Essential

Desirable

Not Needed

Interaction Net



The interaction net is another tool to adaquately asses a large building program. The diagram establishes the difference between public, private, and working spaces. Each of these different functions will gather and divide spaces to allow for an idea of the use of the building. This breaks down programs even deeper and can be taken even further into detail if needed.

The lines in the interaction net are made to present the formal, informal, and casual connection between the already broken-down public, private, and working spaces.

Formal Connection

Informal Connection

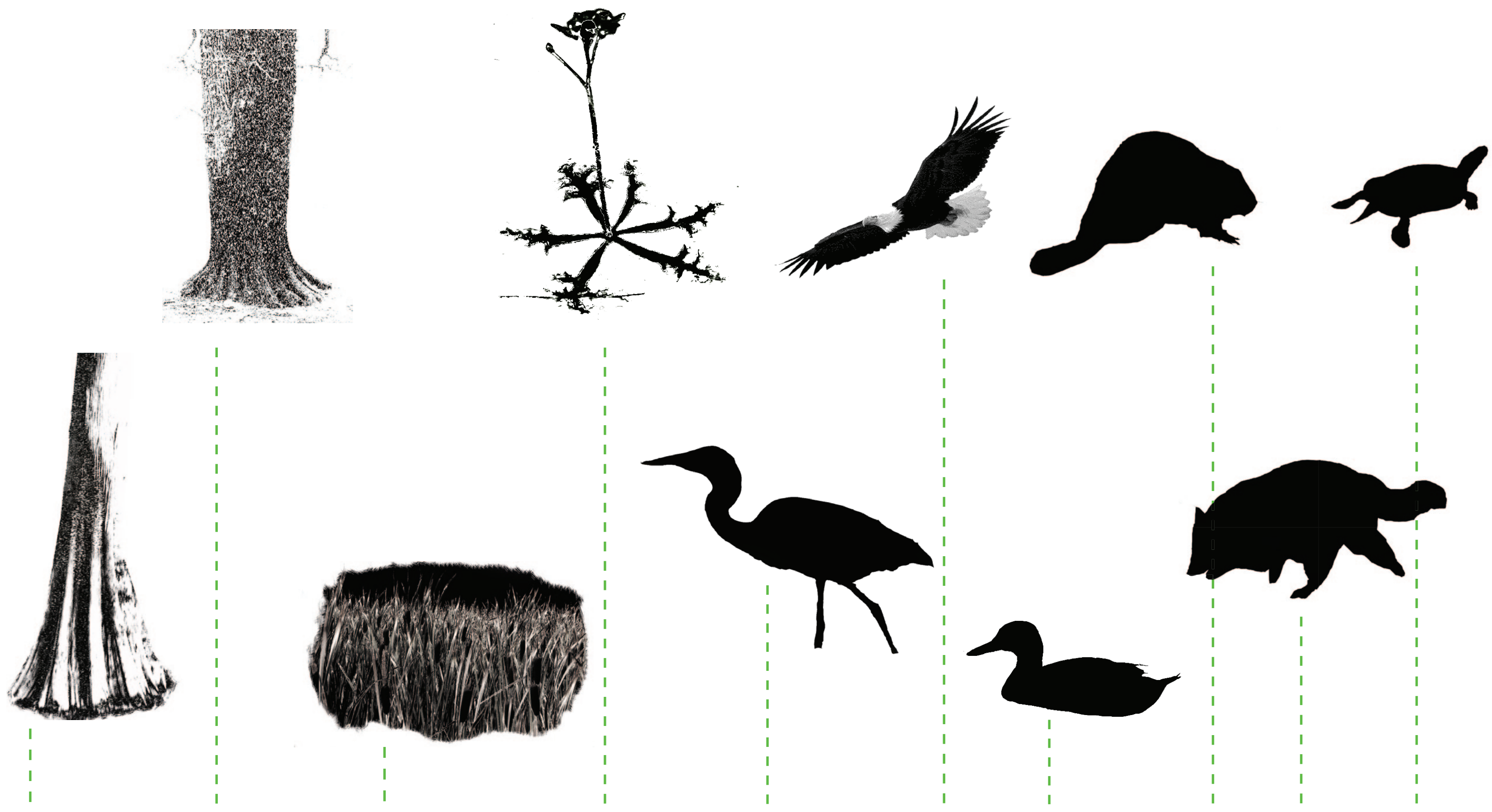
Casual Connnection

Public Spaces

Private Spaces

Working Spaces

Design Process



Column1	Bald Cypress Tree	Swamp White Oak	Cattails (Typha)	Swollen Bladderwort	Great Blue Heron	Bald Eagle	American Black Duck	Beaver	Raccoon	Painted Turtle
Swamps	X	X				X	X		X	
Marshes			X		X	X	X			
Lakes				X	X	X	X	X		X
Ponds				X	X	X	X	X		X
Rivers					X	X	X	X		X
Streams					X	X	X	X		X
Everglades	X					X	X		X	
Flood Migration					X		X		X	X
Flood Perminate Home	X	X	X	X		X	X	X		X
Flood Adaptation	X		X	X			X	X		
Floating Adaptation			X	X			X			
Elevated Adaptation	X	X			X	X	X		X	
Construction Adaptation								X		

Image from: http://water.epa.gov/resource_performance/planning/def_wt11.cfm

WETLANDS.....

Can store up to 360,000 gallons of water in one acre.

Can Filter Contaminated Water

Are a Habitat to a Wide Variety of plants and animals

will Retain Excess Water.

Types of Wetlands (Wildlife, 2011)

Wetland is a broad term to describe many specific types of ecosystems. To get a grasp of what wetlands are, here's a short summary of each. marshes, bogs, fens, and swamps.

Marshes -Marshes are bodies of water that are relatively shallow water levels and full of grassland type plants and no trees. The animals include a wide variety of mammals and birds. The water can be freshwater or saltwater, in each the seasons or tides can change the water levels.

Bogs - Bogs are water bodies that have had plant material (peat) cyclically grow and die from the outer edges to move inward over the water to create a thin layer. The thin layer then slowly fills till the entire body of water is filled with peat that can be 5 to 10 feet deep depending the age of the bog. In some bogs it can take up to 50 years to produce just one inch of peat(Refuge). This creates a unique environment for many plant materials, but is generally dangerous for most mammals due to drowning(Refuge).

Fens – Fens form from water has percolated through alkaline soils to create unique plant and animal environment.

Swamps - Swamps are forested bodies of water that are generally shallow in depth.

Vernal Pools- Vernal Pools are seasonal bodies of water that eventually dry up and re-form year to year. This ecosystem gives amphibians in particular a uniquely safe environment to survive from season to season (Basic Wetland Facts, 2010)

Design Process

Main Building Elements

Average Roof size
of a Home is 40'X60'

the population
of Fargo/Moorhead is
132,360

Can store up to 360,000
gallons of water in one acre.

reduce the
heat Island effect

317,664,000 square feet
of roof runnoff

Filters Contaminated Water

retain and utilization water

198,000,000 Gallons of Water
after one inch of rain.

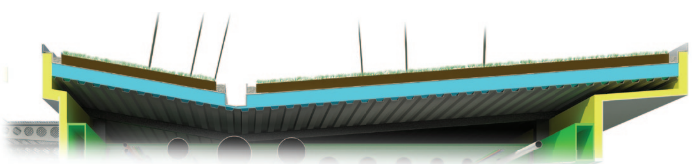
Habitat to a Wide Variety of
plants and animals

Interior sun Protection

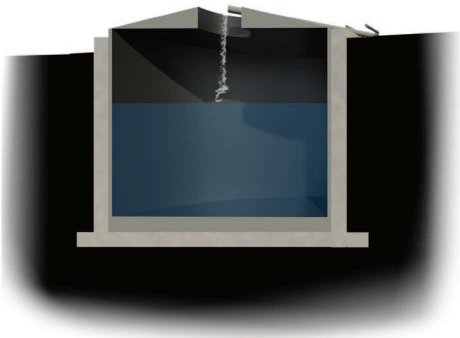
Grey water storage can be
used for gardening, toilets,
and possibly purified as
drinking water

Retains Excess Water.

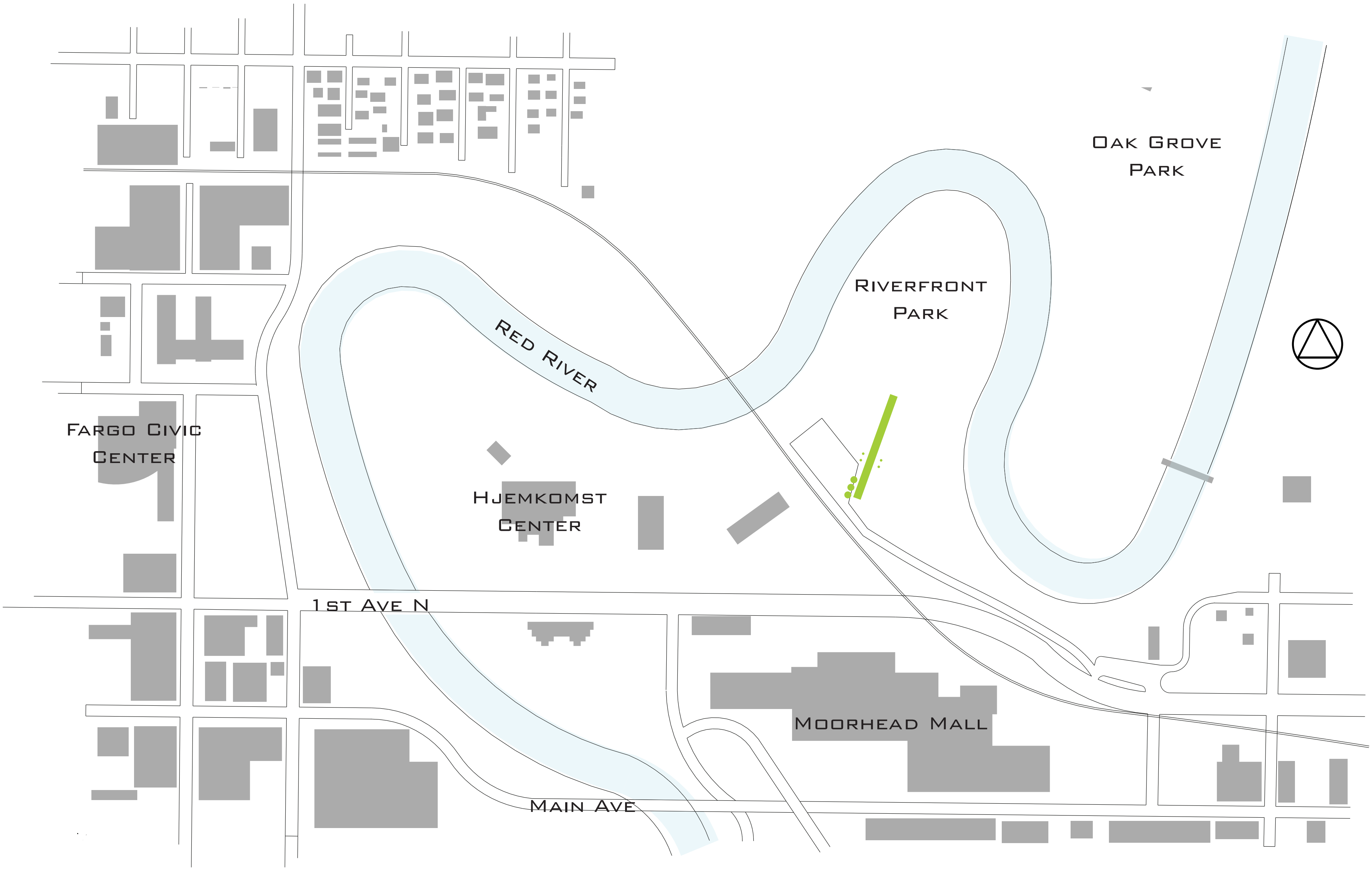
Green Roof

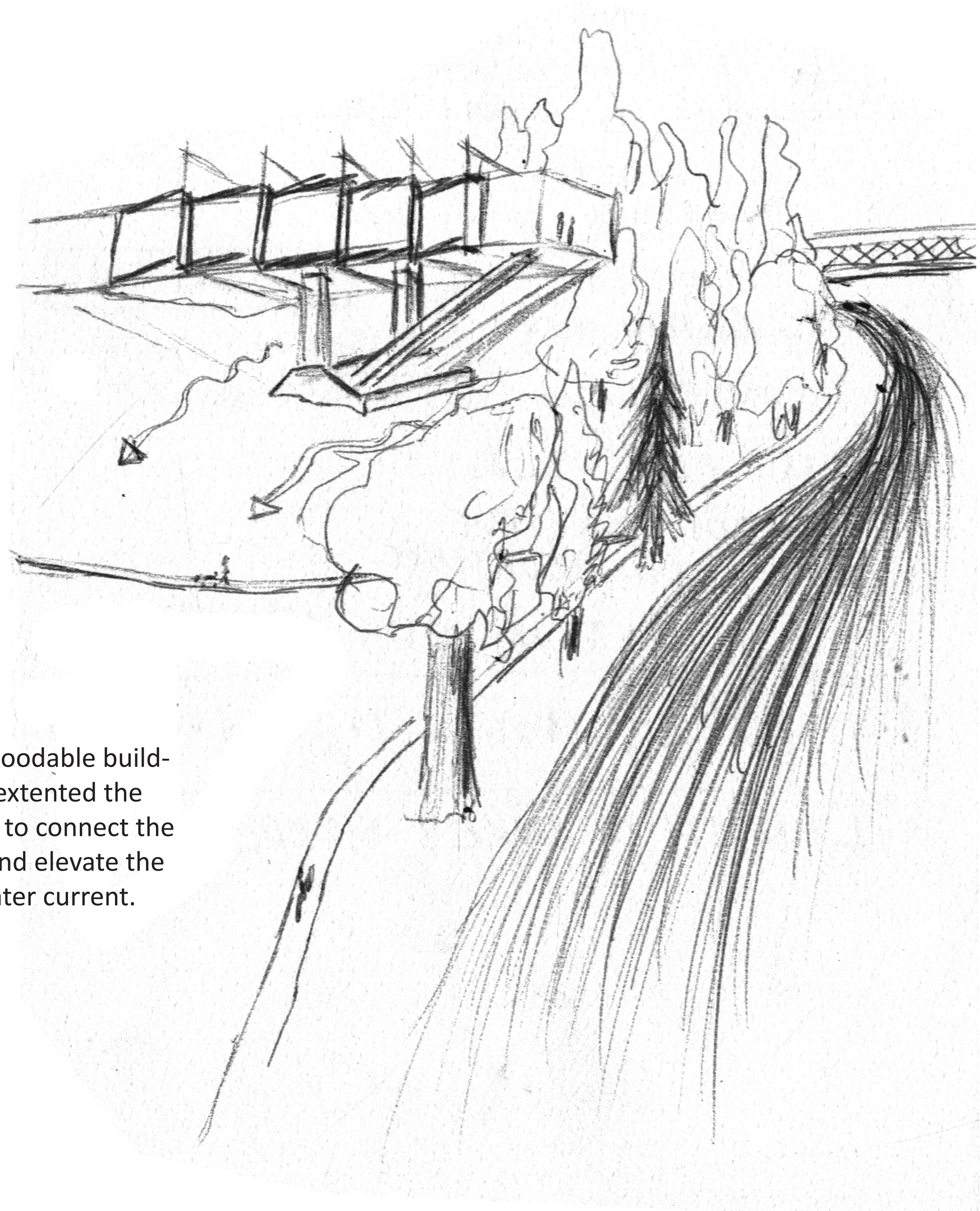


Water Collection



Wetlands

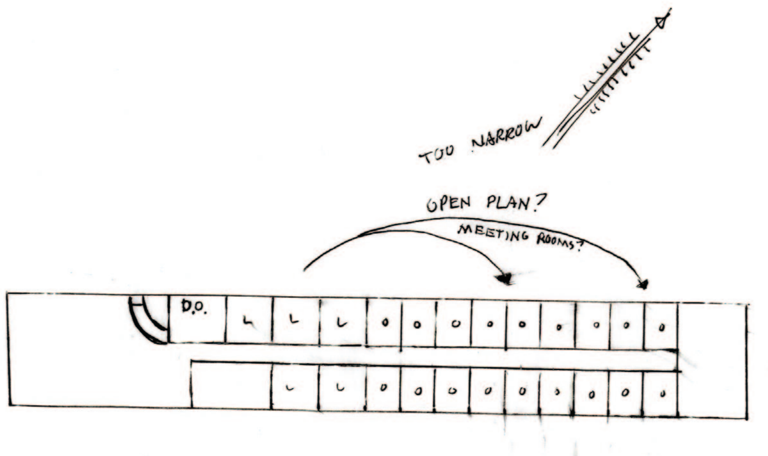

Oak Grove Park
Riverfront Park
Red River
Fargo Civic Center
Hjemkomst Center
1st Ave N
Moorhead Mall
Main Ave



