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Digital Library of Duluth

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

By

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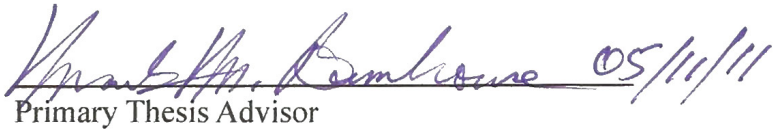
In Partial Fulfillment of the Requirements
for the Degree of
Master of Architecture



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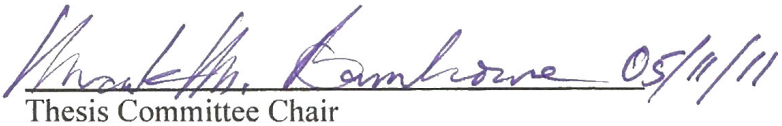

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abstract

The underlying concept for this thesis is the beginning of discussion overtly looking at how computing technology is used by architects today. The discussion will center around critical analysis of uses of software in processes by designers, how technology may be misunderstood or under appreciated by designers, and how we can maximize our design abilities by using technology to our advantage.

In the last 20 years the world has seen a tremendous change in technologies; mobile phones, home computers and the internet all have enabled people to become much more advanced in every field of work.

The expediency of new software available to architects grows almost daily, further thickening the misunderstanding of available technologies. With recent development of high-powered and user-friendly software, which promote use of parameterization, 3D modeling and simulations, due to the battle to maintain solvency by architectural firms, the software becomes lost.

These conditions, combined with the speed at which designers are expected to produce architectural documents today, lead to a recipe which stifles the architects ability to advantageously use software. This lead to the topic of this compilation of writing.

Keywords: Technology, Parameterization, Process, Library, Simulation, 3d Models,

problem statement

How do the use of advanced computing techniques influence the design of the built environment?

statement of intent

Project Typology
Multi-use library.

The Claim
The architect's shift from desks and rulers toward computers and 3D modeling is a radical turn from centuries of unchanged methods for practicing architecture.

Premises
Software being used by architectural firms is directly linked to traditional ways of developing architectural documents, further restricting design opportunities.

With advanced methods such as the use of parameters, simulations, and 3D models, processes should change to reflect such uses and abilities of technology.

Particularly with the use of parameters, architecture has the ability to simulate alterations a building could conceivably change through, providing an avenue directly into a dynamic architecture.

Theoretical Premise/Unifying Idea
By taking a critical look at available technologies, ourselves as architects, and our processes, we should come to the realization that outdated methods of design are severely hampering the results of our work.

Project Justification
This project aims to increase the knowledge of architecture in the field of computing. It intends to broaden the understanding of computers in design and highlight the lack of exploration by architects. Society could benefit from such an exploration. This will result in showing the potential use of computers and the resulting influence on the final design.

proposal

narrative

Through ages of painstaking line drawings, countless hours dedicated to architectural documentation, and lives dedicated to one building, history has shown a process of architecture which rivals that of the dedication and skill of the craftsman. Each drawing was, line by careful line, drawn with ink or pencil, and carefully considered in just how it was applied to the medium. Each finished document was a work of art and representation of skill in itself. The documents were and still are simply a transfer of information from one person or group, to a group of people tasked with assembling a building based on the information gleaned from the architectural document. Designs often reflected the preparation and abilities of the architect, as well as the site and clientele requests. But more often than not architecture has tended to reflect and change according to the active cultural thread of that day.

Culture is the reactive strain and lean of society as it reflects upon advances in knowledge and changes to lifestyles. The thread of culture through time has long been raveled and wound, plucked and pulled by numerous advances in technology. Even as we look strictly at architectural history, we see moments in times which lead to the precursor of more radical designs and further pushing of building limits known at that time.

Today, architecture has moved to the use of computers largely for the ease of production. The ability to easily manipulate drawings, alter renderings and reduce the need for large bulky drawing boards has led to a shift in computation of design documents. As software has developed and become more easily available it has also progressed past the skill levels of many architects. The vast majority of architects use software which is directly linked to historical aspects of practice. The lines and ink on paper progressed to CAD software, which essentially replicated the same aspects of prior practices. With CAD the only advancement was the ability to easily manipulate drawings with simple clicks of buttons. Revit software is an advancement on CAD; it allows drawings to be linked to a model, facilitating the simultaneous 3D model and orthographic drawings within the computer.

This allows for the easy modification of design documentation through the simple modification of one aspect of the information, the 3D model.

The dialogue between the architect and the design documents is still eerily similar to hundreds of years ago. With modeling programs allowing the easy manipulation of a project through parameters, simulations to view such changes, and 3D models to allow these things, should not architecture respond appropriately to such abilities at architects literal fingertips?

This project will attempt to employ such measures in a typology of a building whose program is also undergoing a radical change. The library of yesteryear is no longer simply a collection of books. Libraries today recognize the resources and knowledge available through the internet. The typology of a library is in flux, in the process of redefining itself as not simply a collection of knowledge, but also a resource to decipher the knowledge. This situation seems an appropriate topic to cover parallel with the use of advanced computer processes.

user client description

This design will be oriented toward the residents of Duluth, Minnesota, with special emphasis being geared toward developing businesses.

As a city-owned building, to recover the costs and give the city residents a return on their tax money invested into the building, the value of the holistic project will be maximized. This will be fulfilled through the construction of an a typical library one which will attempt to create and retain businesses within the city and regional area through the adjoining business development outreach.

Library Users

The library portion of the building will be geared toward those who simply use the library for their need and enjoyment. The space will accommodate a number which will be appropriate for a city of 86,918(http://www.duluthmn.gov).

Peak usage will primarily be during after-school hours in the fall, winter, and spring, and during the day in the summer.

Parking

An attempt will be made to not increase traffic in downtown Duluth, hence library patrons will not be given courtesy parking areas. Areas along nearby streets will be available, as well as encouraging parking in nearby parking lots and ramps.

Auditorium Users

The auditorium will be an area of great interest. It will allow business owners and developers to showcase their products and business opportunities to others through talks and lectures. It will also be a space in which performances can be given through the media of music, body performance, acting, or illusion.

Peak usage will be during the time of performances or talks and lectures.

Parking for auditorium users will be treated as similar as other building users.

Library Workers/Maintenance Workers

This group of users and maintenance will be accommodated through personalized space and space orientated toward fulfillment of specific functions.

Peak usage will occur during normal business hours.

A parking area will be granted to these users.

major project elements

A city, when looking toward the implementation of new infrastructure, should look at ways to benefit the city residents to the maximum. The ability to foresee how a multi-faceted library, if planned right, could benefit the city in more dimensions than simply through access to literature and the internet will be the majority of the goal programmatically for the building.

Historical Library/Research Portion

This portion of the building will operate within normal business hours, adjustable as needed by the management staff. It will have a view of Lake Superior and have an airy, spatial feel, with plenty of natural day lighting.

Digital Library

This new programmatic element will incorporate some of the newest technology available for the public's use. It will be staffed with a knowledgeable staff able to assist the patrons with their needs for various types of information. It will be spread out through the library and not specified to a particular room or zone.

Auditorium

The auditorium will be a multi-dimensional space with use allocated by prior reservation. The space can be reserved by any group or person in advance. The space will be one of flux and change with the goal of a well-lit, well-sounding, functional space. It will also be open to the outdoors during appropriate weather.

Conference Rooms

These will be available for reserve upon request for any one who desires to do so. With view of the city, lake or both they will incorporate tools to assist the meeting groups with their work.

Maintenance/Mechanical

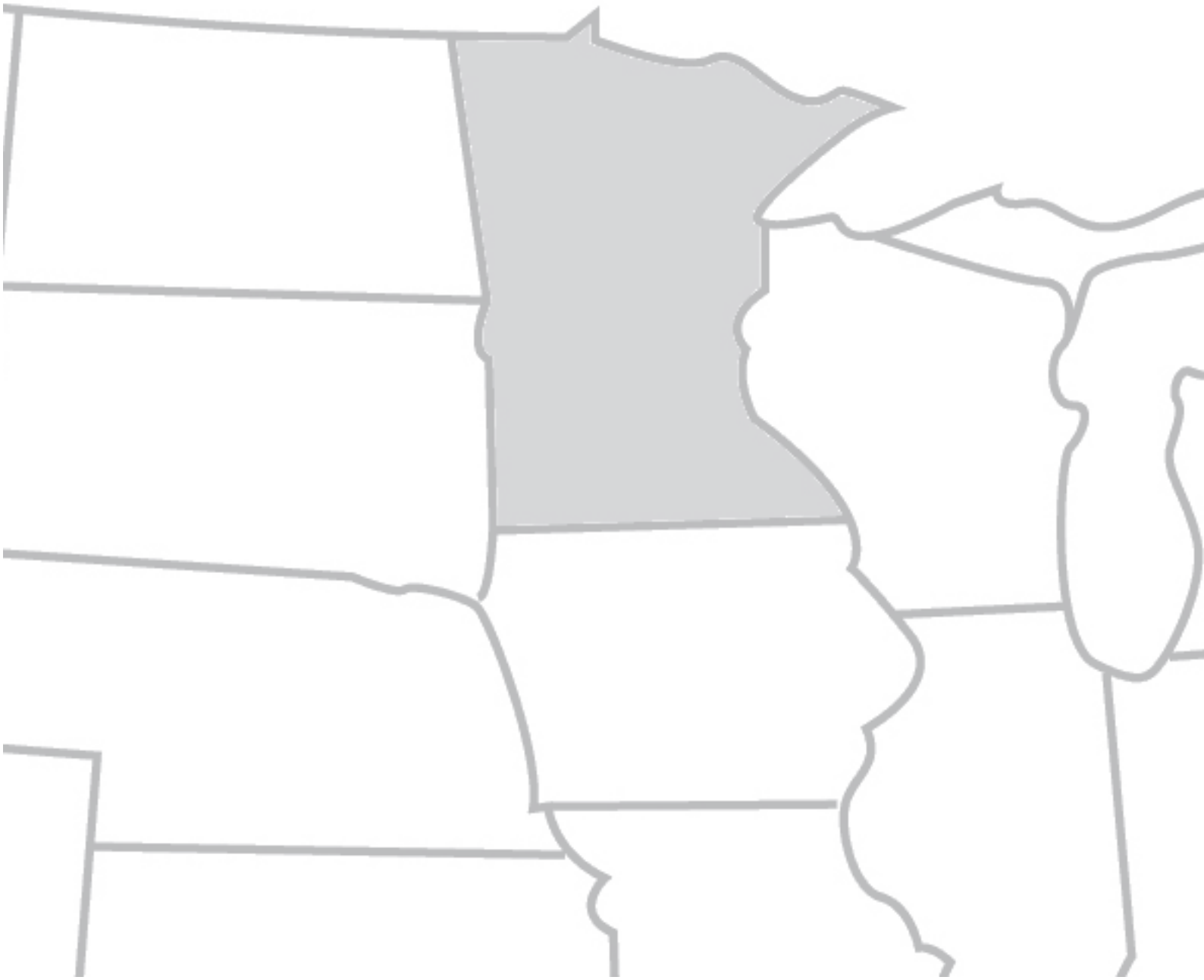
This will be solely available to city employees with key card access. Very functional and well-lit work spaces will be allocated for maintenance personnel.

Parking

Other

Vertical Circulation
Horizontal Circulation
Lavatory

site information



Duluth, Minnesota is located at the tip of Lake Superior, and is known as the largest inland port in the world (www.duluthmn.gov). It is also the farthest western port accessible from the Atlantic Ocean(www.duluthmn.gov): Duluth has extremely varied topography, being placed on the shore of Lake Superior , bordered by ancient glacial granite hills, with a river to the south splitting Duluth from its sister town of Superior, Wisconsin.