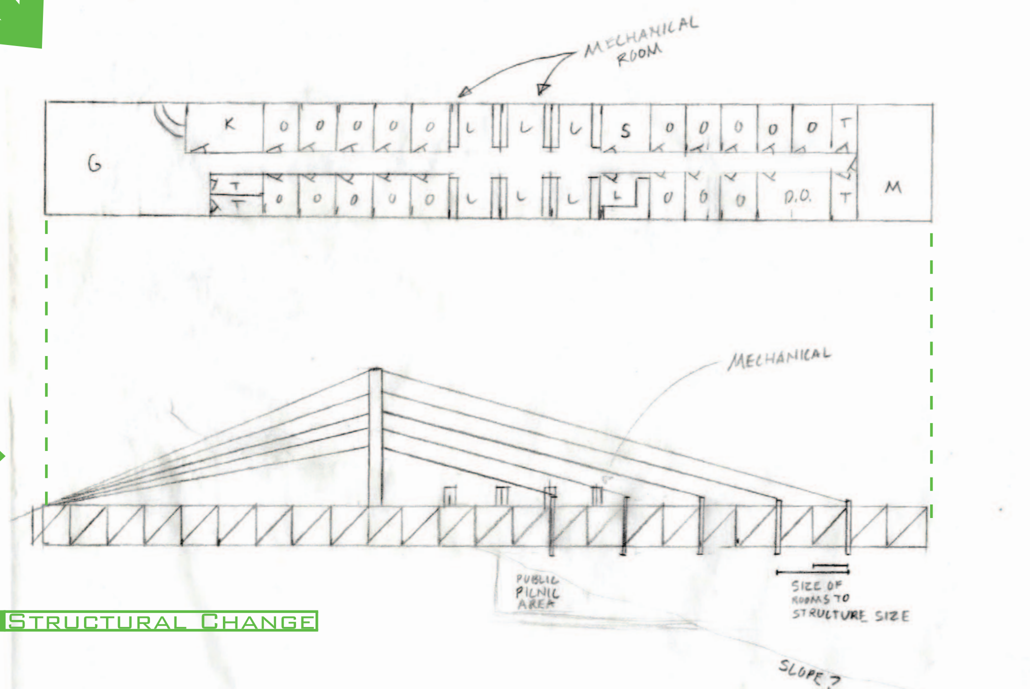
Due to the limited non-floodable building space of the site I extented the building toward the river to connect the occupant to the water and elevate the structure from the water current.

Design Process

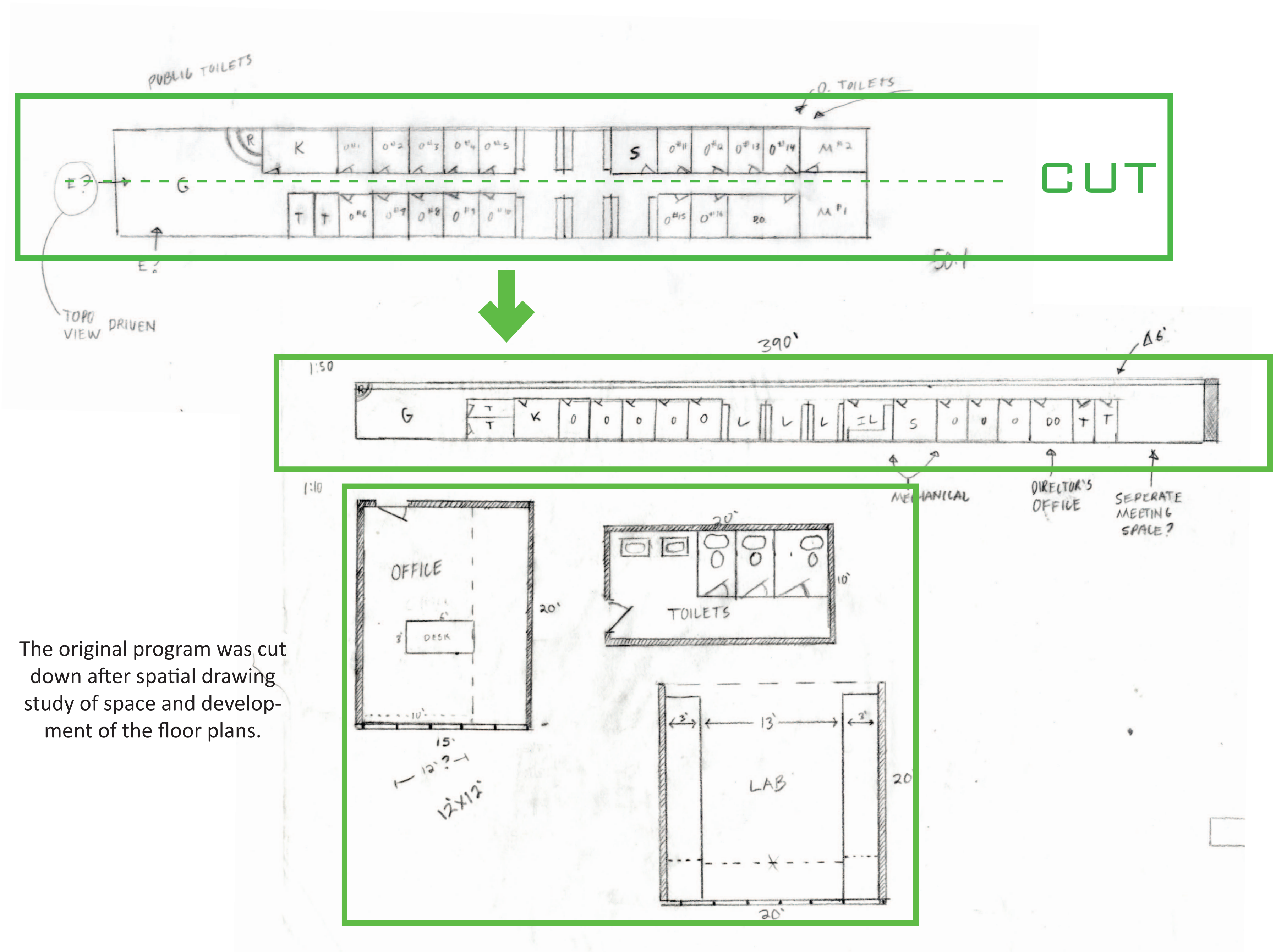
Plan Development



The structure was altered from the bottom to the top of the building to avoid any complications with the Red River from flooding and any water currents that may interact with the main structure.



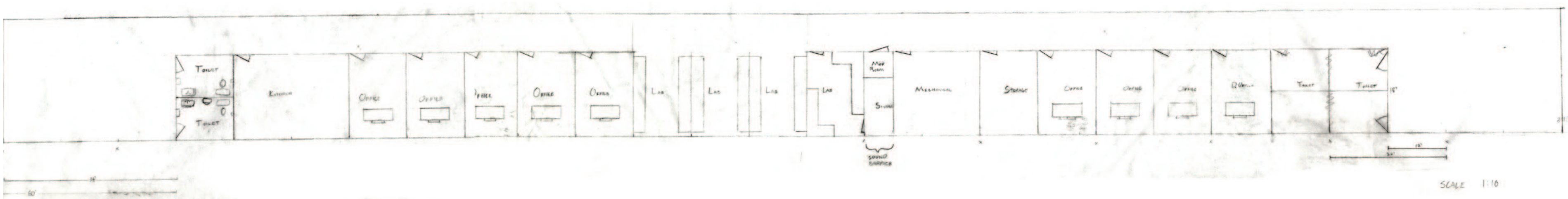
Structural Change

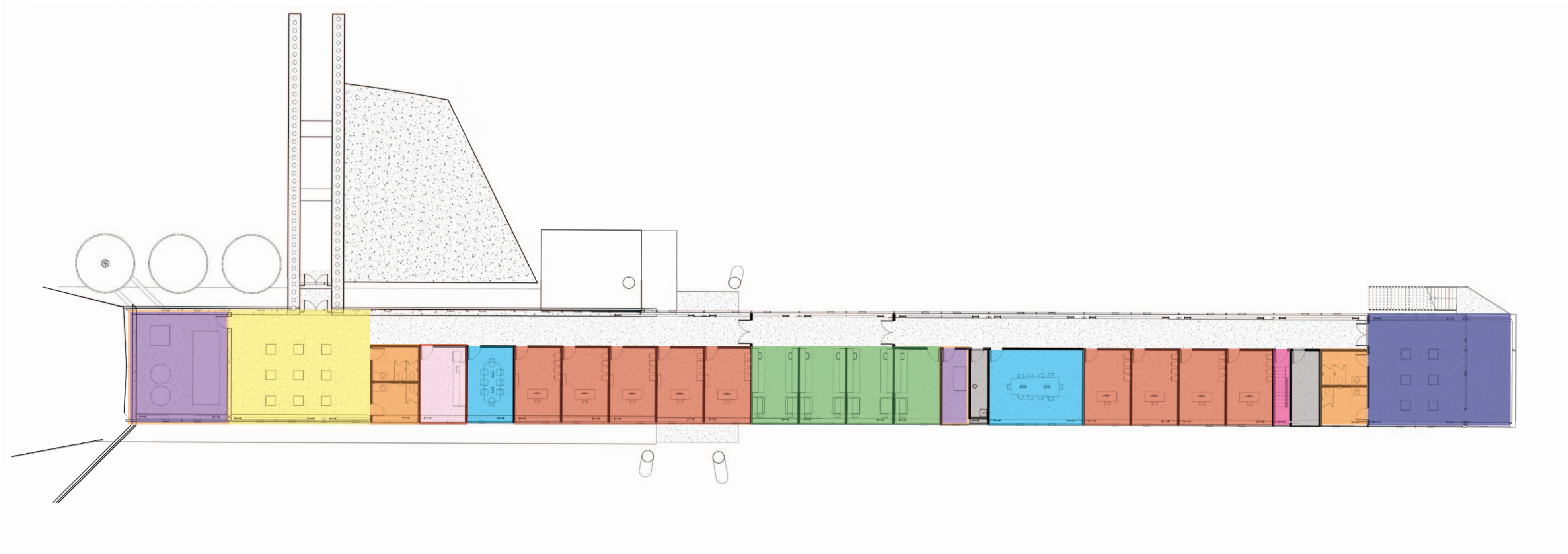


The original program was cut down after spatial drawing study of space and development of the floor plans.

Design Process

Plan Development

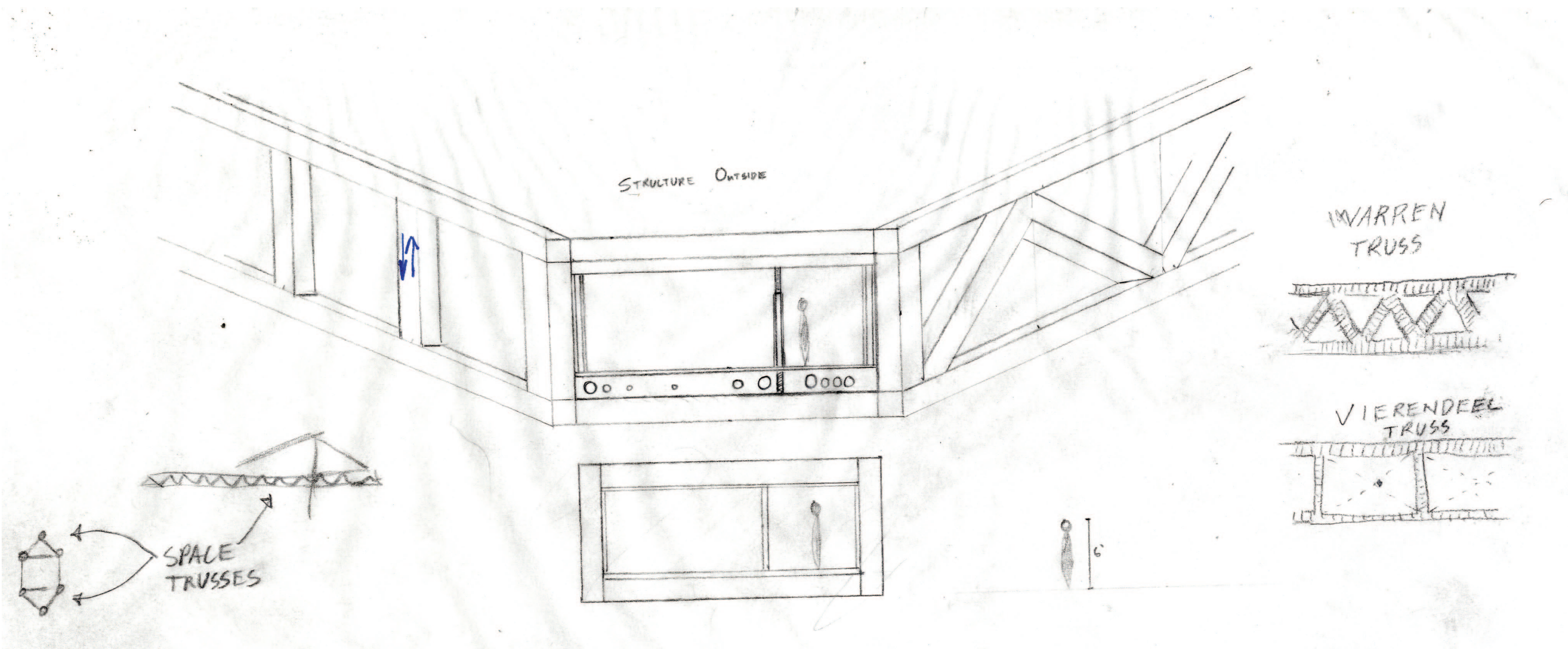




- Exhibition Space
- Toilets
- Kitchen
- Offices
- Meeting Rooms
- Laboratories
- Storage
- Mechanical
- Public Viewing Space
- Stairway