Duluth city limits.

Proposed site limits.

Historically, Duluth was built upon the transportation industry; shipping and rails became the backbone for years of growth in this port city. In today's world the transportation of knowledge via the internet has become a new commodity. Duluth, along with many other cities, has entered in to a competition to entice Google to install ultra-high-speed internet in the city as a test for viability on a broader basis. This possibility would undoubtedly create new business opportunities within the city and region. It is with this interest that the design of a library was conceived and became the basis for development.

The proposed site is located at a key spot between Canal Park and downtown Duluth. The link between these two spots is sorely lacking due to the division of the freeway which runs between downtown and the shore of Lake Superior.

project emphasis

Duluth is the location of the largest inland port in the world, sharing this honor with it neighboring city of Superior, Wisconsin. The head of the shipping lanes for the Great Lakes, and the gateway to shipping all across the mid west and northern part of North America, it is a city built on the industry of transportation. With the possibility of a new type of transportation, namely that of information, available for the city to reenergize and grow, this project seems to run in a parallel with exploring software development for aiding design for architects.

The focus of this project will be emphasized on the literacy of the design within the computer. The goal is to maximize use of available computer programs to their fullest in an attempt to realize the potential for architects concentrating on possibilities that parameterization, simulations and 3D modeling bring to an architect. This aim is intended to approach without the full grasp of particular programs, with the result being something I may not have expected.

The program of the library and its functionary design will be the secondary focus of the project. The aim will be on how to integrate an information-based business sector in conjunction with the library and how they can not only coexist but mutually benefit each other. Lastly, a focus on how the design is integrated and connected with the lake front, to the downtown and to Canal Park the popular shops section adjacent to the lift bridge as outlined in the site information.

documentation

The research for this thesis will be conducted through many avenues, all of which are important to this project. Examining how this typology has changed through time, and it's historical context examining this typology and its importance to society and how it may be shifting in how it serves society and programmatically examining how this is important to the typology. The site will be studied in depth to see how the resulting design may impact and/or benefit it and the surrounding area. Lastly, the theoretical premise will also be a major driver in the formulation of the research.

The accumulation of information for this thesis will be conducted via a mixed-method analysis. A mixed-method means of gathering information involves both quantitative and qualitative data. These data types will be merged during the duration of the project, and will aid in appropriate and constructive means of outcomes. The focus in data will be driven by the theoretical premise and unifying idea as well as the major project emphasis.

A concerted effort will be made to document weekly the information pertaining to the project for a compilation. This will be done via scanning of sketches, copies of related images and related information. This will all be compiled into a digital directory made accessible. In addition a physical folder of original documents will be compiled and available for review as well.

prior studio experience

2 Year Fall 2006 — **Mike Christenson**

TeaHouse	North Dakota
BoatHouse	Minnesota
Multi-Use Commercial	North Dakota

2 Year Spring 2007 — **Mike Christenson**

Historical Casting Replication Collaborative Group Project	North Dakota

3rd Year Fall 2007 — **Steve Martins**

MN Cultural Center	Minnesota
Stone Masons Lodge	Minnesota

3rd Year Spring 2008 — **David Crutchfield**

Performing Arts Center	Texas
SpacePort Hotel	New Mexico

4th Year Fall 2009 — **Aly M Bakr**

High Rise Design San Francisco	California
KKE Drum Competition	

4th Year Spring 2010 — **Daryl Booker, Frank Kratky, Paul Gleye**

Urban Planning Revitalization	Dominican Republic
Appropriate Housing	Dominican Republic
Marvin Windows Competition	Africa

5th Year Fall 2010 — **Ganapathy Mahalingaham**

Architectural Research Dynamic Architecture	Minnesota

research results

Evolution of Architectural Information

For us to understand why new digital tools for architects are important, we must examine the path the discipline has taken over time to arrive at the point it is at today. The concern of this thesis lies in the realm of new architectural computing tools which could possibly alter and redefine aspects within the discipline of architecture, both in the field of work and the education arena. Tools are generally understood as an aid to humans; how they assist us depends on how a particular tool is applied and if it is applied correctly.

The tools architects use have evolved in the past 30 years to become heavily dependent upon computing tools. With the wide range of software available to architects today, one has to ask why do architects limit themselves to hereditary computer tools. What I mean by hereditary is tools which lead to more advanced and productive tools, but are based off of tools used in prior years.

When we examine the history of technology in buildings, we can see how architecture has fully embraced new methods of construction. It has followed and reflected cultural and technological changes throughout its documented and undocumented history. One can ask how could anyone know that architecture reflected cultural and technological changes through undocumented history? One can not "know," but speculatively say that if architectural thinking did not advance through undocumented history an uncharacteristic series of advancements would have been found during the early period of documented history. The main point is that architecture, culture, and technology simultaneously evolve, change, and affect each other.

Early history in India shows a profound thoughtfulness in the architectural relics available for us to examine today. "A phantasmagoric composition of mythical monsters, the temple is a treasure-house of visual treats and spatial experiences, apart from ritual overlays and symbolic significance" describes Yatin Pandya of the Indian cave spaces(Pandaya, 2005).

One can examine these "caves" and temples wrought from solid rock, in the creation of spaces for worship for dedicated religious groups. How these caves and temples were documented, if they were, in preparation for excavation we can only speculate. The immense detail within some works shows attention to planning for the production of the work. Were the architectural tools simply the mind, and remembrance of how one thought a particular project should proceed during excavation?

Even as we look at early documented architectural projects, the method of delivering documentation for the builders is not unlike what architects currently do today. The plan of St. Gall, Switzerland, is the only surviving architectural drawing before the twelfth century(Powell & Leatherbarrow, 1982). Yet it appears as though it could be used for a building today. Powell and Leatherbarrow say elevations of projects were not drawn during Middle Age architectural construction, as master masons only needed to know the details of buildings, such as the molding of columns and carry of arches for buildings, aside from full-scale ground plans. They go on to state there is minimal evidence of any elaborate plans and elevations drawn of Gothic cathedrals during the early Middle Ages.

Yet, during the Renaissance, the next age of architecture, or culture, Branko Kolarevic(2003) writes in his book on digital design and manufacturing that Leon Battista Alberti noted the separation of architects from the building trade, which resulted in the requirement of more extensive documentation of building components.

Today the depth and breadth of architectural documentation is continuing, but has become much more detailed, a reflection of the complexity of buildings and new materials. Not only from the complexity of the buildings and materials themselves, but also a reflection of society and the culture which we live in today. Specifically, American culture is a litigious culture, a culture which seems to require that everything be documented in preparation for possible lawsuits. Each material for each component of each building must have a specific standard which applies to it, which is inherently good in itself, but the weight of preparing the documentation for each material becomes a drag on the project.

One can thoughtfully say that no longer are craftsmen and architects producing buildings in which their own judgment is used, but rather the judgment of what documentation of a particular material states it is allowed to do. Kolarevic writes that, "The rifts between architecture and construction started to widen ....when drawings of the earlier period became contract documents"(Kolarevic, 2003, 56).

This situation is the result of a culture that has embraced the idea of litigation, partly as a means of protection of one's self, but also as a means for producing money in morally tilted situations. This type of culture restricts the ability for architects to innovate, for the cost associated with using new procedures can be potentially expensive if they become entrapped in lawsuits.

Computers and their tools bring a new avenue for innovation to architecture. Now designers are able to model in 3D, allow for implementation of parametric design, and create simulations to preview designs through time, all while expending a fraction of the time to do these things by hand. These abilities are the result of the innovation of an industry that has very little oversight and restraint on it due to the lack of litigation applied toward it by dissatisfied users. These innovative computer programs are the result of software designers creating tools which people can use. But ultimately, the construction or production of a product or service primarily rests on the shoulder of those responsible for that service. The select times one sees litigation surrounding software is when it has allowed information of a certain content to freely be released, without the authors/creators consent, such as music web sites.

This illustrates clearly the industry computers are involved with: information. It is this ability to quickly process, alter, and create information through the use of advanced computing techniques that has brought computers to the forefront of architecture.

Computing tools are redefining the ways in which architects use information. Historically, information was passed via oral instructions, and more recently it has been relegated to construction documents. With the application of computers, the ability to generate large quantities of information at a much faster pace has swamped architectural practices in the documentation of construction documents.

Gehry & Partners architectural practice has attempted to solve the rigors of paper documentation through the application of 3D models as construction documents and as a legal piece of information(Kolarevic 2003). Their strategy was to use the design model as construction information/documentation. This shift from documenting how a building should be constructed toward interacting with fabricators and builders to extract information from the design model begins to illustrate the implementation and importance of computing tools for architecture.

Architectural Computing Tools

3D Modeling

3D virtual models are the embodiment of architectural information. They allow more freedom for designers, who can also utilize the power of the computer to grasp select bits of information to aid in the production of architectural components.

Ali Rahim writes these "new techniques destabilize existing practices," referring to the use of 3D models as a basis for building production(Rahim, 2006, 75). He goes on to state that the use of CATIA software on the Bilbao museum project "has altered the way buildings are designed and made". This allowed the architects to work in close proximity with the builders and fabricators to produce architectural components that fit within the scheme of the design. A number of Gehry projects have implemented the use of 3D models as a basis for generating construction information, and his success has led him to push for broader acceptance of 3D information as building submission requirements(Rahim, 2006) (Kolarevic, 2003).

Parameterizing

The aid in production of select parts of building components, whose relational form is similar yet sizing is not, drives an interest toward implementation of parametric tooling. Parameters have ranges of inputs that are controlled, but the output is controlled based only on how the structure is set up.

In this way various forms can result through simple alterations of a few inputs. The International Terminal Waterloo Station, built in 1993 by Grimshaw & Partners, is illustrative of the use of parameters. The mass production of 36 different drawings based on one input began to demonstrate the ability of parametric tooling. The implementation surrounded a long curved site of varying widths. Thirty six different trusses were modeled through a parametric application toward the truss. Similar restrictions would shape each truss, but the length from end point to end point was based on the width of the site(Kolarevic, 2003).

This project shows the forefront of the subject of mass-customization. It centers around the concept of parameters and supports the production of products which are similar but have the same limitations for each project. Web sites have begun to offer mass-customizable artifacts such as Nike with their "programmable shoe." This concept is particularly important in the installation of buildings which have non-typical geometries. One system can be used to span or structure a plane or non-uniform surface, with different sizing specific for each unit and its particular place on the surface, as was shown during the construction of Waterloo Station.

Performance/Simulations

Performance architecture software programs have been around for more than four decades now. The first performance analysis tools were called PACE.(Package for Architectural Computer Evaluation)(Kolarevic & Malkawi, 2005). The program allowed for optimization of designs at various stages of the project, and used a range of appraisal measures to quantify the design. It also measured cost, spatial, environmental and activity performance. This precursor to modern analysis programs also had an interesting capacity to "learn" as it stored selections of designs by the designer for later reference in generating geometrical possibilities in the future(Kolarevic & Malkawi, 2005).

There are many types of analysis tools widely available today in common software programs. Rhinoceros, for instance, has a Gaussian analysis, which is used to determine the curvature of surfaces. Gehry & Partners has used it as a quick way for determining cost analysis for complex surfaces.

The test will quickly determine if a surface is slightly curved or double curved, which costs more(Kolarevic & Malkawi, 2005).