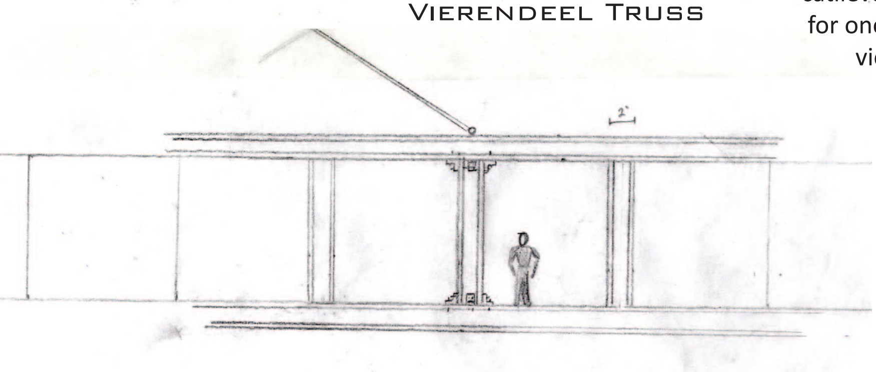
Design Process

Structural

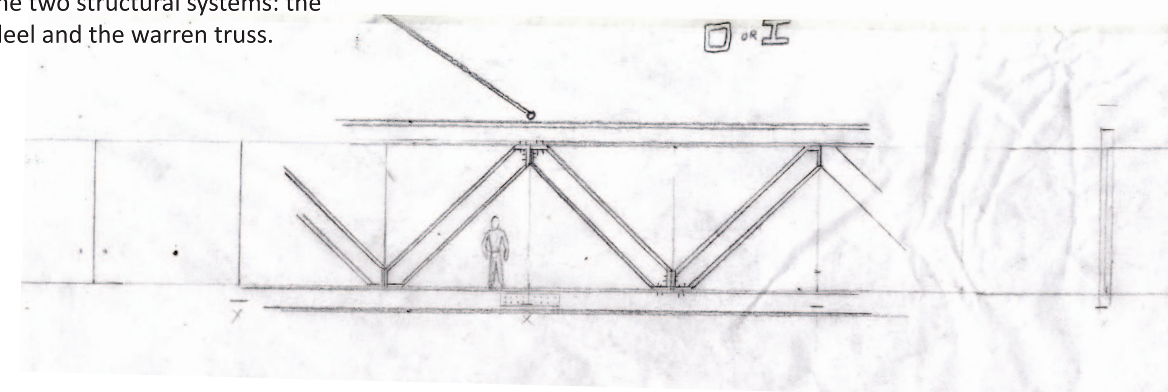


The building's structure had to resist high gravitational and windload forces due to the catilever action of the building. This called for one of the two structural systems: the vierendeel and the warren truss.