Other simulations of performance involve stress tests for tall buildings subjected to wind loads, optimization of non-uniform shapes for structural efficiencies, and proposing changes to a building based on optimized passive strategies.

The engineer firm Arup has used performance simulations to change building codes in the Asian subcontinent. They consulted on a project where the code required sprinklers to be present in case of fire. The code stated that the sprinklers could not be part of a structural system. Due to the design constraints Arup wanted to integrate the sprinklers into the structural trusses which spanned a large room. The code officials would not allow it even after simulations proved that the structure would not fail during a fire, but in fact perform better due to the cooling effect water had on the metal. Arup then constructed a full-size model and subjected it to extreme fire conditions and proved that their simulations worked, and predicted nearly exactly how the sprinkler system would work. The building code was changed(ARUP, 2010).

Sensory and Components

The history of computing has powered a radical shift in cultures around the world. The world seems to have grown smaller due to our ability to reach into almost any town in the world and learn about it. Yet in the past 10 years mobile phones have created a new phenomenon, mobile information and connectedness.

This growth has expanded to digital cameras, portable computers, and high tech mini computer phones, which allow access to the internet from nearly anywhere. This phenomenon is referred to by John Markoff, in a *New York Times* column, as "Computers As Invisible As Air." He writes about the combination of computing power and progressively smaller space being needed for the computer(Markoff, 2010).

Markoff comments on how Moores Law has predicted the continuing rise of computing power, "while costs fall just as rapidly"(Markoff, 2010, 1). He continues about a new computer switch in Silicon Valley under development. The switch, being simpler and potentially smaller, could revolutionize the size of computing power(Markoff, 2010).

This leads to back to the initial title of the essay written by Markoff, "Computers As Invisible As Air." The possibility of the integration of computers with buildings begins to hint or sketch toward a new type of design, one with computers as a fully integrated partners with the building, not simply as a component which operates within the boundary of the building planes as we often see with furnaces, desktop computers and TV's.

The integration of environmental sensing components into a design begins to blur the divide of static architecture and dynamic architecture. With new technological advances that allow for the automation of nearly anything one can conceptualize, it leads towards the idea of operable architecture.

Kas Oosterhuis speculates on "programmable buildings" in his book on E-motive architecture. He says we are "on the threshold of programmable building types," and that buildings will "change shape contracting and relaxing industrial muscles"(Oosterhuis, 2003, 37). The borrowing of ideas from other fields is never more possible than in this distinct realm of architecture.

Prosthetic limbs show great promise as examples of how architecture could expand in the coming years. The limbs have gone through a revolution in the past decade, becoming more responsive, agile and allowing those in need of them a greater sense of freedom. Some limbs are built upon material responsiveness, while others are powered by small micro motors. Robotics also have advanced significantly, their achievements are simply stunning, and they become another push for architecture to envelope the possibility for operable or programmable architecture.

Oosterhuis continues to describe a project developed to resist wind loads on surfaces through programmable muscles. A soft flexible "muscle" is driven by components called muscles, which are in fact robot components, and can respond based on differing wind loads applied to the surface.

Later on in his book, Oosterhuis describes a project which has seven different components of a building which slide in relation to one another based on the controls implemented by the designer. He says that "no one person will see the same results, resulting in a constantly changing configuration of masses" (Oosterhuis, 2003, 12) what he does not touch on is the interior space which is equally or moreso important. The dynamic of changing space inside a building would bring about an effect of timelessness, the creation of a charged spatial continuum.

Libraries as Information Store

We know that libraries over time have been relegated to a place in which a collection of books, or in recent times other media are stored and not for retail. It is with the onset of computers and their ability to store large amounts of data easily that have changed how libraries are being used. If we compare a library to any search engine available on the internet, we see parallels in how they operate. Both deal in information and the access to that information. While on the internet not all of the information is certifiably correct, the same is true of some books. The internet carries fiction, non-fiction, alternative media such as music, videos and current news. Libraries also carry fiction, non-fiction, and alternative media.

When we examine the history of these respective modes of access to information, we see the library, which has a foundation of centuries upon centuries of comparative ways of operating. The other, the internet, has barely been widely available for more than 20 years. Yet the usage of the internet is growing more year after year.

A recent article in the *New York Times* comments on the digitalization of an undergraduate library on the campus of the University of Texas. The University has elected to move 90,000 volumes to a new library within the university system. The resulting space, 6,000 square feet, will be used for more computer space and a 24 hour all access information commons(Blumenthall, 2010).

This phenomenon of creating a purely digital library, or a space in which information can be accessed through computers corroboratively, known as software suites, shows the still-shifting spectrum of libraries reacting to influences of computers and the internet.

For example, Mark Herring writes that the first choice for college students in accessing information is a search engine over a library 72% of the time(Miller & Pellen, 2009). Yet the the argument against the internet is the lack of certifiable sources. Herring argues that the internet is a non-physical source, whose lack of physicality should result in a reluctance to use web citations as certifiable sourcing.

He cites a study where the JAMA(Journal of the American Medicine Association) found through a study of scientific papers, of the links citied, 28% were useless after 24 months(Miller & Pellen, 2009). This highlights the convenience of the internet, the availability of information at our fingertips creates a situation in which the ease of finding some type of information is better than spending hours looking for verifiable information. This shows the approach of perhaps a disconnect between how a library should work today in creating a situation in which their database is more available, yet one can still depend on the information being there for an indefinite amount of time.

Research Results Summary

The results of the research revolving around these topics of architectural tools is interesting. These information driven tools allow for massive amounts of complex calculations, simulations, and processing to be done, that just would not be cost efficient for an architectural firm to do on a regular basis by hand.

When we examine the functions and calculations that these information tools perform for us as architects, we have to understand how they came to be. The foundation for today's computer programs, one can suggest, comes from the point in time which separated architects from the building site. This separation from the job site is now beginning to come full circle and return with a design process which integrates engineering and performance of critical conditions early on.

This leads me to ponder what state architecture might be in if that rift had never happened. Would architects still be working in close association with the craftsmen, or would they have jumped directly into computers? Or perhaps the computers would have seemed useless, as there never had been a need to document anything prior so why start now?

In either case it is important to note that the separation of the architect was important to the generation of documentation software or CAD, which made their jobs easier. The CAD programs then shifted into the realm of virtual models, parameters, and finally simulations. It completes a circle, which in my opinion started at the point architects began to document construction documents solely for the purpose of written instruction on the job site.

These specific computing tools that are available to architects today have begun to crack the insulated barrier that seemed to have formed around them. With the ability to fully model a design, structured with layers geared toward each different system of components comprising a building, the ability to involve other individuals into the refinement of the design becomes possible.

3D models also allow for the exploration into what were previously considered unapproachable projects due to building costs as well as the difficulty in documenting how a design was to be rationalized and built. 3D modeling is really the basis for the other tools to perform upon, for without the model, performance testing would be close to impossible.

The ability to parameterize projects is important, but I believe that there is a danger in this area as well. If a design is not properly understood prior to being subjected to the parameters, inconclusive or potentially dangerous results can occur. The results from parameterization should be given proper thought in terms of the expectations for results. I think that the abilities to refine and harness parameters for solutions embodies the concept of mass-customization which can be an extremely useful tool.

This concept is an enabler of non-rational designs to be built through an ability of easy-to-formulate results which depend on similar systems of structure with varying inputs. So a building or structure that uses curved or non-typical wall heights, or roofs which require a consistent span design or patterns, can be customized in their design but with differing span lengths.

Performance tools for architects are becoming increasingly important as a means for testing building performance on many variables. Clients are no longer satisfied with simply a building, they want a building that performs to their expectations. This requirement by clients has begun to drive architects into the field of performance testing. As stated earlier, the engineering firm of Arup has fully embraced the technology and techniques of performance testing. It is this type of consulting which I believe will become more widespread and important as the field of architecture moves forward.

Libraries

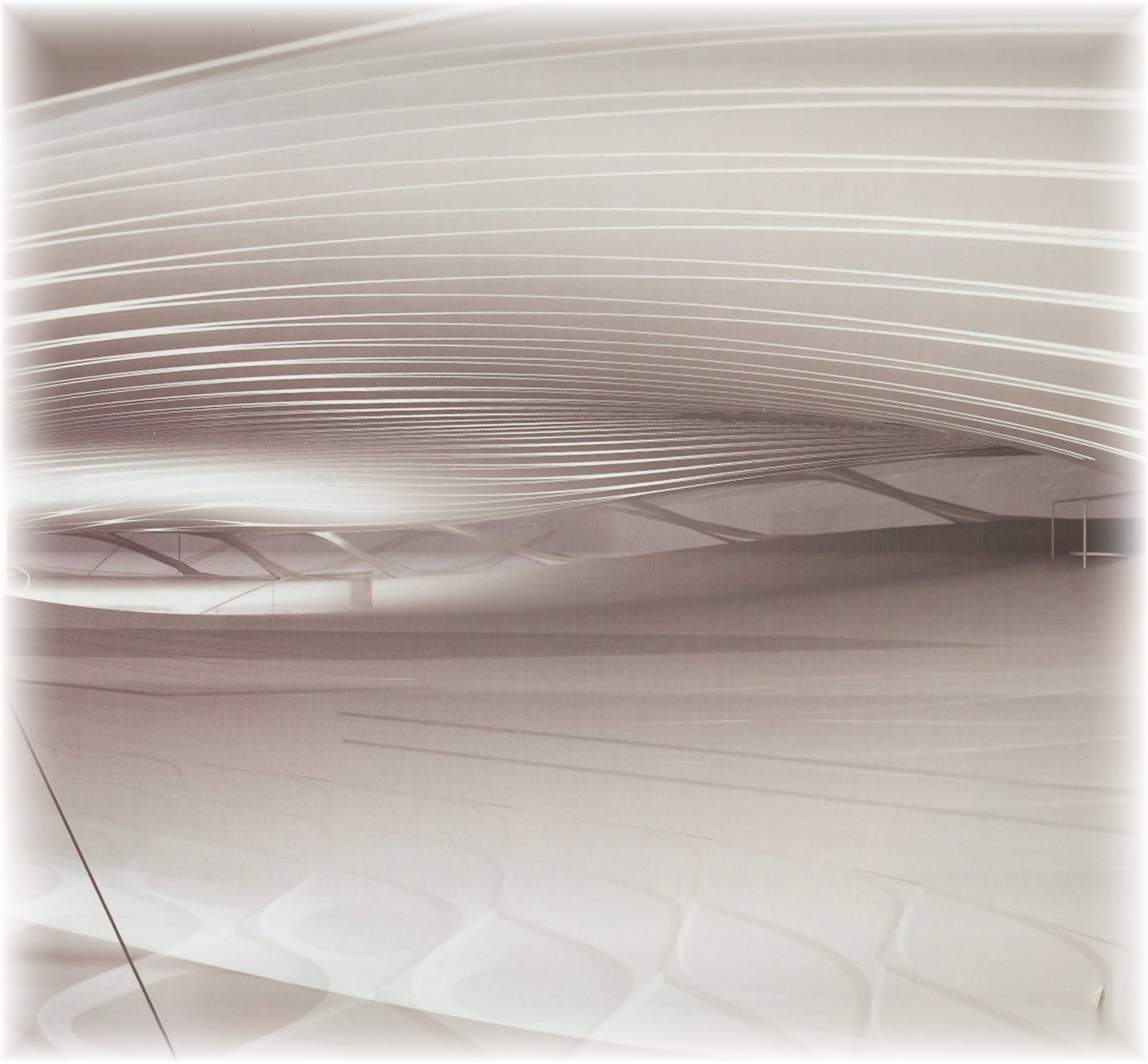
The future of libraries seems to lie in their ability to harness the power of the internet and computers, in a way which results in a purely dependable source of information. Not just information for the sake of information, but information that is dependable for students, researchers, professors, or anyone who is looking for an ultra dependable source of information.

The internet indeed does have a lot of information, but the type of information creates a situation in which it is not entirely dependable. When one has a book, the book is there, and if it is in your hand, it will be there as long as you want to hold it. You can put it down and return to the book, it will not leave on its own from that spot.

But the internet has a different face to it. Web pages are added, deleted and changed constantly; this results in forms of information that become largely non-dependent. For example, if the power is cut off from your computer, can you still access the information? If the web page is suddenly changed and the former information deleted, altered, or modified by the host, how can the information be retrieved?

I think that these are issues which a library must think deeply about, issues that I hope I am able to address in the outcome of this research.

typological research results



Library for the Information Age
Contemporary Achitecture Practice
Karachi, Pakistan
325,000 Sq. Ft.
2005

The library proposed for Karachi, Pakistan is a library with many dimensions. It is geared toward the integration of the public within the building as much as possible. The library will house paper-based, as well as digitally based media, and is also being planned as the base for a global information network for Pakistan. Space for a book collection, area for digital access of information, as well as facilities for public uses and functions are organized in the building.

This library is an interesting project on many levels. The focus of the library is on information, but it has reached out to embrace the networked world through creation of a hub of information about Pakistan in the library. The vision, it seems, is to support paperbased media, but to try to embrace and reinforce the use of digitally based media.

Digital usage in libraries is increasing yearly, as we can see by the implementation of more and more computing-based activities throughout libraries. It is this usage of information that has influenced designers to use an information-based process to derive the building. The interaction with people and digital media requires a two-way flow of information. Paper-based media is a static form of information; the flow of information is one way, toward the interested party handling the piece of media at that time.

Process

The process used to generate the form of the library was particularly interesting. The designers noted that digital information caused a two-way interaction between users and the machine. They proposed that the library have influences of high and low pressure between the city and the site. These high and low pressures were then weighted in a computer program through the use of inverse kinematic chains.

All case study 1 information, images from Rahim A. (2006)

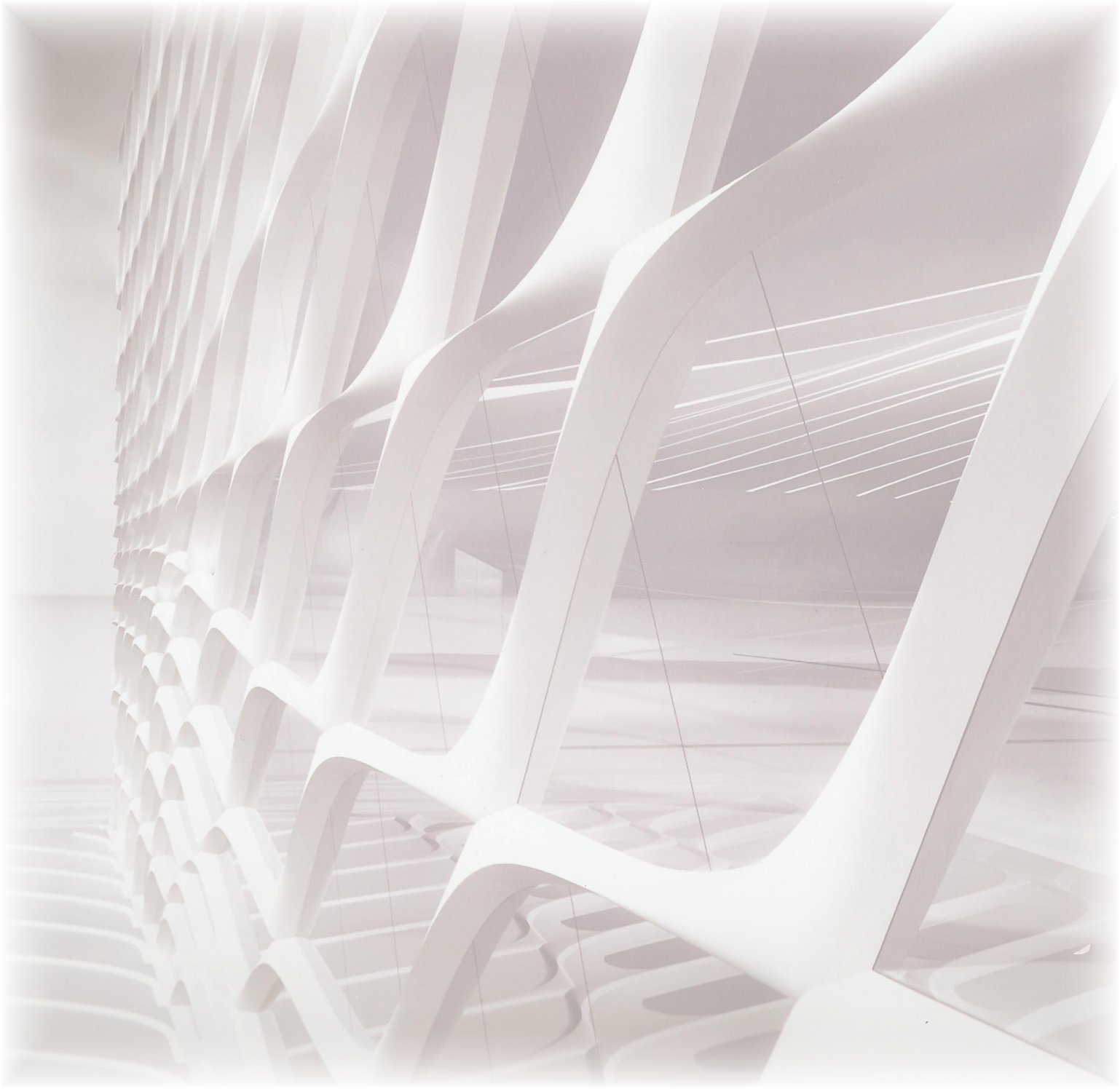
The resulting flows caused a highly non-typical sequence of spaces. Areas of high pressure; resulted in more closed and static spaces, while low pressure areas resulted in flowing spaces of opportunity. The resulting forms began to dictate the programmatic layout of the building.

This project is particularly interesting on many levels to this thesis. First, the building form is a typical rectangular box, but the way in which the building spaces and structure are implemented is highly irregular. The ability to document this building in a typical way through plans' sections and elevations for a builder to construct would be very difficult. To document one of the spaces, sections of the structure would have to be drawn through nearly every increment of space just to understand how the space undulates and changes. The difficulty in then attempting to create the space though the use of those section and the plans of that particular space are nearly beyond comprehension for a person. To replicate this throughout the building would be nearly impossible.

Conclusion

This case study presents a project difficult for humans on many levels. The ability for a person to generate the type of spaces as detailed as they are shown through the illustrations is very difficult and time consuming. Yet with the ability of tools to aid architects, the symbiotic results of computers, architects and clients can see the result in spatial configurations of non-typical space.

This ideal returns to reinforce the theoretical premise stated earlier in this these, that outdated methods are severely hampering the results of our work. The ability of computer tools became the enabler for this project through the selection of the design process, and the selection of the resulting design. This project shows the power of what computer tools can do with a relatively small amount of time and energy invested in a project.



Analysis

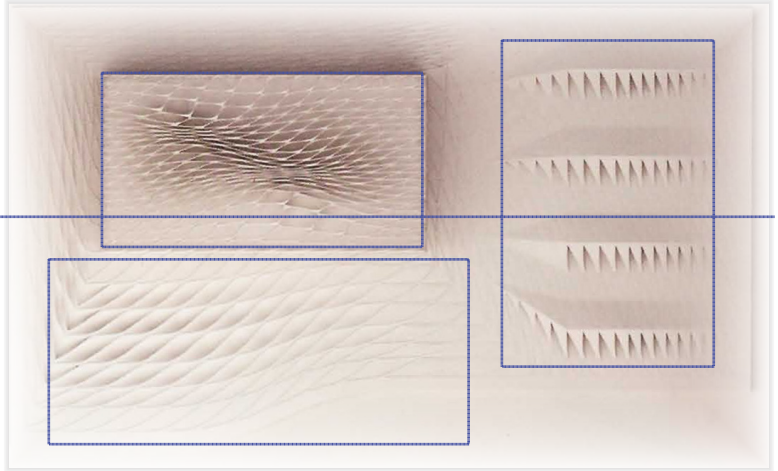
The over arching formal composition of this project is a basic volumetric shape, a cube whose cut views and modes of circulation do not follow the volumetric composition at all. They only hint at a varied spatial layout inside the composition of the facades of the design. The cubic composition of the building is reflected through to the paving and landscape elements shown in the site plan.

The section of the building begins to illustrate the symmetry in the placement of the spaces throughout the building. The open spaces seemed to be placed at a visual spatial balance throughout the building. The section also points out the flow of space from one side of the building to the other on multiple levels.

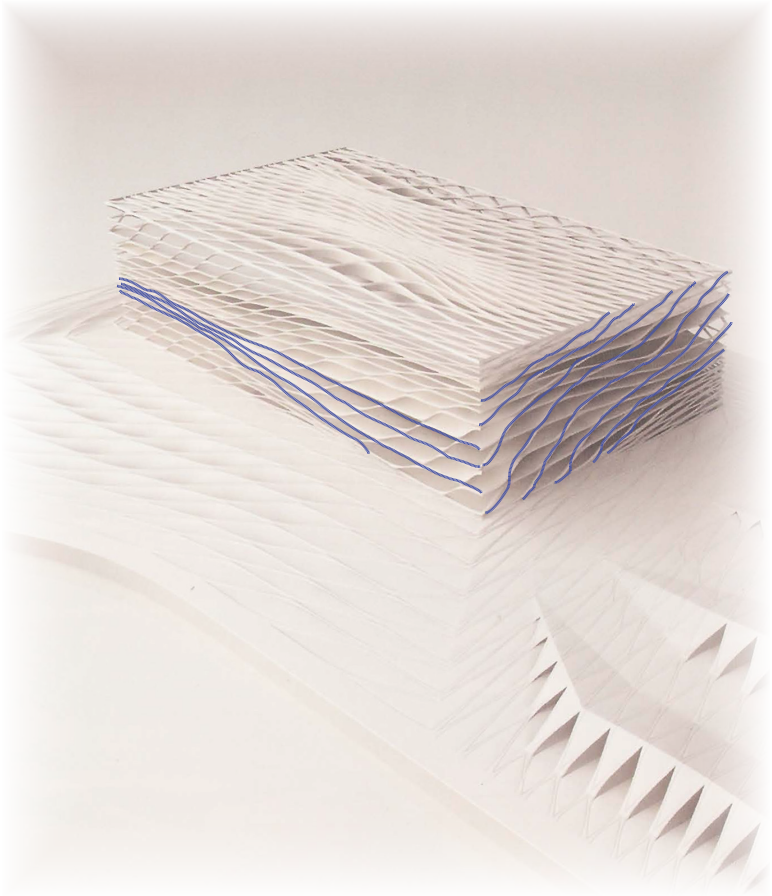
One can begin to understand how the implementation of the weighted IK chains and their pressure forces are used to generate the forms. With the view of the perspective model one can begin to realize how the less dense areas begin to represent the spaces, while the dense areas begin to realize a static space. It is further illustrated with the section, as the structural geometry is followed through the building. The section also begins to show the influx of much daylight flowing into and throughout the building.