Vierendeel Truss

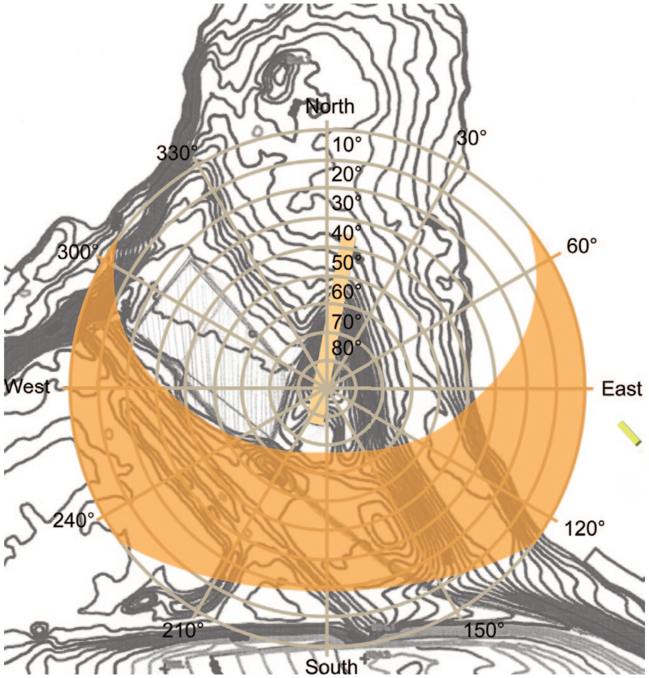


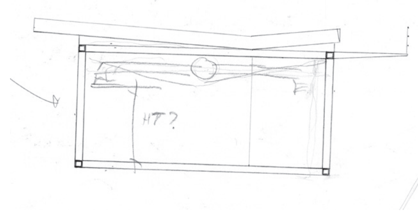
Warren Truss

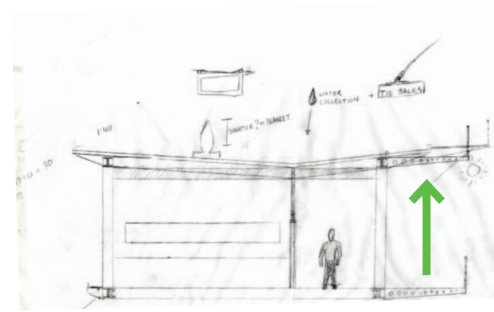


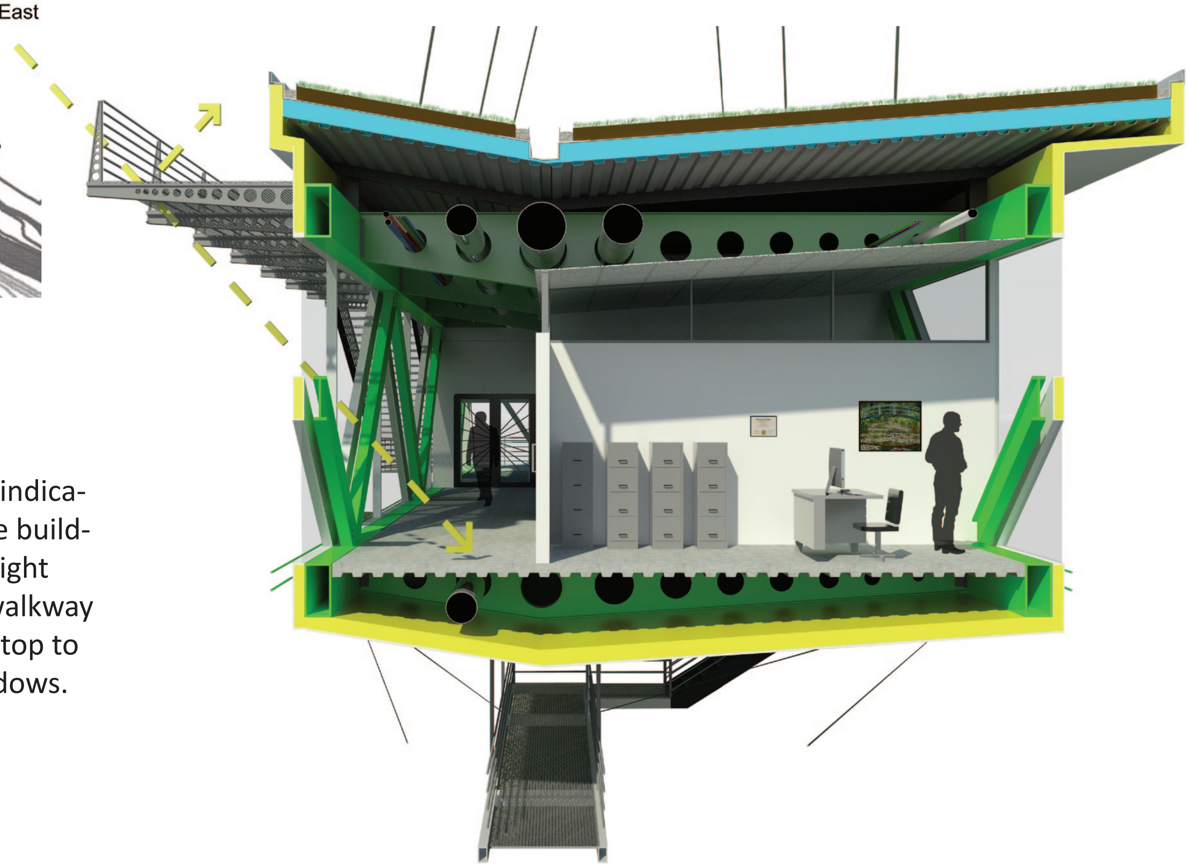
Design Process

Sun Studies





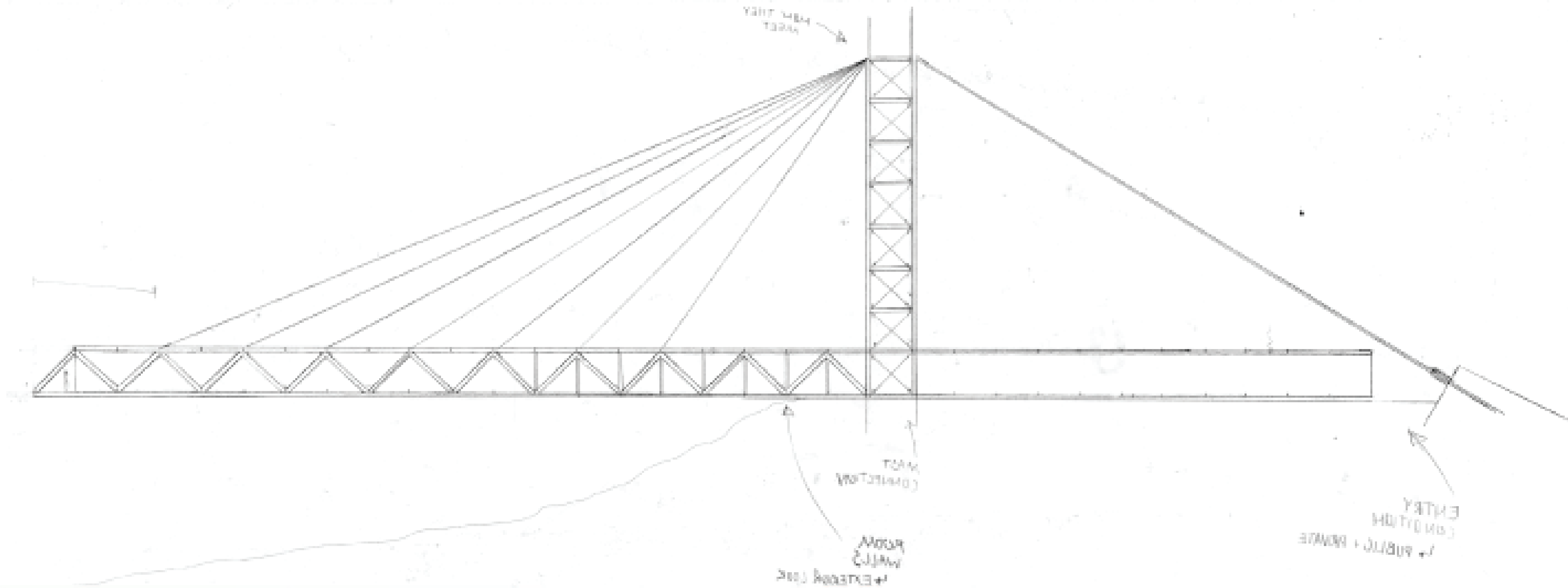


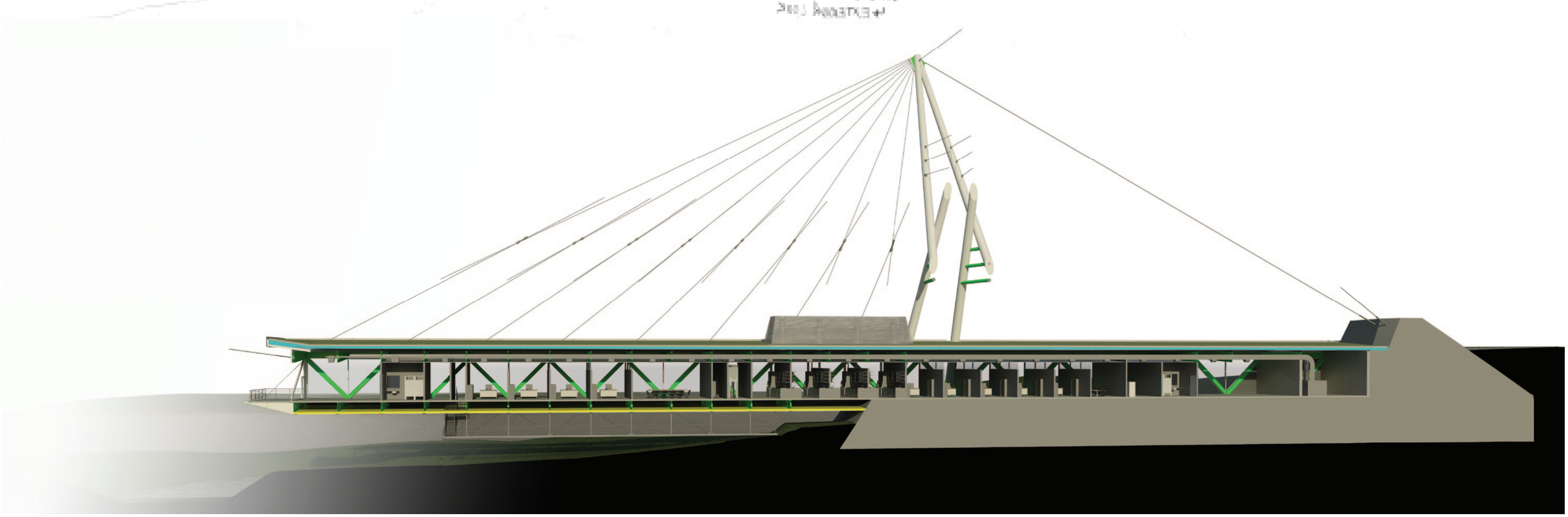


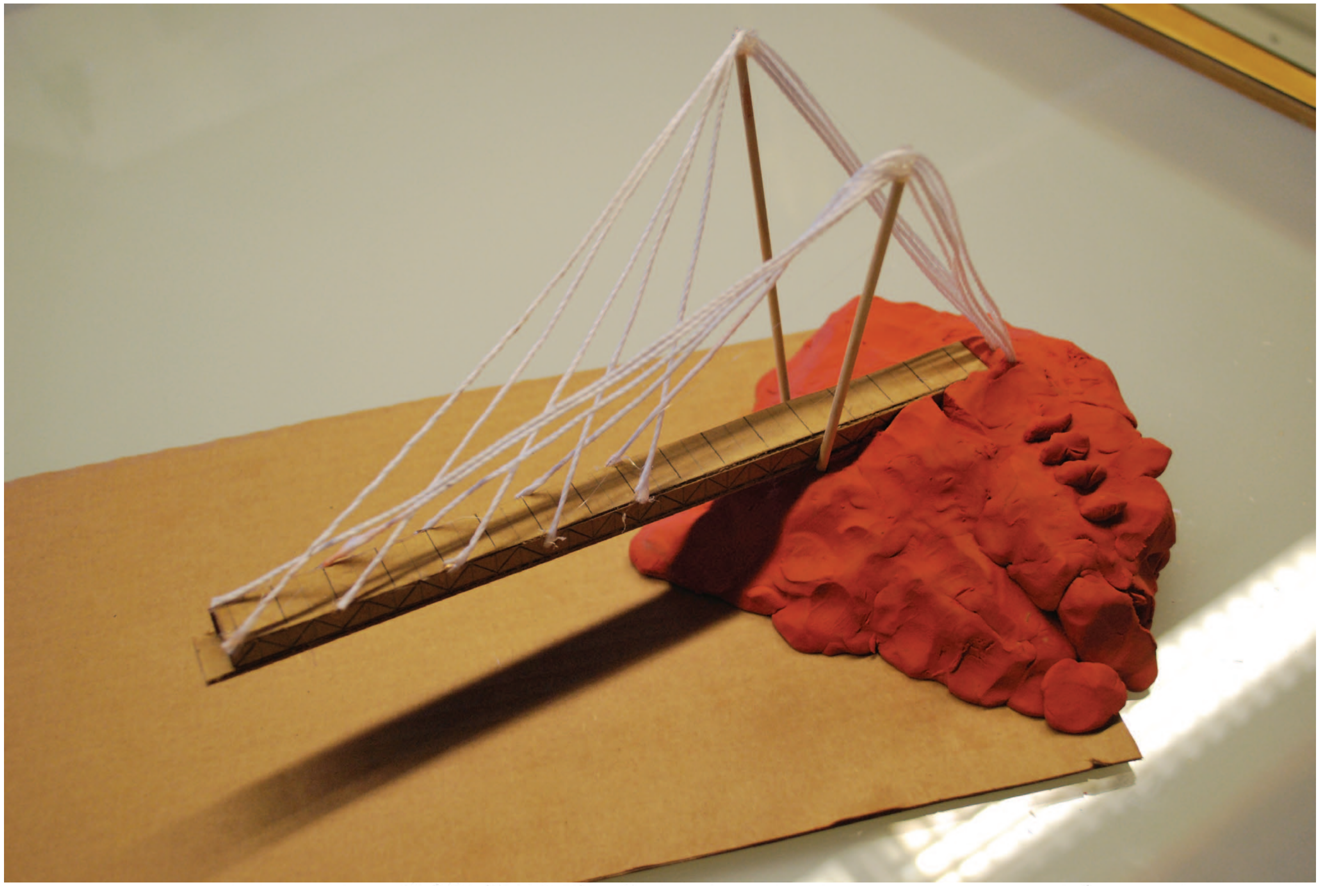
The sun study of the building provided vital indicator that the western sun would overheat the building in the late hours of the day. The upper right drawing illustrates how my exterior public walkway design changed from the bottom the to the top to accomidate shading for the west facing windows.