The third floor plan gives a thorough understanding of the spatial layout and how the influence of structure begins to realize the final layout of space. The smaller areas, or nooks, shown around the periphery of the library, illustrate a repetitive pattern which is repeated across the building as well. This begins to reinforce a sense of spatial balance through the building.

The way the large flowing space leads to a small transition space dedicated to the stairs also helps to reinforce the sense of low and high pressure within the building. The over arching largeness of the space in the center of the floor lends connectedness to all other spaces throughout the third level. This reinforces the sense of structure of the building which seems to be a continuous mode of structure.

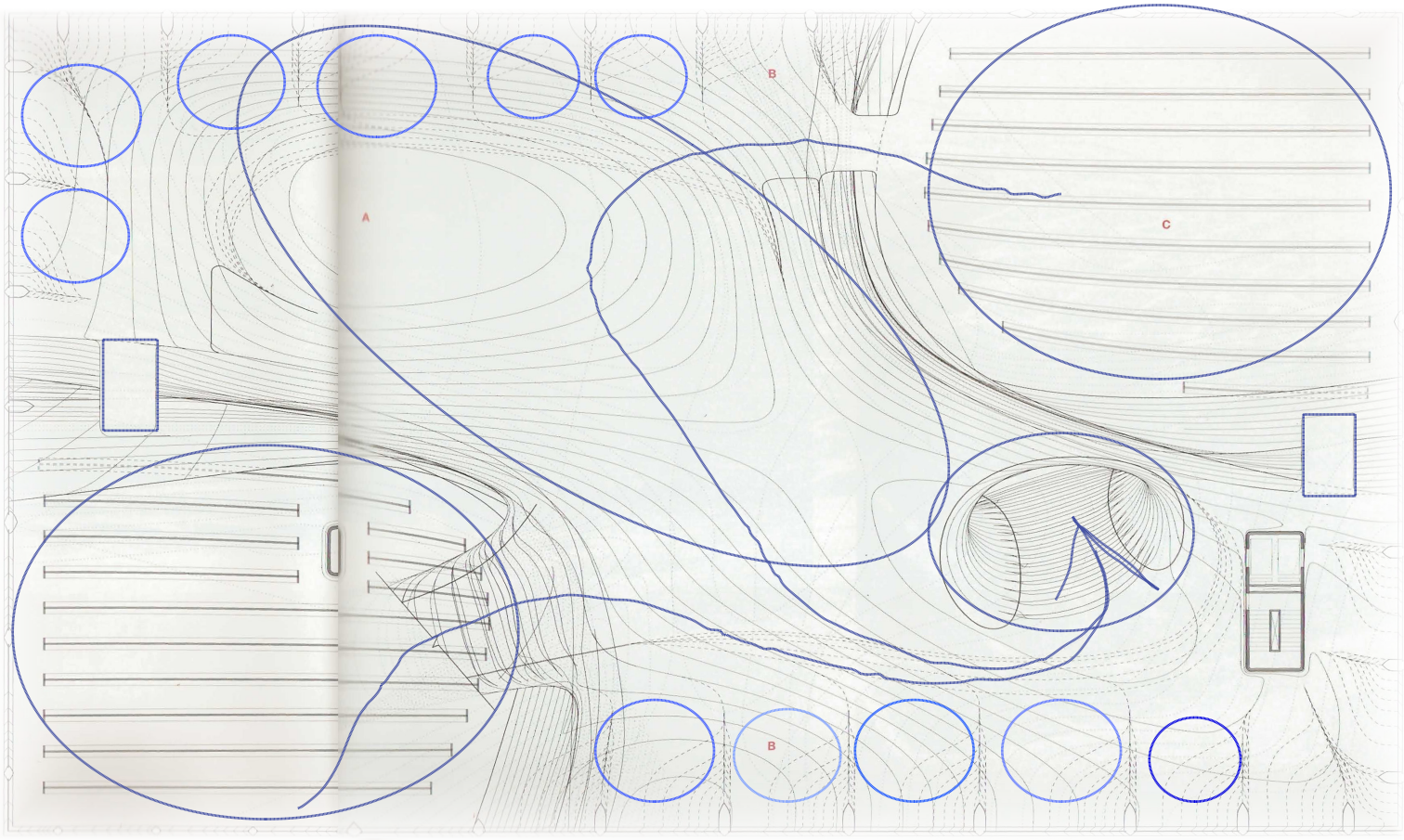


site plan

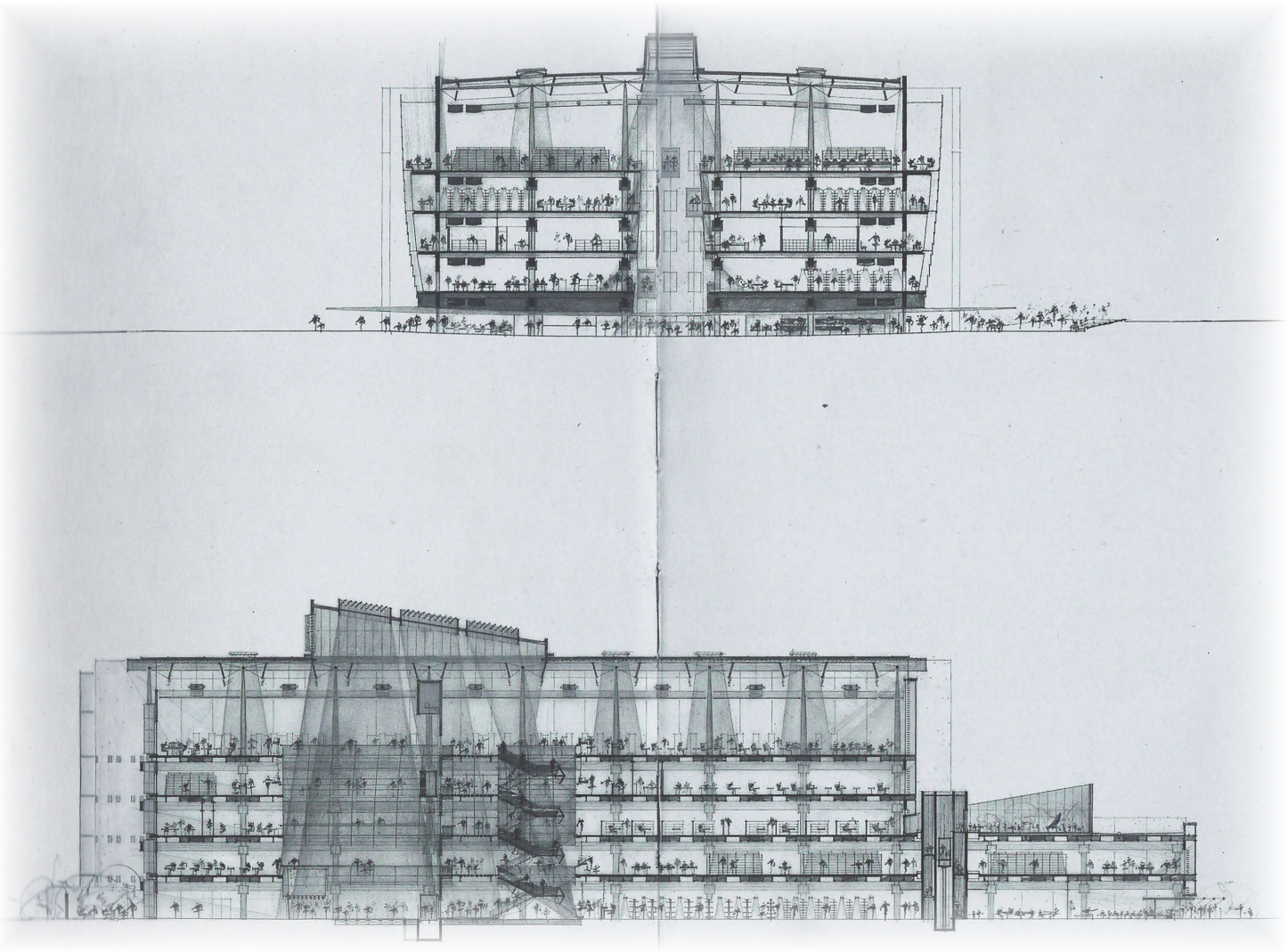


model perspective

section



3rd level plan



Phoenix Central Library
bruderDWLarchitects
Phoenix, Arizona
280000 Sq. Ft.
1989

This building built for the city of Phoenix is the result of a designer, a client, and environmental influences dictating the form and function of the design of the building. It is described as a building of monolithic stature, signifying a call for iconography on the surrounding landforms of buttes and mesas to integrate into the city. It has a scale which refuses to approach and comfort the human proportion; rather it ignores the size of humans and sits squarely amid a city of repetitive buildings, an echo of the surrounding landforms of the desert.

The library was commissioned by the city to be a warehouse for books, as the city of Phoenix circulated the most books for the least cost of any city in the United States. This requirement was the sole driver to begin the structural layout of the building. The size of the books on the shelves, and the repetition of shelving layout began to describe spacing for structural columns. This column grid was followed all the way through the building up to the fourth floor. On the fourth floor the columns stop short of the skylights which seem to designate the order of the columns. Here a tension structural system seems to make the roof float, and the perimeter skylights along the walls enhance the floating sensation.

On the east and west side of the building, "saddle bags" were placed to house the required mechanical and ancillary tools to support the building. This echoes the history of the early cowboy on a horse with his tools for survival stashed inside his saddle bags. The "saddle bags" of the building also create a tone for the building which directs and reflects the surrounding landforms. Inside the library a canyon of crystal brings light to the depths of the library. These descriptions of the buildings tend to reflect the process the architect used to design the building. A close relationship with nature, the history of the area, and functional requirements have resulted in an internationally recognized building, which has lauded Will Bruder, the architect, with many awards of recognition.

All case study 2 information, images from Ojeda O R. & Tehrani N. (1999)

What interests me is the way the building was documented for construction, and how the architect was able to work with building industry people, to convince them to work in ways other than the situational norm. This notion of trying to drive innovation in the related crafting businesses shows an architect who strives to see a design, and its intent, through to the completion of architectural components which fit within the restraints of the design. While the design was typical in the sense of being able to document the spaces through typical means, the process of finding components and materials which fit the design were different than a typical project.

Structural columns, for example, were custom designed, but they stopped short of the roof, and the roof was suspended through tensional components. The screening of the "saddle bags" was created out of a thin mesh copper, yet the process to create it was intensive. It was purchased in Germany, perforated in Chicago, roll-formed in Nebraska with equipment for grain storage elevators, press-formed in Cleveland using truck trailer paneling technology, and finished in Arizona.

Yet these components of the building would not have been found or created without the drive of the design team insisting to the building industry what the formal outcome should be. This shows a reintegration of the architect back into the building industry, creating an innovative product which follows the intent of the design.

Conclusion

Will Bruder designed a library for a city that reflects both the usage of the library as well as the history, landforms and environmental influences of the climate. While the design may not have required the use of more advanced computing techniques, the question remains, what would the outcome have been with the usage of 3D modeling, and performance testing? While the design does stand for itself, how could it have been improved with the use of performance testing with the existing design? These are questions I ask because the possibilities for using advanced tools are such that their value is under appreciated.

Analysis

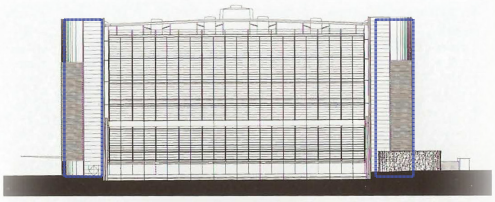
The spatial composition of the library is reflective of the structural ordering of the building, and as a result of the circulation spaces and how they were designed. The stairway is a space which pierces through each level of the building and balances the top public space on it as a "support column." The building support spaces are on each side, west and east, of the building, supporting it much the way a post might support a floor beam. This spatial composition leads to the understanding that on each floor the support spaces are followed up through each level. The stairway is also the space through which light flows deep into the building. This area is known as the crystal canyon because the glass which lines the sides reflects light down to the ground level.