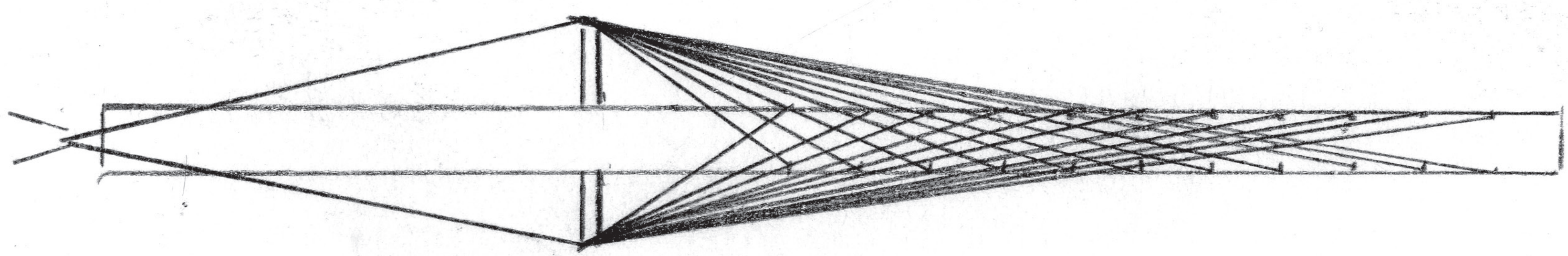
Design Process

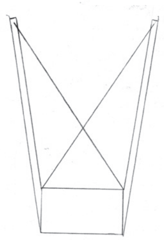
Structural

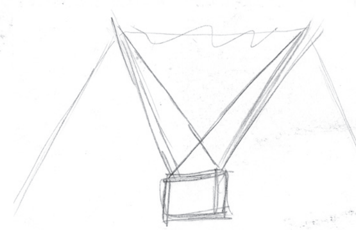


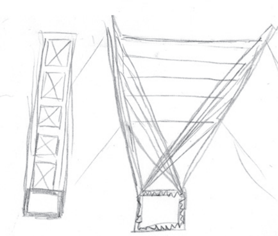


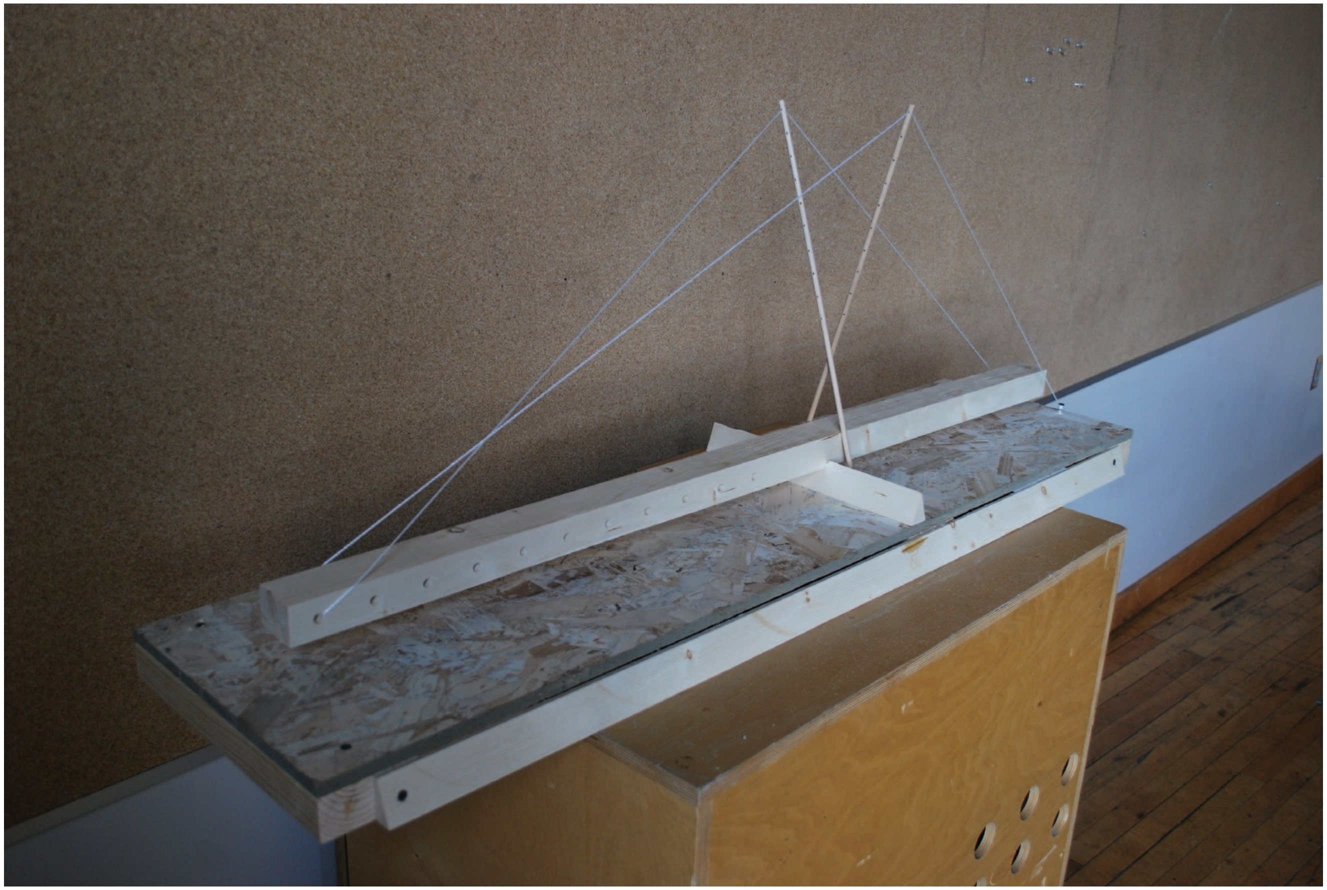


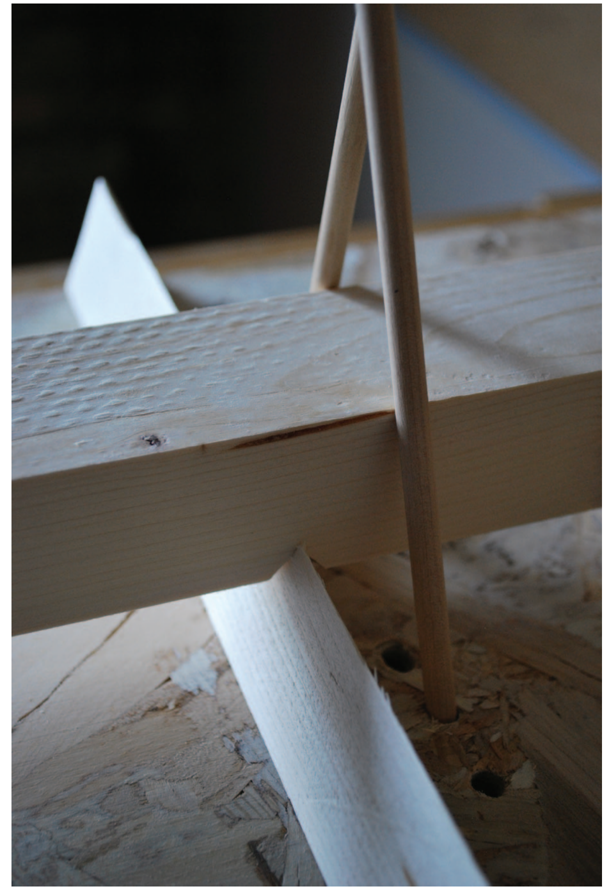


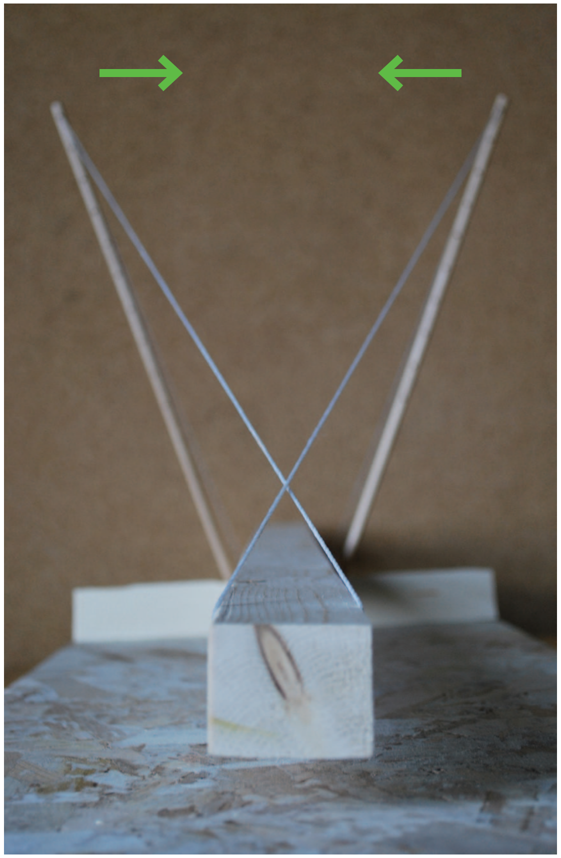


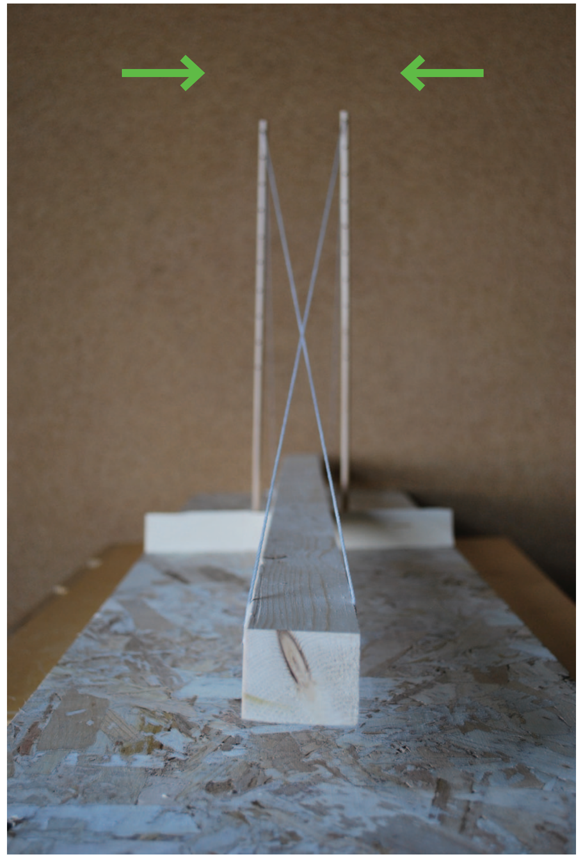


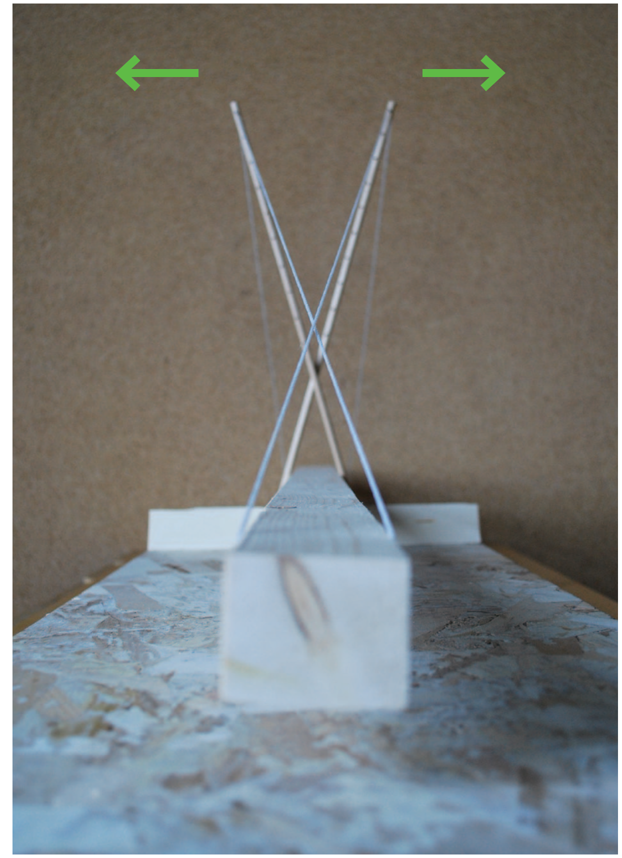


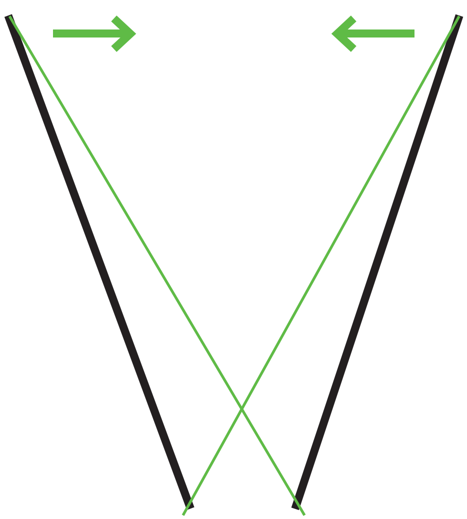


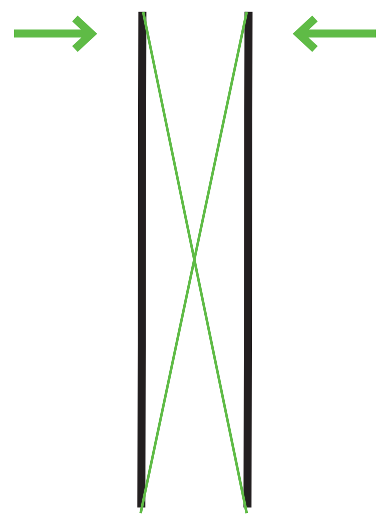




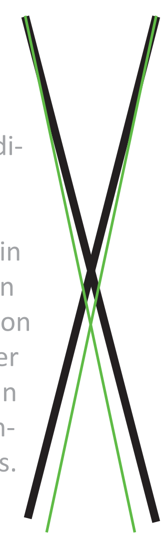


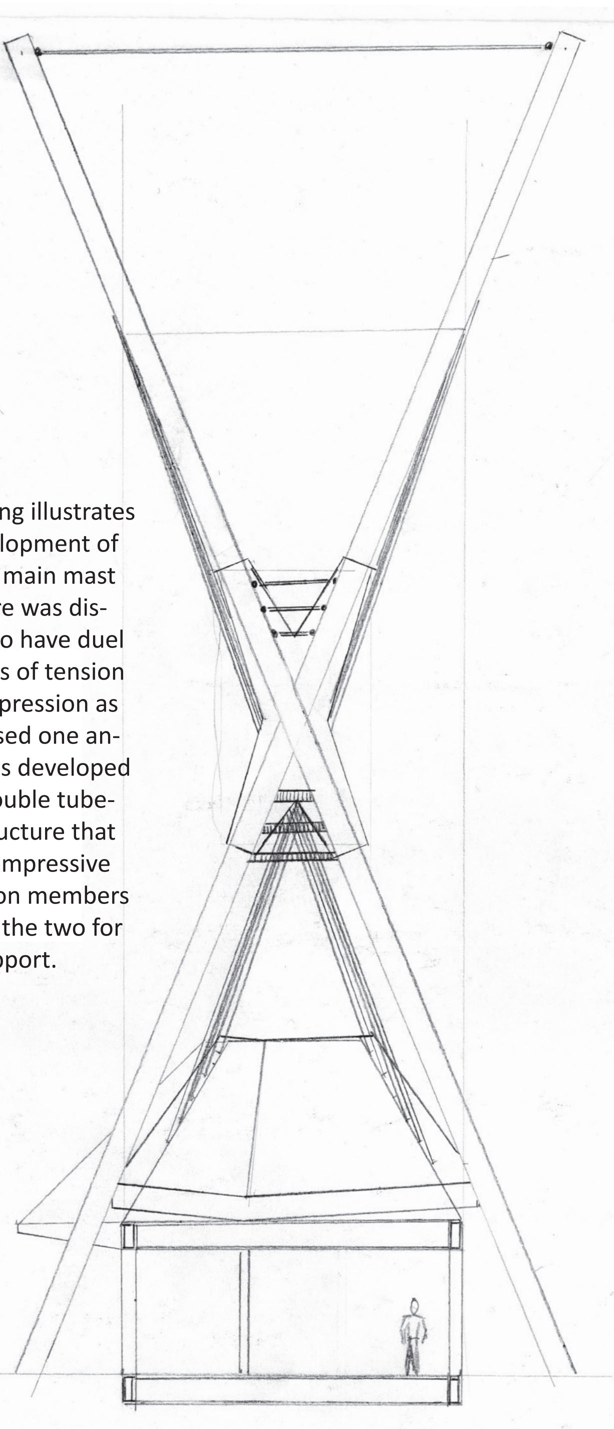




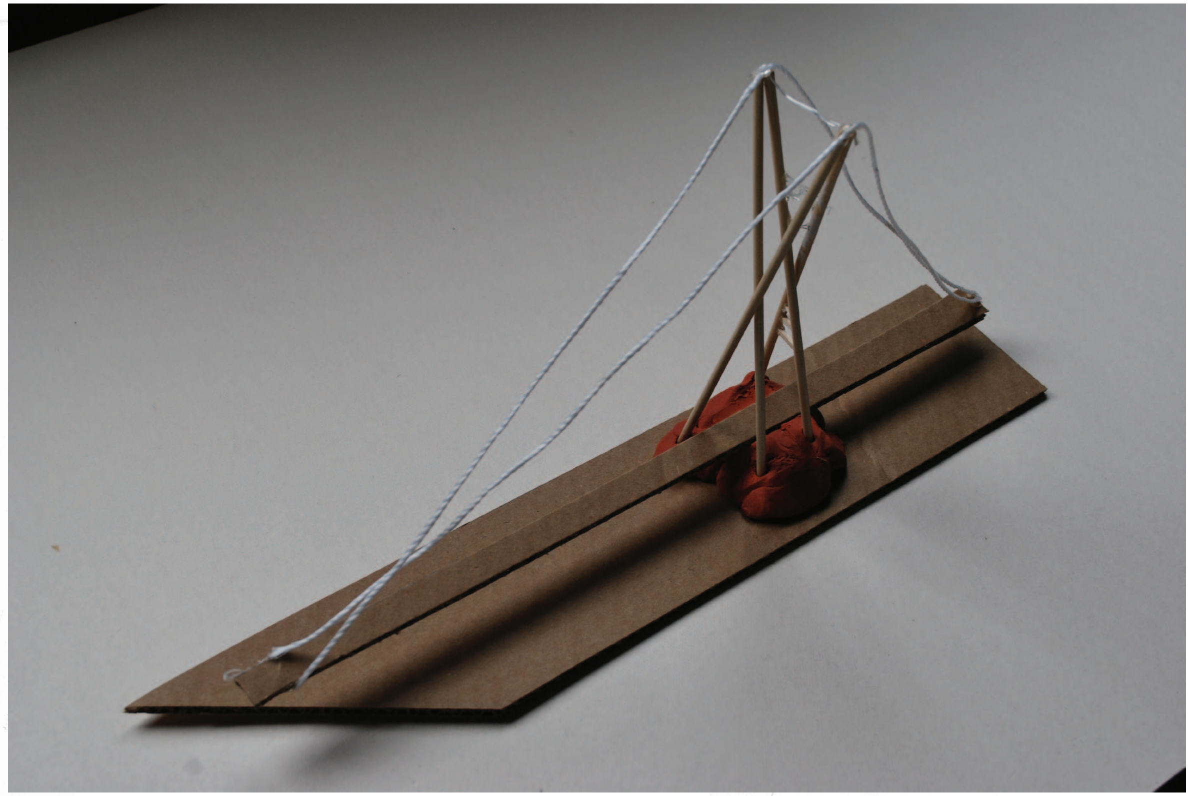


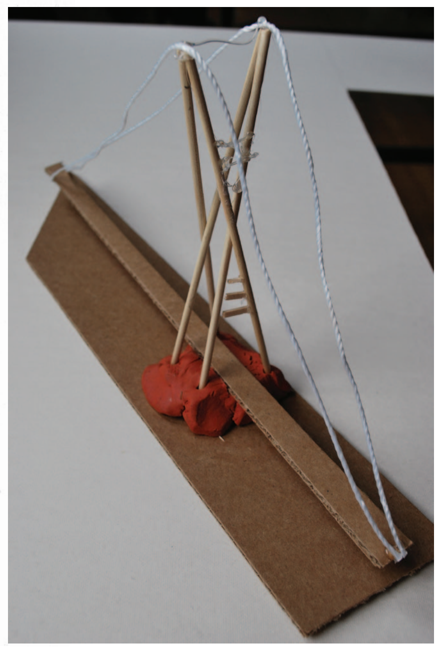
This structural rendition of the mast allowed the top cross -member be in tension rather than compression. Tension allowed for a lighter mast structure than the other two compression renditions.

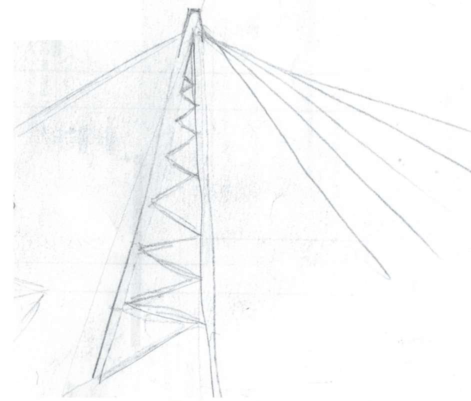


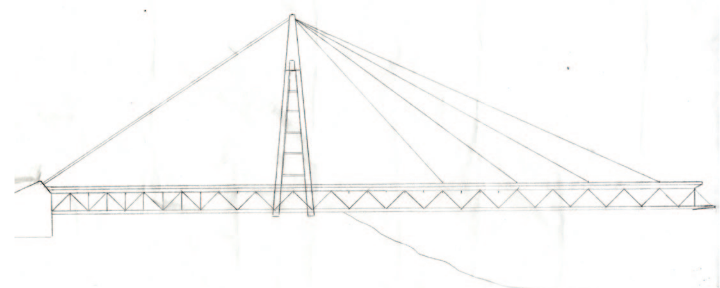


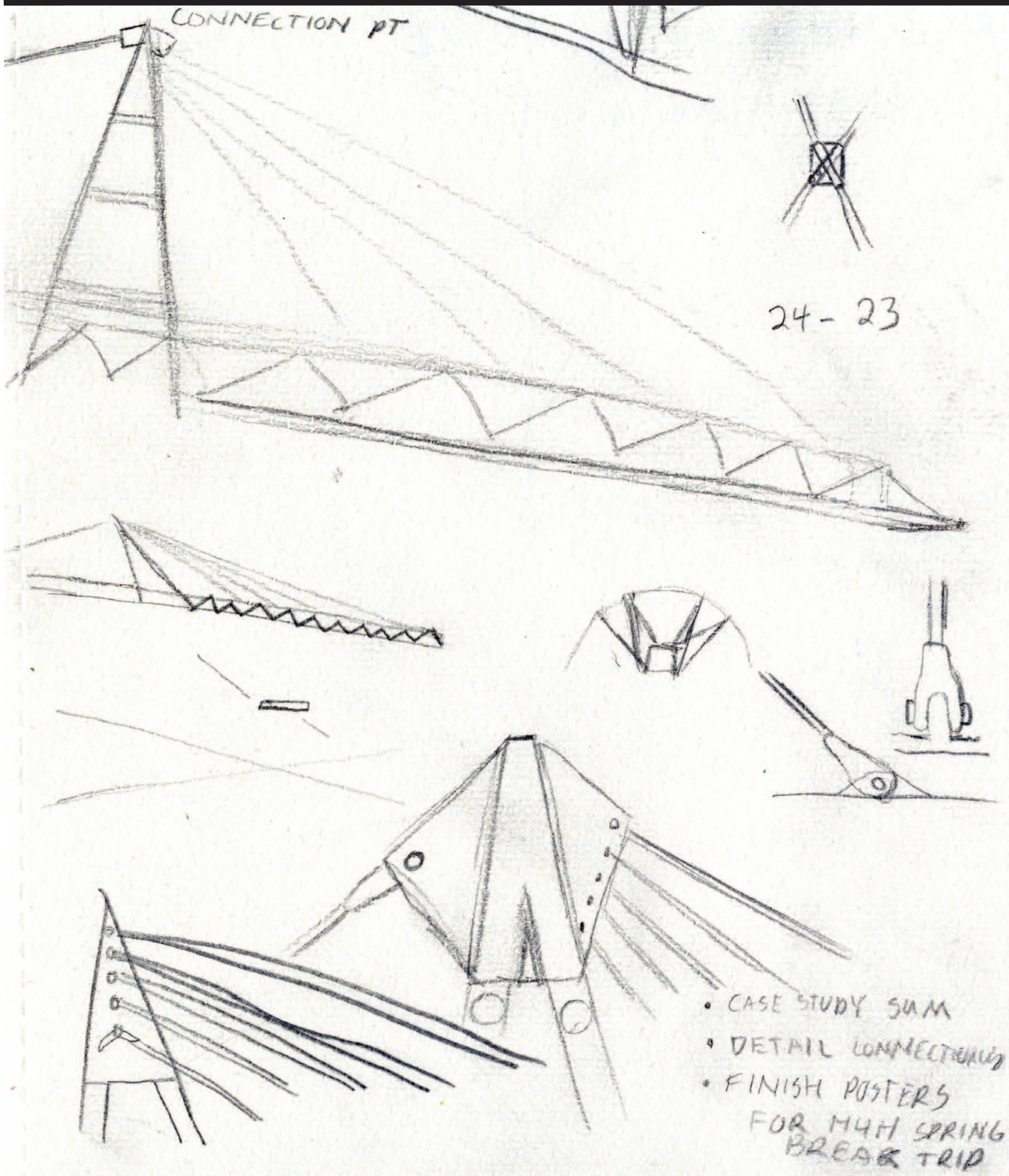
This drawing illustrates the development of how the main mast structure was discovered to have duel properties of tension and compression as they passed one another. This developed into a double tube-mast structure that wove compressive and tension members between the two for support.