The structure of the building is a very defined grid. It begins to define each space at a personal level, in the sense of how support furniture is placed for ease of movement and function around the support columns. The grid begins to permeate through the building on elevations which are shown on both the south and north elevation drawings.

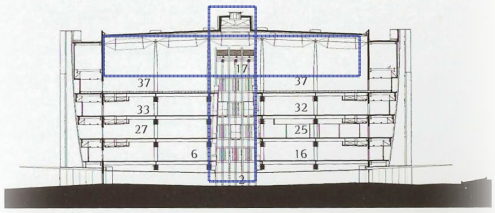
The overall form of the building is a set of cubes in elevation view, but as soon as the plans are shown, the curvatures on the east and west sides are shown. This is also reflected through the ground level entry space. The flow into the space seems to reflect the shape of the curvature of the exterior "saddle bags".

The circulation is similar for each level, to be able to move between levels. But the ground level shows a particularly different characteristic of spatial composition for movement than the other floors. The only other floor that has the same curvature of movement as the entry is the third level. One possibility for the curvature movement on only two floors could be a reflection of the curvature on only two sides of the the building in plan. This begins to reflect and underscore the importance of the underlying themes of the building.

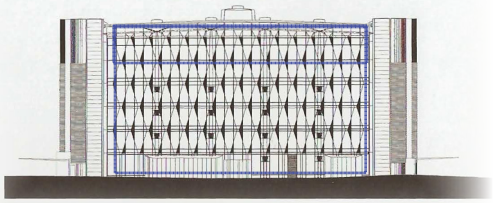
The site shows a rectilinear grid reflecting the composition within the building. It also delineates the spatial integration from roads into the site, and pedestrian movement through the site on the same pathway which enters the building on the ground level.



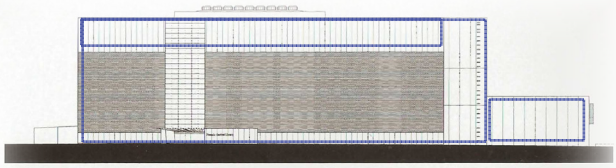
South elevation



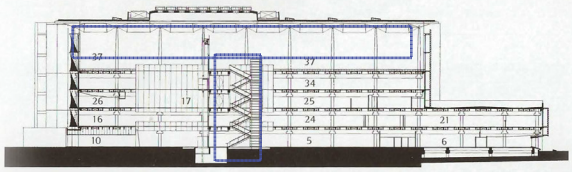
East-west section



North elevation

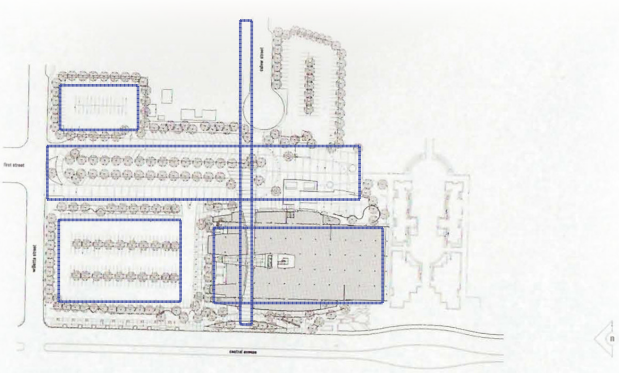


West elevation

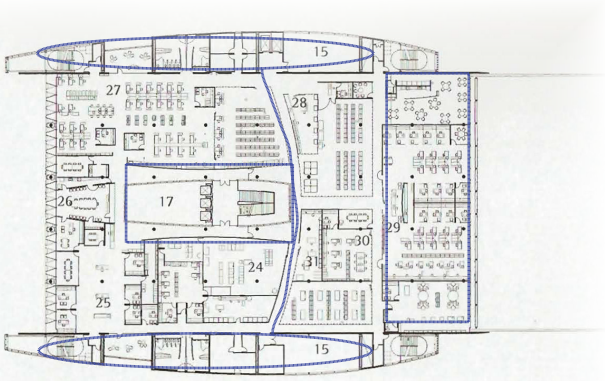


North-south section

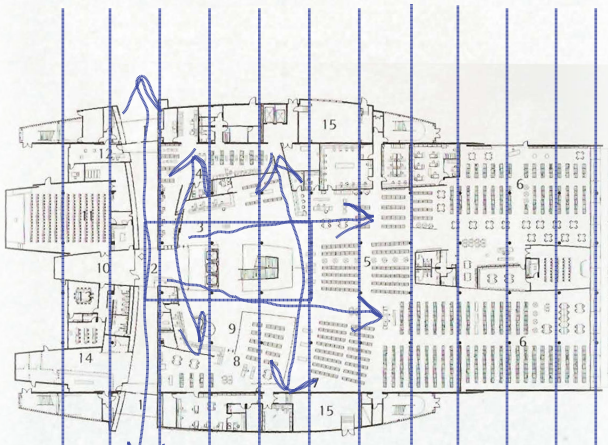
East elevation



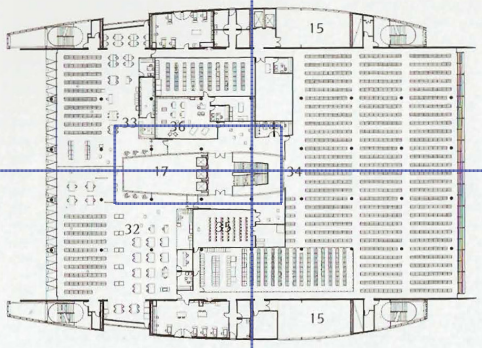
Site plan



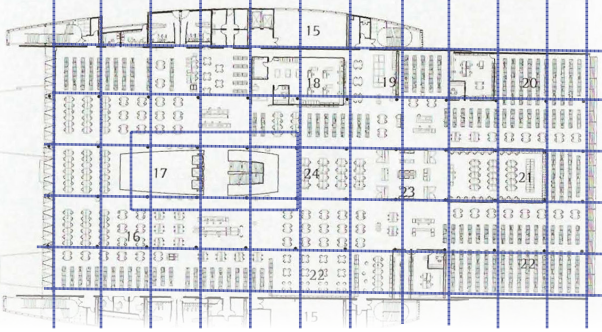
Third floor plan

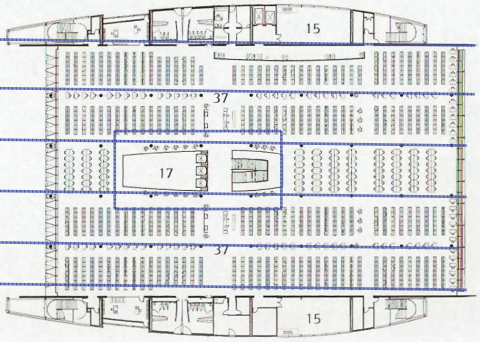


First floor plan



Fourth floor plan





Fifth floor plan

Experimental Performance Space
Tristan d'Estree Sterk
Chicago
2001

This project is a non-built and experimental project which begins to speculatively question the future of design in architecture. The structure is imagined as a responsive performance space, meaning that the built platform will respond to environmental influences and will essentially conduct a performance for those who inhabit the space at a particular moment. It is situated in the harbor of Chicago, stationary above the water at the termination point of an unrealized civic axis monument designed by Burnham.

The space is accessed by a small boat, where upon arrival a series of steps leads up to the platform and the platform space. The platform is enclosed by a skin which responds to your arrival in a way which is unanticipated. The skin is powered by a series of actuators which receive direction from sensors. The sensors "read" the environment around it, including the presence of people, and reacts by causing the skin to respond and "dance" in a responsive manner.

This type of architecture is the result of innovation being reduced from an urban scale, to the scale of small components and sensors, explains Tristan d'Estree Sterk. This shift in innovation is beginning to direct and implement a new vocabulary for designers.

Sterk goes on to comment about the components which are already embedded within buildings, and have been for some time, most notably thermostats and elevators. These components are really a function of need-based design, and while they have changed and shaped architecture, their influence today has become a static influence on design.

Sterk explains the rationale in beginning to develop a project that actively responds to social and environmental conditions, by referring to buildings in the 1980s which had technology embedded within them that responded to wind and earthquake loads subjected to the structure.

All Case Study 3 infromation from Liu Y (2004)

These structural advances have been designed for large buildings, namely skyscrapers, to actively respond to these loads subjected on them by either redistributing the loads or counteracting forces by causing the building or structure to vibrate at a frequency which cancels the forces out.

Conclusion

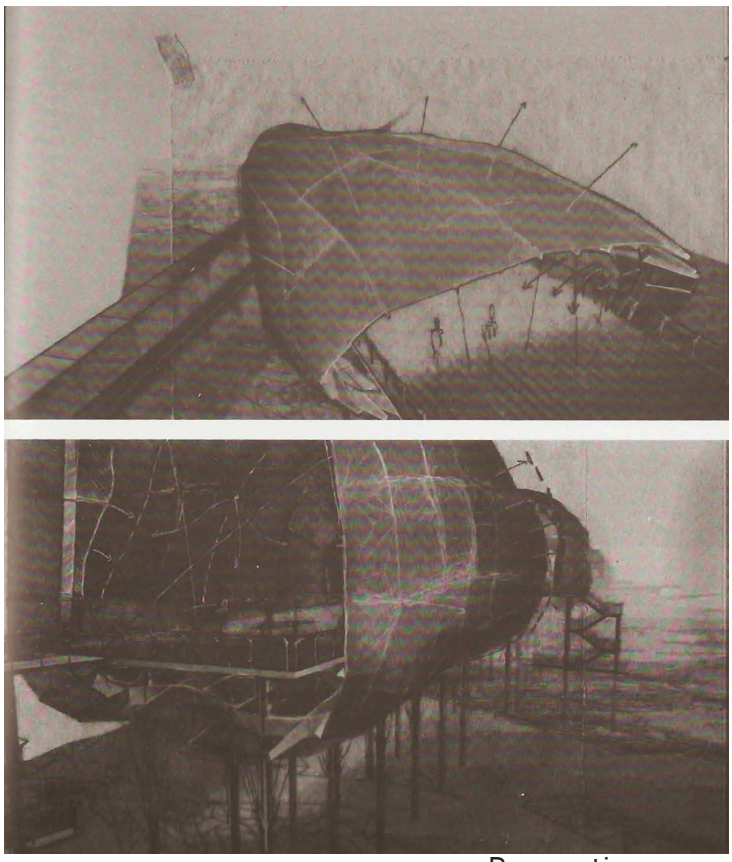
This conceptual project begins to highlight directions in which architecture has yet to fully explore. The ability to integrate components and sensors into a building, to become a fluid integration of the design, shows significant promise in a type of building that begins to process information from its environment. This ability to process environmental information could create a building which theoretically would be as Sterk describes his performance space for Chicago.

What is interesting about this project is that the time for developing such a project is now. The cost of developing such a building, even on a small scale, prior to today would have been enormous.

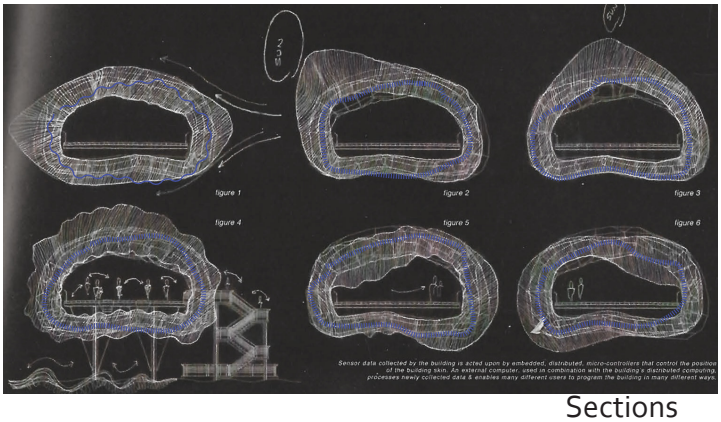
Although the building would require an immense amount of design and manufacture of a series of architectural components to support the construction of such a design, the resulting benefits would be amazing. We have already been exposed to projects which alter and respond to some degree to the environment.

We can see how developing and changing technology has driven architects toward a type of design which begins to push understandings of what designed space is considered to be.

The Milwaukee Art Museum by Santiago Calatrava is one such building which has an operable feature designed for the building. Other such projects include the proposed shifting tower by David Fisher, and towers with rotating spaces at the top, such as the CN tower of Toronto and the Space Needle of Seattle.



Perspectives



Sections

Analysis

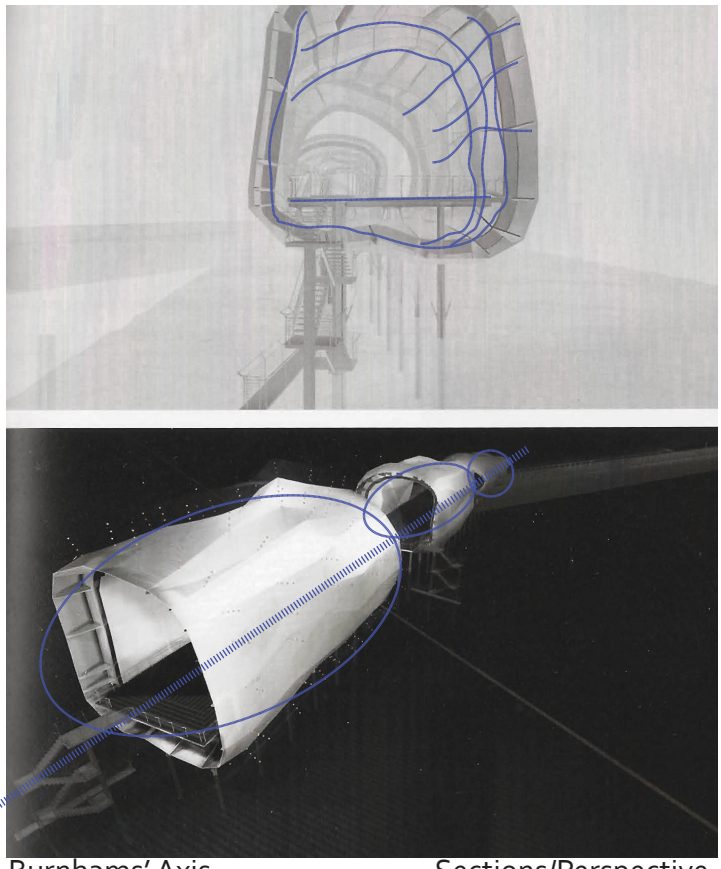
This project became somewhat difficult to analyze due to its different nature of responsive boundary planes. Although the overall form is responsive, it still has limitations in how much it responds. The overall form seems to be oval in shape, depending on the time and how much sensory input it is receiving as is evident in the sections.

The structural composition is evident with the lower section shown. The ordering of the structure seems to reflect an overall composition of repetition. The repetition is shown in both the structure, the repeated pavilions, and the course of repeated changes in the pavilion's alterable boundary.

The linear fashion of the composition is a reflection of the Burnham plan, and shows a linear composition which is followed through to the linear structural components which become reflective of the orderly fashion of the project.

Light is predominantly available throughout this project, as there is no closed space in the project. The operable surface is also understood to have a translucent material, which would be very interesting viewing how the light changes in its effective play into the space as the surface responds to the environment around.

What is also interesting is the way the project is situated in the harbor. This tends to reflect the unknown nature of both what is under the surface of the water, as well as how the pavilion will react during the course of a day, week, and month.



Burnhams' Axis

Sections/Perspective

historical context

Historical Context Of Libraries

A library is by definition a place in which literary, musical, artistic or reference materials are kept for use but not for sale(Merriam-Webster, 2010).

The exact beginnings of libraries are difficult to place, and while many remains of libraries have been found due to excavation, their exact time and the full extent of the libraries can-not be truly agreed upon. For example Egyptians were known to have kept extensive writings, but it was on a type of material which broke down easily and also burned(Casson, 2001).

The earliest dated recovered tablets, which were records kept by a palace they were found in indicating the possibility of a library, dated to 2000 B.C.(Casson, 2001). This points toward the possibility of libraries in existence before the first documented library, The Library of Alexandria.

The "mass-production" of papyrus paper by Egyptians began as early as 1000 B.C. Through years of replicating the process of creating the paper it became a widely sought-after parchment. The Egyptians' ability to sell the parchment was limited only by how fast they could ship the created paper.

The continued shipments of the parchment allowed the continual copying and authoring of various pieces of original literature. Eventually, over centuries of time, enough manual copying and authorship of manuscripts led to a vibrant trade in "book" selling. This created a problem revolving around accuracy, in terms of how accurately the documents were copied. Copying manuscripts was easily done, all one needed to do was purchase or borrow a manuscript and copy only what one felt one needed. This led to problems of, as we know it today, copyright, as well as accuracy and correctness of the literature.

Around 300 B.C. there were two events which took place that began to influence the creation of a "repository of trust-worthy copies," or a library. The first was the creation by Aristotle, over a period of time, of a personal library that was larger than any royal library, so much so that he even taught kings how to arrange their collections. The second event was a decree by the Athenian government for a place to house trustworthy copies of literature(Casson, 2001).

This was a result of issues revolving around incorrect copies, incomplete copies and mixing of manuscripts. This became such a problem that it led to the decree from the Athenian government for a trustworthy copy housing center. This center became known as The Library of Alexandria. It was available to the public and housed various types of literature and books, unlike Aristotle's personal library which was geared toward his work.

Throughout time, as we know, libraries became more prevalent and available throughout the world. The role of libraries had not changed much through time until around 1990, a time in which computers were introduced into them.

Computers and information available on the internet have forced libraries to change and adapt to this new way of accessing information. It is also this phenomenon of widely available information that brings us back to a near completed circle in time.

In a book titled *Googlization of Libraries*, Mark Herring writes about the problem of research articles and the links they are cited by. It was found that after 24 months, 28% of links, which were citations in articles in the *Journal for American Medicine Association*, had disappeared(Miller & Pellen, 2009).

This begins to identify an issue which is similar to the issue the Athenian government dealt with, untrustworthy information available on the internet today. How can we know a site is certifiable, how do we know the information is certifiable and how should libraries begin to maximize the potential that the internet offers?

This also raises questions surrounding sites which are constantly maintained by people who author them. Such a site is Wikipedia, the well-known free encyclopedia site. It is a site that has been set up by a group of people in an effort to create a central place of information that is free as well as trustworthy. Institutions of higher education have many times criticized this site, due to its lack of peer reviewed status, as a non trustworthy location of information. While peer reviewed information is important, does a degree automatically qualify one as an expert?

These questions are eerily similar to the ones the Athenian government faced just prior to the time of the establishment of The Library of Alexandria. Information was being widely circulated, while being copied incorrectly and incompletely with no way of knowing what a trustworthy piece of literature was.

The issues of trustworthy information for libraries is a viable issue which libraries face today. Although it may not be understood as a particularly architectural issue, it is an issue that I would like to address during the project in an attempt to try to find some resolution.

Historical Physical Context

This project's physical context begins at the establishment of the city of Duluth, Minnesota. The earliest known inhabitants of the area were members of the Sioux and Chippewa nations. These were two nations of people who fought constantly.

Around 1650, a French explorer came to the area and realized an abundance of beaver. The news of the plentiful beaver brought a second Frenchman by the name of Daniel Greysolon Sieur du Lhut to the area in 1679 to attempt to establish a fur trading settlement, to make peace, and a trade agreement for furs with both the Sioux and Chippewa nations.

Although he was unable to establish a trading post, it is for du Lhut that the city of Duluth is named. The establishment of a permanent trading post was successful in 1817 by John Jacob Astor. In 1852, five years after the abandonment of the fur trading post, the first permanent settler arrived on the shore of Lake Superior in the Duluth area.

A few short years later copper seekers flocked to the area in search of copper deposits. By 1856 the city had officially been named Duluth and became the county seat of St. Louis County.

A series of events, including the panic of 1857 and scarlet fever in 1859 , stifled the early growth of Duluth, and by the end of the Civil War only two houses remained occupied in town. But soon after, quartz deposits holding gold were found in nearby Lake Vermillion and iron ore was also found in the area by geologists.

As these developments spurred growth within Duluth, at approximately the same time a businessman named Jay Cooke determined that the Mississippi & Superior train line would terminate in Duluth, and soon after woodsmen from Maine relocated to Duluth to set up a logging industry.

By 1869 Duluth had a permanent population of 3,500 inhabitants. By 1887, in a mere 18 years, the city had grown to 26,000 residents, and received permanent reclassification as a city.

The early growth of the city was due to two key factors; one was Lake Superior, the other, man made, was the railroad. The enormity of Lake Superior allowed large ships to sail across the lake eastward toward manufacturing plants, while the railroad opened the area to mining initially by bringing in supplies and people and bringing resources back out.

By the end of the nineteenth century the city of Duluth was home to more millionaires per capita than any other city in the world, a testament to the unique position Duluth was in early in its history. Yet as the demand for taconite, the ore from the iron range in northern Minnesota declined, so did the population of Duluth. After peaking at just under 110,000 people in the 1970, the population has declined to about 87,000 people today.

This decline in population has put the city of Duluth in a sense of imbalance, as direction of growth is uncertain with demand for the main generator of employment, taconite, declining yearly(MN DOT 2010).

Although Duluth is heavily dependent on shipping, being the number six ranked port in terms of tonnage in the United States, the local economy has begun to diversify in response to the population decline. (MN DOT 2010)

Two hospitals support the region and employ more than 8,000 people, and the focus on tourism has begun to bring money and jobs into the local area as well. The local University of Minnesota-Duluth is also present as an institution of higher learning in the city.

In March of 2010, Google announced plans to select a test city ranging from 50,000 to 500,000 people as an experimental site for its ultra fast high speed internet. Duluth was one of the many cities which has vied to become the test site(Google 2010). Although Google will not announce the winning city until the end of 2010, it is a goal for Duluth that would spur growth in the city again(Duluth history information from United States History 2010).

Architectural Tools/Documentation Context

Architectural drawings are understood as a form of information. This information is used as a "template" or a set of visual instructions on how a building should be constructed. Today the documentation of buildings is complex, lengthy and time consuming, but this was not always the case.

The period of time known as the Middle Ages has an abundance of buildings left for us to study, examine and marvel at their advanced methods, for that time, of construction. What is interesting is the amount of documentation from that period of time. The Middle Ages is understood as the time from the 5th century through to the 15th century. This time frame came after the fall of the Roman Empire and before the modern age.