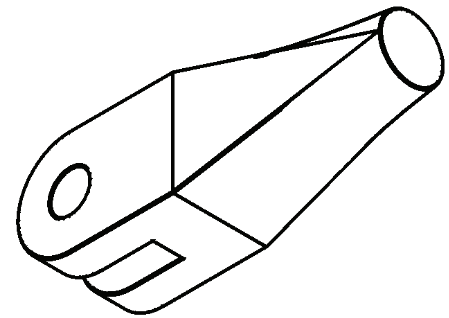


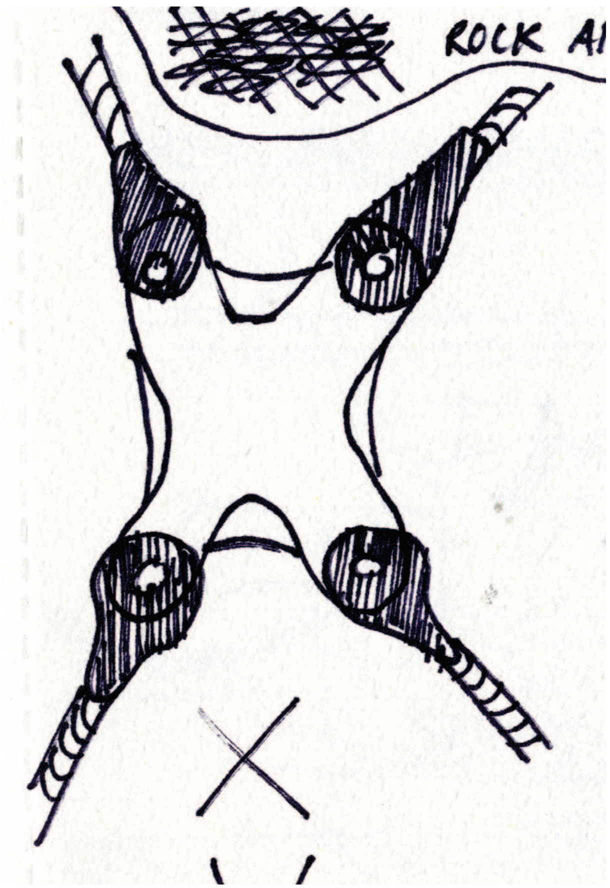


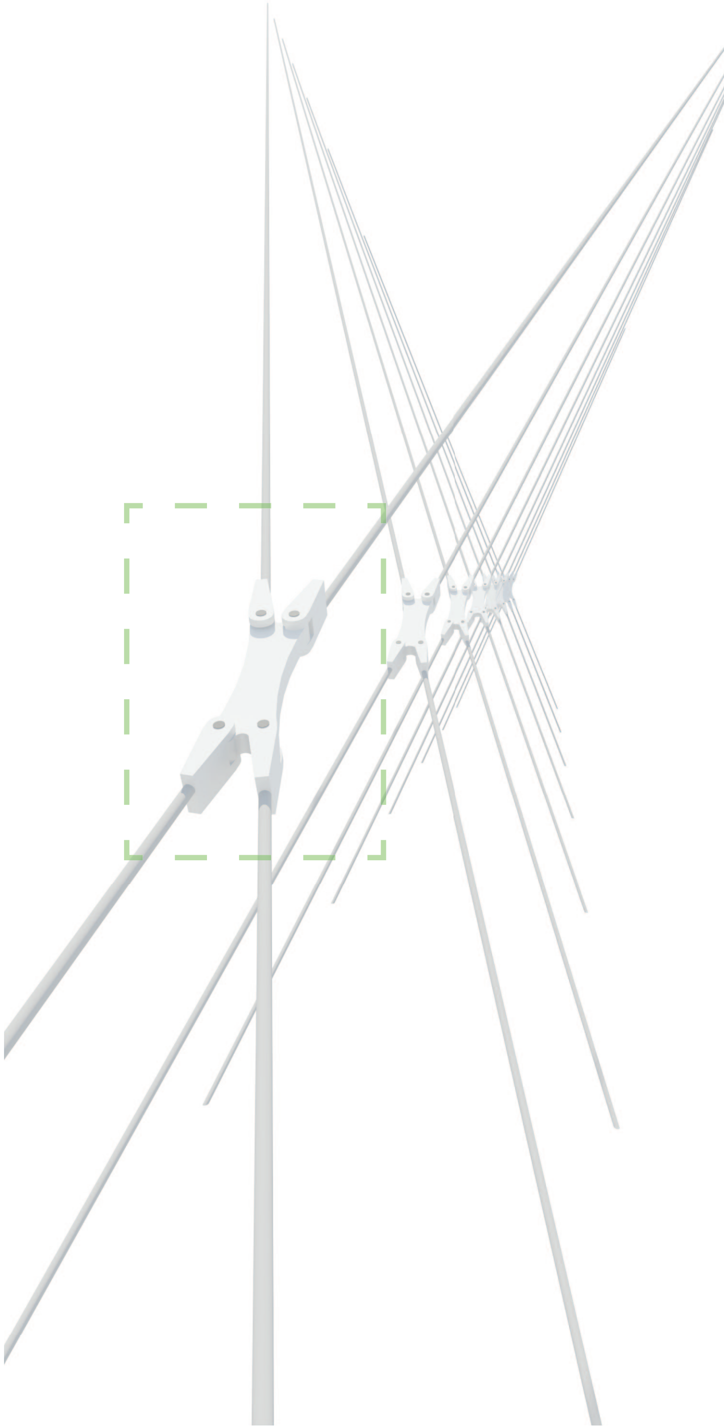


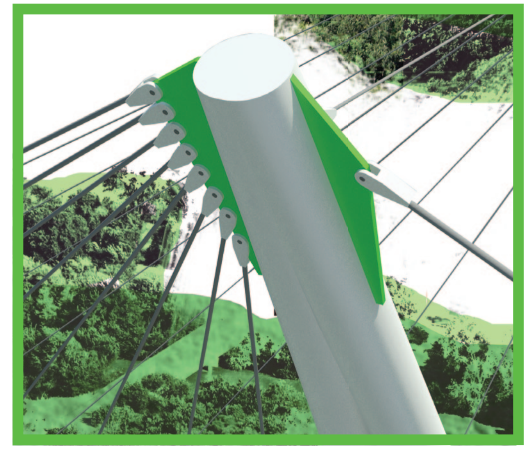
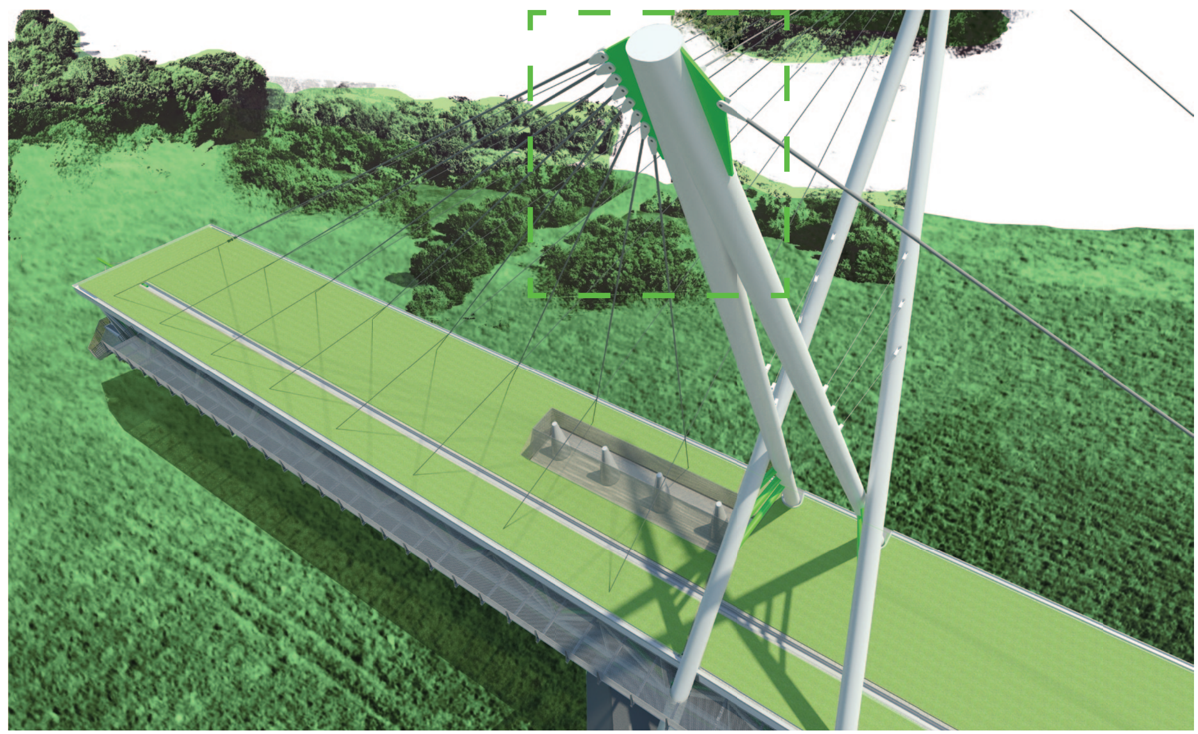


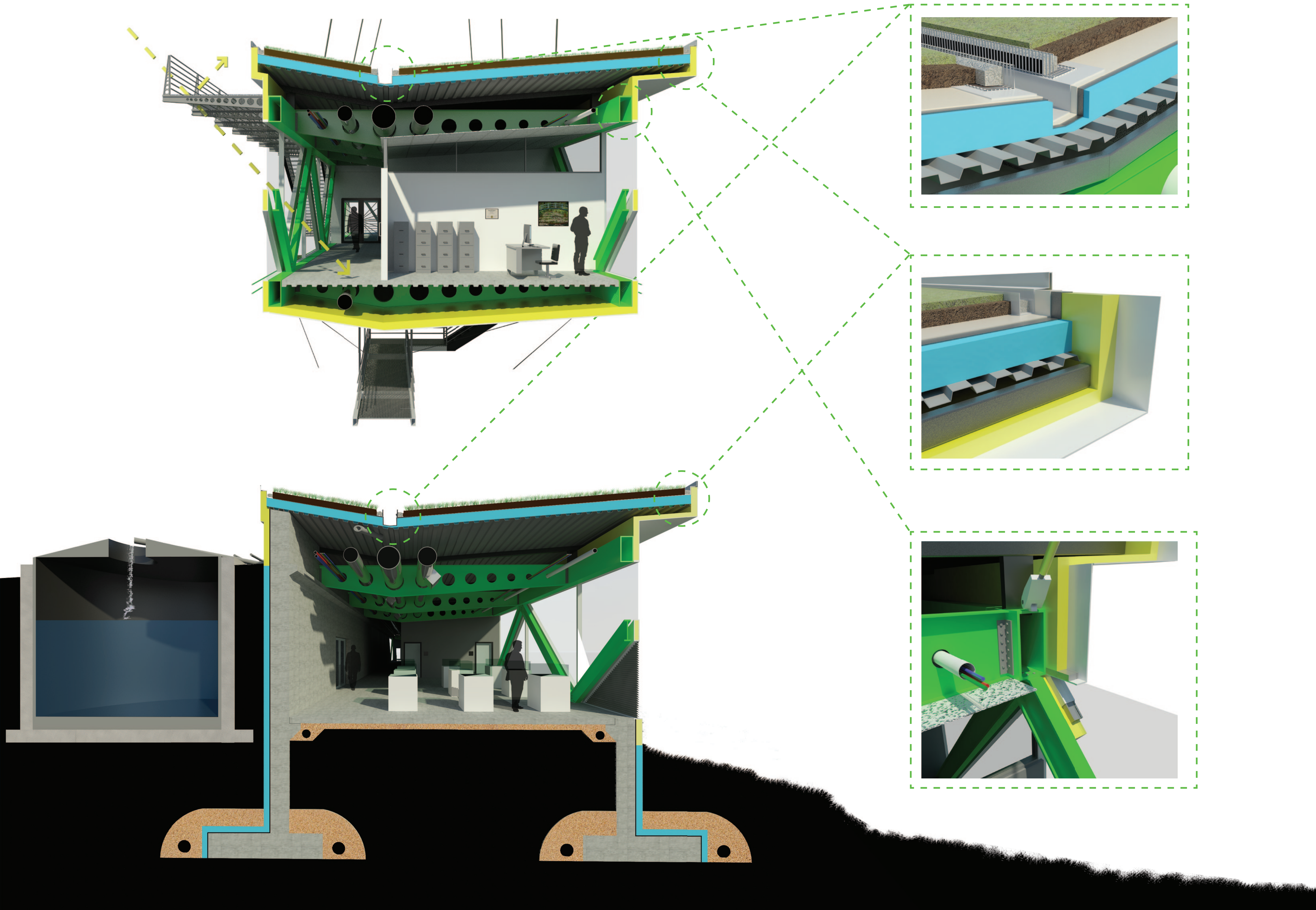

CONNECTION PT
24- 23
• CASE STUDY SUM
• DETAIL CONNECTIONS
• FINISH POSTERS
FOR M4H SPRING
BREAK TRIP




ROCK A

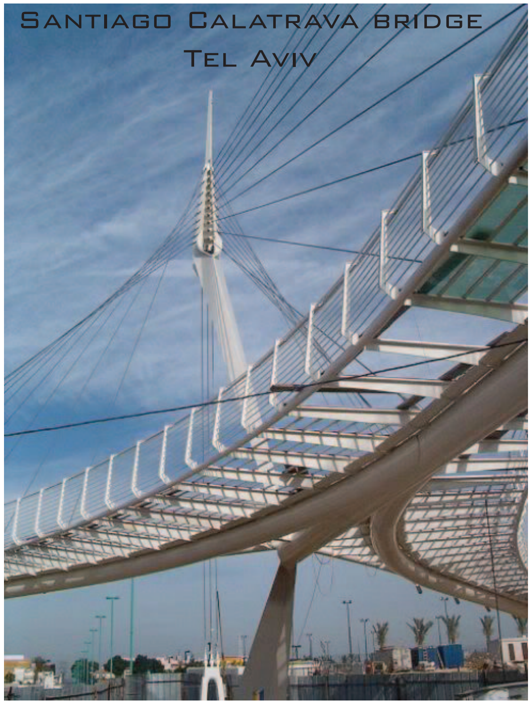


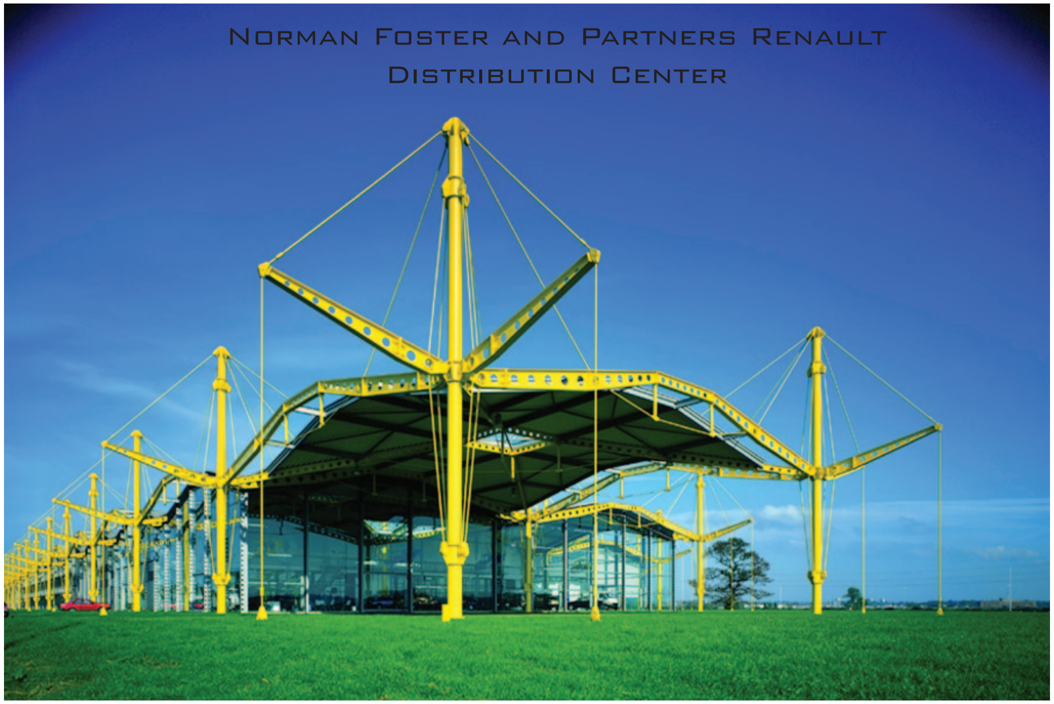


Design Process

Case Studies

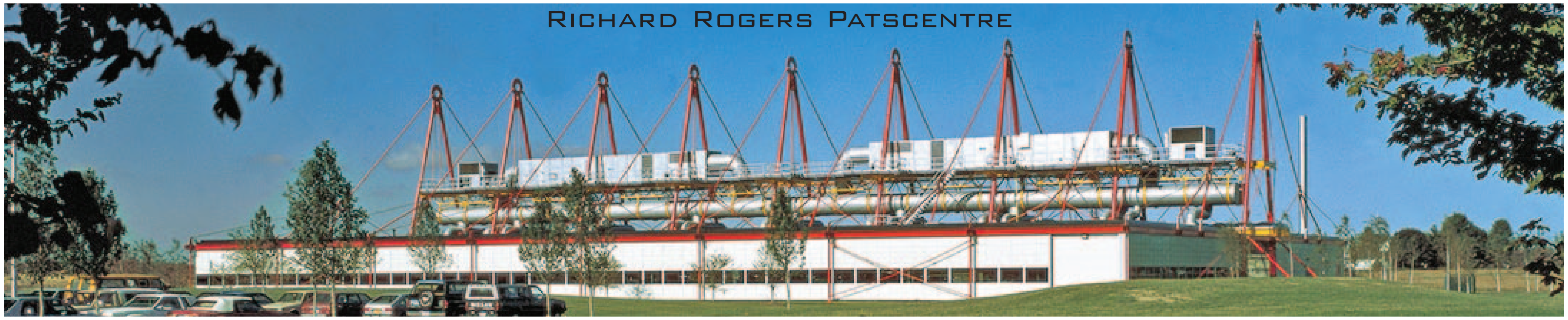


Santiago Calatrava bridge
Tel Aviv



Norman Foster and Partners Renault
Distribution Center

Richard Rogers Inmos Microprocessor Factory

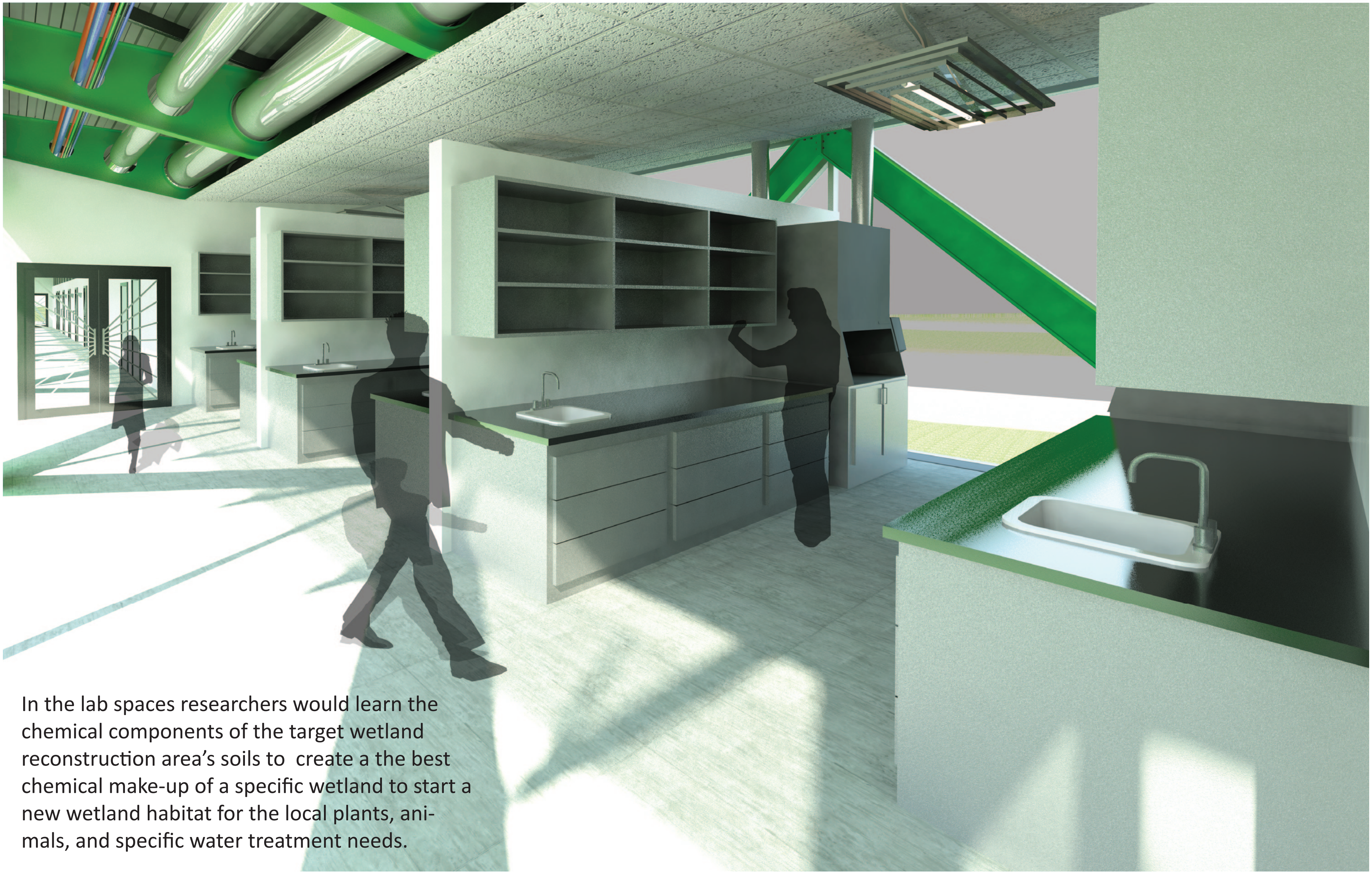


Richard Rogers Patscentre

Final Product

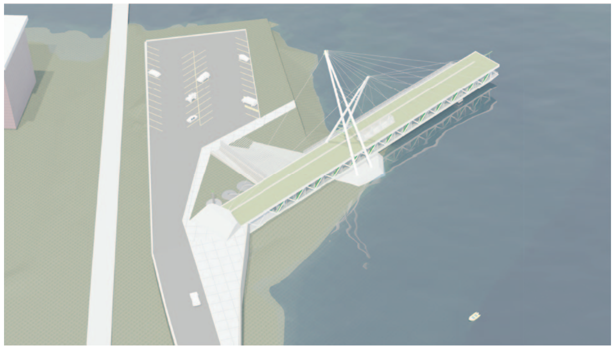
Interior Hallway Perspective

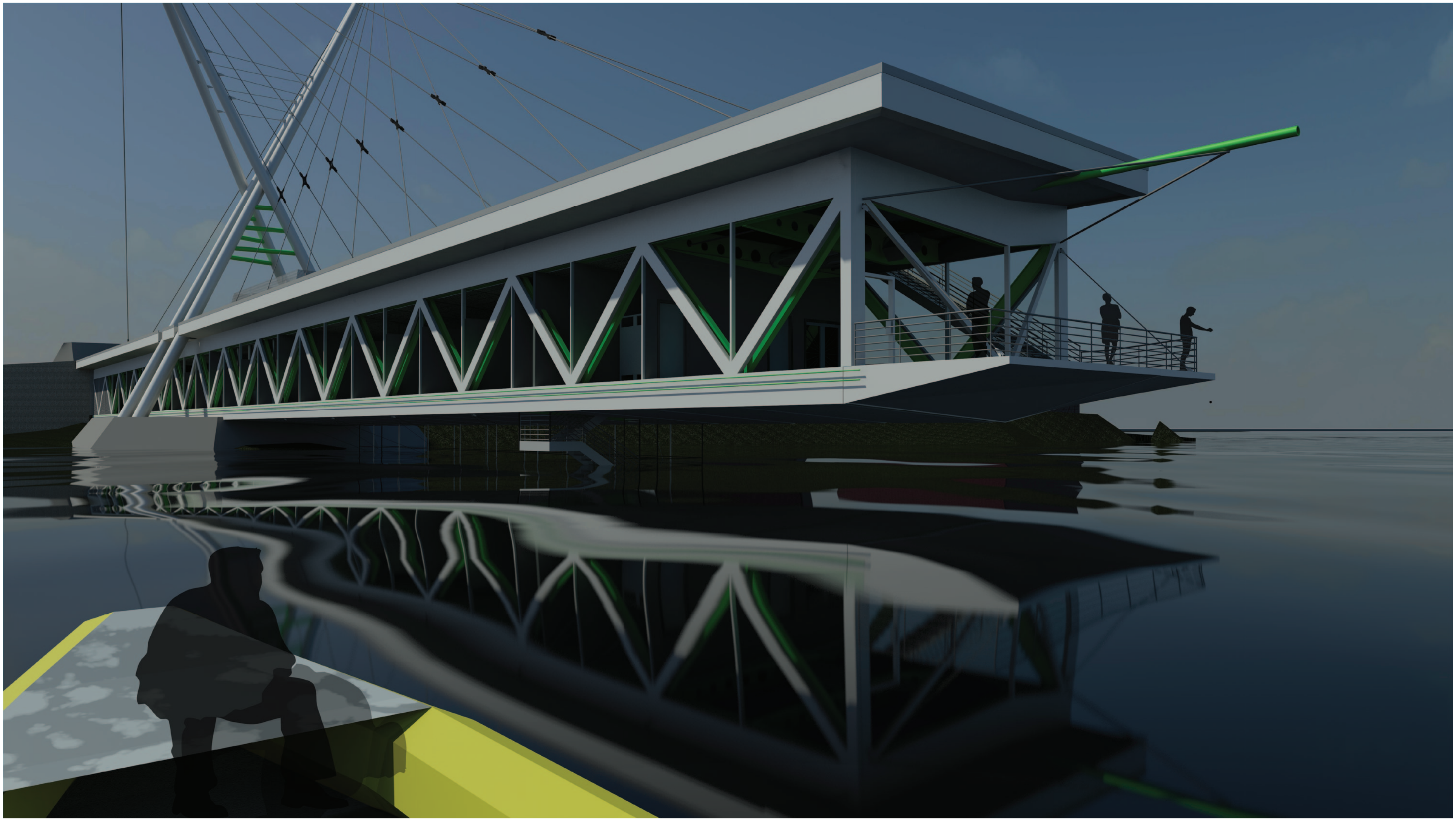
Interior Laboratory Perspective



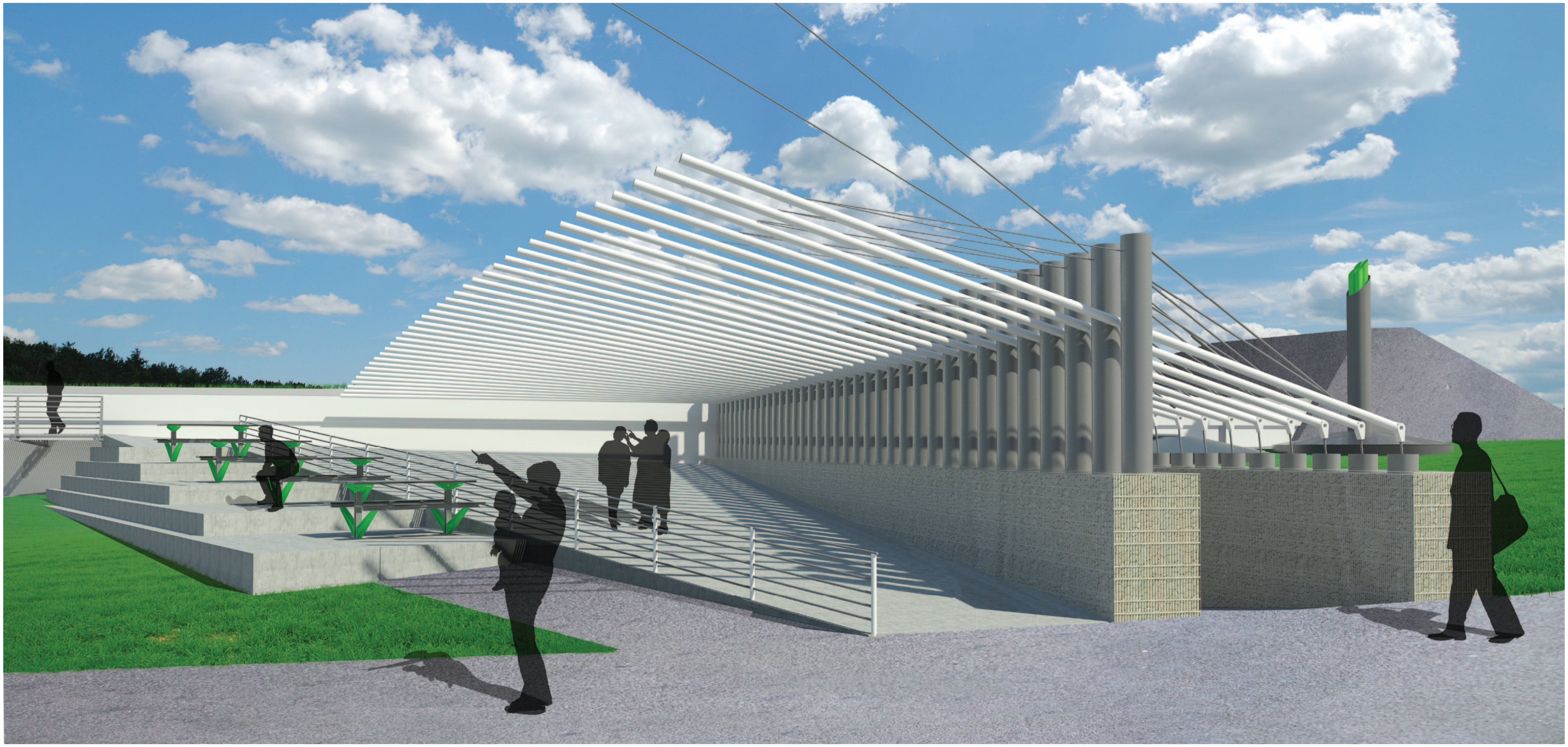
In the lab spaces researchers would learn the chemical components of the target wetland reconstruction area's soils to create a the best chemical make-up of a specific wetland to start a new wetland habitat for the local plants, animals, and specific water treatment needs.

Exterior 100 Year Flood Perspect





Entry



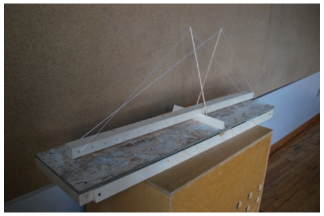
Northwest Perspective from Riverfront Park

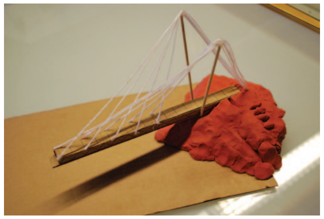

FLOOD RESEARCH CENTER
Problem Statement
How can architects respond to a inland flood research center in extreme flood plains through solutions in nature?
Abstract
This project will outline research into the flood prevention methods in nature and in the man-made world to translate into a new innovative inland flood research center design. This project was in response to the widespread flooding epidemic in the various regions of North Dakota. I hope to give dwellers in flood prone areas a chance to dwell in harmony with nature's natural events. The research facility's main function is to re-establish the wetlands to allow water to have space to expand and retract. The expansion of wetlands will reduce the fast pace runoff from fields and concrete hardscapes of cities to safe manageable rates.
The Structure was developed through a series of structural models to adequately assess the forces acting on the tensile structure.
The Diagrams below Express the process taken in cre-ating the mast.
The building design responded to the Red River's 100 year flood plain by allowing the river to flood without inundating the building on the limited high ground site.
Water collection and water retention on the landscape was key in the discovery of how wet-lands act as a natural flood prevention elements. Wetlands absorb water to slowly let the high flood waters out over a longer period of time. Some of my methods in the design included on site rain gardens, water collection cisterns, and a Green Roof.
Richard Wright
Studio 772
Thesis Advisor: Mark Barnhouse
Software Used: 3DS Max - Revit - Adobe Illustrator - Adobe Photoshop

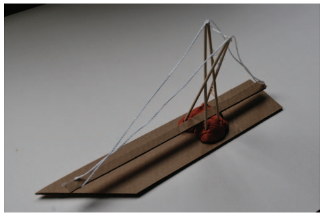

FLOOD RESEARCH CENTER

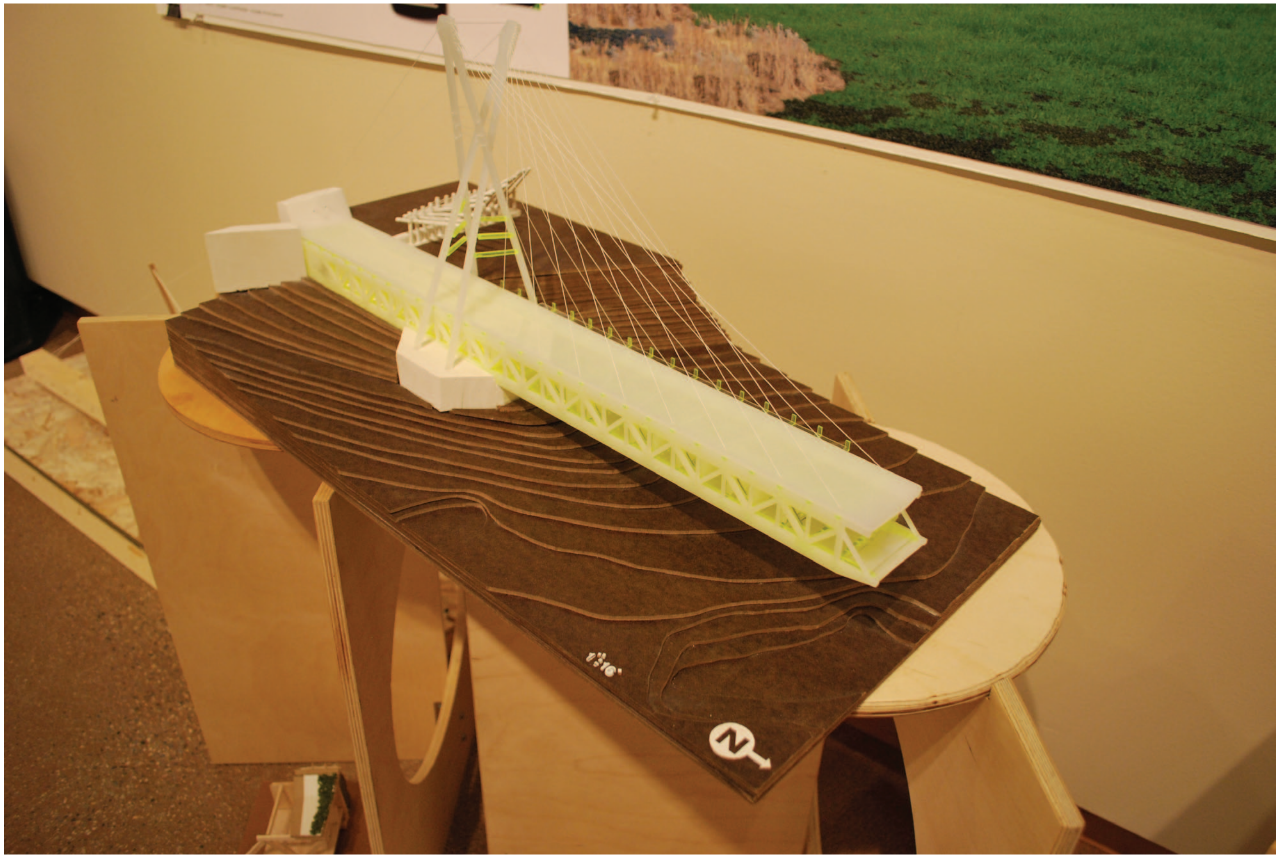
Final Model

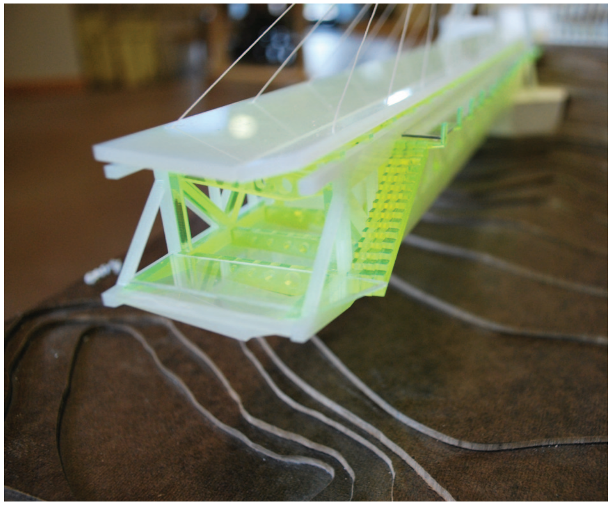
Process Models

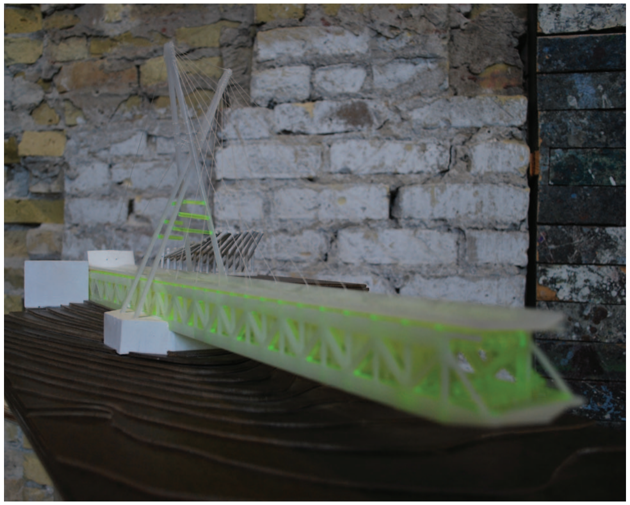












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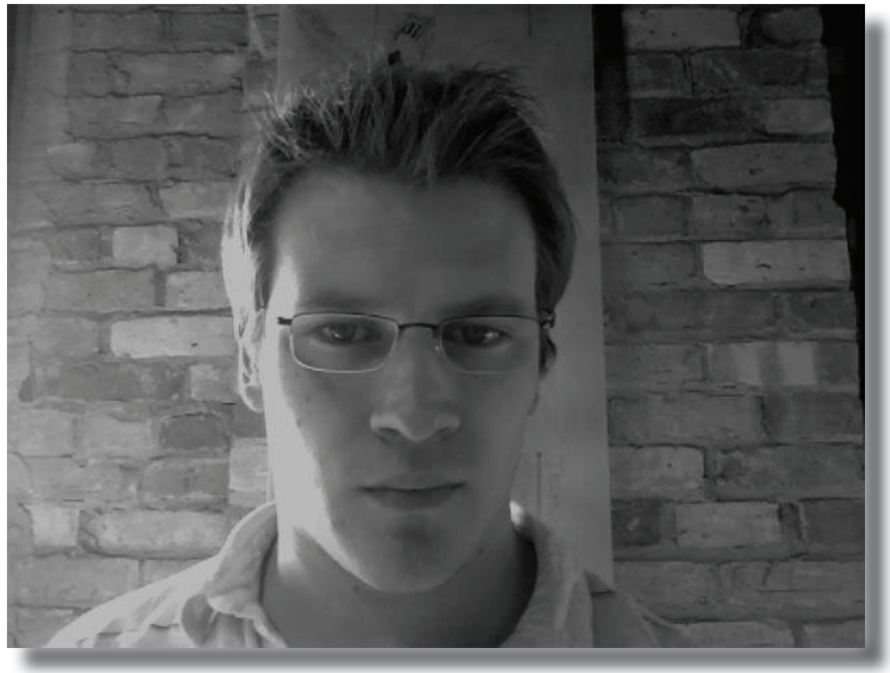
Home Town:

Moorhead, Minnesota

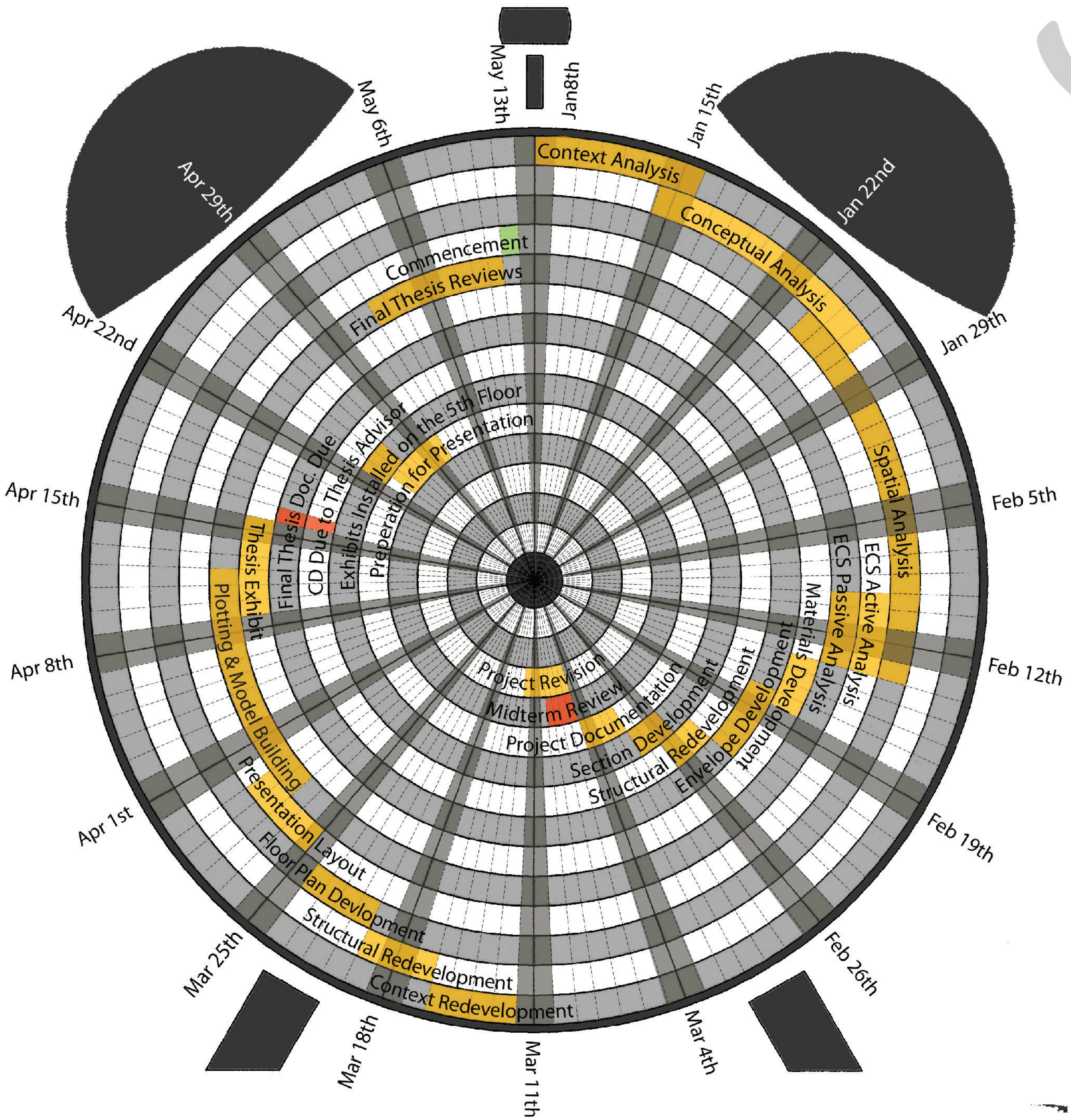
A Quote about NDSU:

"Is there blood on the model!?"



Schedule

Schedule



Jan8th
Jan 15th
Jan 22nd
Jan 29th
Feb 5th
Feb 12th
Feb 19th
Feb 26th
Mar 4th
Mar 11th
Mar 18th
Mar 25th
Apr 1st
Apr 8th
Apr 15th
Apr 22nd
Apr 29th
May 6th
May 13th
Context Analysis
Conceptual Analysis
Spatial Analysis
ECS Active Analysis
ECS Passive Analysis
Materials Development
Envelope Development
Structural Redevelopment
Section Development
Project Documentation
Midterm Review
Project Revision
Context Redevelopment
Structural Redevelopment
Floor Plan Devlopment
Presentation Layout
Plotting & Model Building
Thesis Exhibit
Final Thesis Doc. Due
CD Due to Thesis Advisor
Exhibits Installed on the 5th Floor
Preperation for Presentation
Final Thesis Reviews
Commencement