Libraries had been in existence since the first known Library of Alexandria, established around 300 B.C.(Casson 2001). This allows us to establish that writing and documentation had been present for a number of centuries already. Yet, for the number of buildings constructed, and their complex methods and materials, the amount of documentation available is limited.

Some speculate that the medium on which the drawings were scribed was fragile, others say masons saw no reason to preserve drawings after their buildings were completed. Still others claim that the cathedrals of the time were proscribed by geometrical calculations, for which drawings were unnecessary(Powell & Leatherbarrow, 1982).

An architect by the name of Villard d'Honnecourt compiled a notebook of sketches, notes, and explanations of various building plans, components, and designs, during his lifetime of work and travel. This book is now one of the ways in which the understanding of the dissemination of architectural design took place during the Middle Ages(Powell & Leatherbarrow, 1982).

This leads to an interesting contradiction relating to architectural documentation. There are architectural notebooks which prove the existence of architects describing thoughts and design elements, yet few documents survive from the early period of the Middle Ages. Leon Battista Albertti commented on the separation of architecture from the building industry, during the Renaissance, leading to the production of more extensive documentation of designs in an effort to make up for the lack of oral information given on construction sites(Kolarevic, 2003).

This begins to suggest that architects were much more involved with the construction of buildings early on, and it was not until the Renaissance period that the separation occurred, although it may have been taking place for some time prior to the written observation by Albertti.

Although the documentation of architectural projects did happen in some way during the Middle Ages the exploration of new ways to describe designs came through the influence of painting. The late medieval or early Renaissance painters Cimabue, Duccio,Giotto and Masaccio provided a nudge of influence with their introduction of depth and foreshortening into architectural scenes(Powell & Leatherbarrow, 1982). This perhaps became instrumental in convincing architects to pursue "the essence of architecture", writes Albertti. (Kolarevic, 2003, 33)

As the early Gothic designs were based on mathematical calculations, the introduction of perspectives and depth into paintings and architectural drawings began to reduce the amount of time architects spent on the site of construction. Was this by choice, or simply because the time to produce the perspectives was so long it restricted their visits to oversee the construction?

One can say that this became a new tool for architects, to present and explain their ideas, the tool of depth and perspective on a 2D surface.

Today architects spend little time on the creation of captivating renderings and illustrative pictures of design projects. The majority of time is spent documenting the building in 2D for a contractor to construct it.

The new tools for architects today begin to suggest a revolution in how architects produce information, a similar revolution to the medieval and Renaissance transition period of architectural drawings.

The ability to draw things in a complete documentation of 3D modeling underscores the problems with architectural documentation today. With the ability to produce information which is more effective, more understandable, and more time efficient for builders constructing the design, why is the 2D method of documentation still being used?

project goals

Goals

The goals for this thesis project are broken down into three parts; the academic, the professional, and the personal. Each part of these three is considered as equally important as the others. These goals are considered a drive for the completion of the thesis and a guide in reinvigorating the process during times of halting progress.

Academic

The academic goals for this thesis project revolve around the body of knowledge for architecture. It is the hope that this project could contribute to the body of knowledge for architectural students of every age and every location. It is the desire to expand and contribute to the field which I have studied extensively for the past four years, as one of the many factors contributing toward the completion of this thesis project.

Professional

The ability to produce a project that is viewed as a professionally produced, documented, and constructed project is important for any professional. At this point in my life this project is the final product and the result of various influences aiming toward the introduction into a professional career. The goal is to end with a result to be viewed as a compilation of a professionally produced product in all facets of the project, including holistic design, project documentation, and graphical representation. The hope is this project has the ability to stand cooperatively next to other professional projects as a peer.

Personal

My personal goals have changed little in the progression of my academic career. The goal to learn, every day, no matter what is learned, is considered to me a virtue beside that of patience. It is through this learning process that we constantly receive new ideas, reformulate opinions, and reanalyze how things are done. Through new daily information our frames of reference become more biased and perplexing less flexible, yet this is considered the basis of education, and through this process my hope is to find a result for this project that resembles the myriad of information we receive with today's culture.

It is also my goal to be able to properly present this information so that my project can be understood, that others will easily grasp the connections and importance of the project.

To effectively complete the goals above a basic framework of tools I use to complete my work needs to be expanded. It is my hope that my palette of architectural tools becomes expanded to be able to fully accomplish the problems which will confront me through this project. This new set of tools I also hope to use through out my lifetime as an architect to aid in my production of professional work.

Last but not least, it is my hope to produce a sense of satisfaction at the completion this project. With the knowledge that I have fulfilled the goals for this project to my satisfaction, I feel that the final outcome will be one that lends a sense of completion, satisfaction, and a project conducive to further thoughts and research throughout my life.

site documentation

The busyness of Duluth is experienced with prominent cars and people moving around the streets; to the north the city rises up the steep hills and seems to watch the downtown area. The streets are grid-like, and seem to be reflected in the construction of brick and masonry buildings. Their grid of brick work amplifies the city's grid. The access from the streets to across the freeway became somewhat difficult to find and seemed to lack proper indication of where it started from. This created a bit of confusion as to where to access the link out of downtown.

Once the access was located, the rise to above the freeway leads to an elevated vista of Lake Superior and the lakefront area of Duluth. The location of this plaza is adjacent to the selected site, and also at the point where the shoreline of Lake Superior changes from running north and south to an east and northerly direction. The first view of the site was somewhat of a surprise, because the entire site had been surrounded by a fence and construction was in full force. Stairs and ramps from the plaza led down to the lakefront walkway and to the front of the site.

The northwest corner of the site falls away from the corner of the pavilion, dropping an estimated 40 feet. Construction has blocked off direct access from the elevated plaza to the site. The eastern side of the site is a broad vista of, on calm days, a flat plane of water, while windy days cause the lake to hurl waves upon the shore. To the south and east a waterfront hotel sits, blocking views from parts of the site down the shoreline to the south. The southern edge of the site rolls out into the parking lot with a direct link to the beginning of the tourist shops of Canal Park.

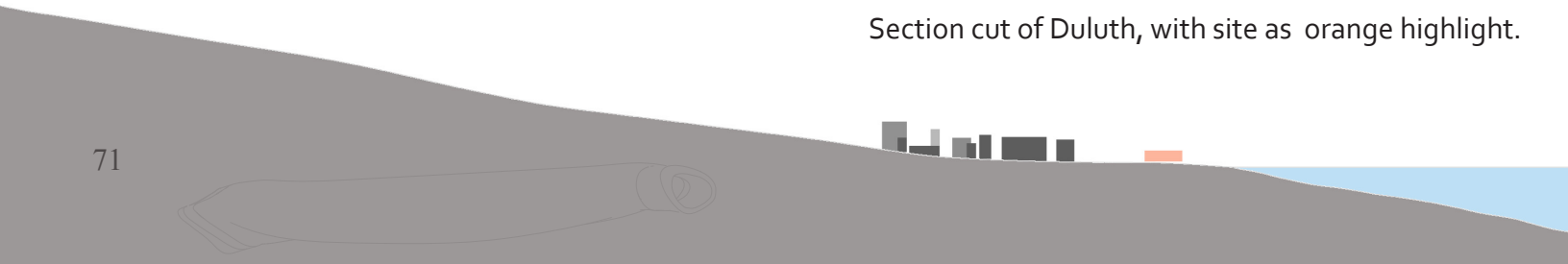
To the west the site tends to slide under an elevated bridge which brings traffic over the freeway and into downtown. On the far side of the elevated bridge is a generating plant and to the south a few commercial stores trying to draw patrons out of the Canal Park shops area. On the north side of the site a freeway sound wall runs along the perimeter, blocking noise pollution from the site while simultaneously creating a barrier to downtown. Yet beyond the barrier the city unfolds up the steep terrain which defines the city of Duluth and its ruggedness. The site has a very built up feeling, with the only connection to a natural feeling the proximity to the lake.

With the location of the site inside the city of Duluth, pinned to the edge of Lake Superior, one would presume that it would have a very distinct busy feel of city activity to it. The city activity has been dulled by the calming presence and aura of the waters of Lake Superior. This site is particularly important because this location is the only void in a nearly continuous theme of activity stretching from the north end of downtown to the south end of Canal Park.

The location is in a way a hinge, or pivot point for pedestrian traffic between downtown Duluth and Canal Park. It also has a defined connection with the lakefront, and as the lake shoreline shifts from running north to south to going east and northerly, pedestrian traffic is defined by and runs parallel to the shoreline of the lake. With a lakefront walkway between the site and the lake which travels each direction along the lakefront, the amount of pedestrian traffic in proximity to the site is increased. Other pedestrian traffic tends to emerge from the stairs in the northwest corner and runs toward the direction of Canal Park, while temporarily merging with the lakefront traffic. Other site proximity traffic appeared to be limited or non-existent.

The site seemed to speak in a very particular manner about transition; the transition from downtown to Canal Park, from the freeway to more localized pedestrian traffic, and from the great bluff down to the rough waters of Superior. This transitory feeling seemed to reinforce the underlying backbone of Duluth and its history of transporting, materials, goods, and possibly in the future, ultra fast information.

A more generalized mood of Duluth spoke, of heights, water, rock and trees. Duluth is the first and last bit of large city along the north shore of Superior until Thunder Bay, Ontario, Canada. To the north of Duluth are largely rural areas of trees and water, with the Boundary Waters Canoe Area not far away. This proximity to the north woods, the closeness of Lake Superior and the protruding hard rock of granite seen in numerous areas within the city limits of Duluth reinforce this notion of ruggedness.



Section cut of Duluth, with site as orange highlight.

Looking east.

Looking north from south of the site.

Looking west.

Looking south from north of the site.

Built Structures

As the site is located within a city, the area around the location is very densely built up. To the north is a railroad and the end of Interstate 35, and beyond the downtown area of Duluth. To the west is a power generating plant, as well as a bridge connecting downtown to Canal Park. Immediately to the south is a hotel, and beyond that is Canal Park. Lake Superior borders the site to the East. There are no structures built on the site at this time, as it is under construction

Light Quality

The quality of light is excellent on the site as it is set far enough away from the adjoining hotel to receive ample sunlight. The original slope of the site increased the intensity of light it received due to the slope on which it was built up. During early morning hours, and particularly during sunrise, the light is amplified and reflected by the lake, resulting in a more intense amount of light received during early morning hours through out the year.

Water

Lake Superior is the visible water and is present year round, although it does freeze during winter months. This is an active body of water, although it poses no dangers to the site, which accentuates the overall aura of the site conditions.

Plant Coverage

The site is under construction, so with a few exceptions of perimeter trees and a small patch of grass and trees in the northeast corner, plant cover is nonexistent on the site.

Human Intervention

The amount of human disturbance on the site is enormous; the site is under construction and therefore has few signs of a sustaining eco system. The surrounding city is extremely built up with the only sense that man has not constructed everything is the steep hill which rises up to the north of downtown, and of course Lake Superior.

Site Distress

The site had two sides of distress. The east side of the site, which overlooks Lake Superior, showed vibrancy with little distress, around the on going construction of the site. But on the west end the pall of a paved-over parking lot, and the site ending nearly under a traffic bridge resulted in a stigma of distress. There were no signs of growth of plants, and garbage was prevalent as well.

Soils/Slopes

The soil on the site is considered to be a type of loam soil for a depth of three inches, and from there on the soil is classified as stratified loamy coarse sand to silt loam. These classifications are also known as sandy type soils. Along the beach front there is gravel type soils present as well. The water table is at a depth of greater than 80 inches. There is not concern of flooding or ponding on the site. Slopes on the site range from 0 to 8 percent(UDSA, 2006).

Utilities

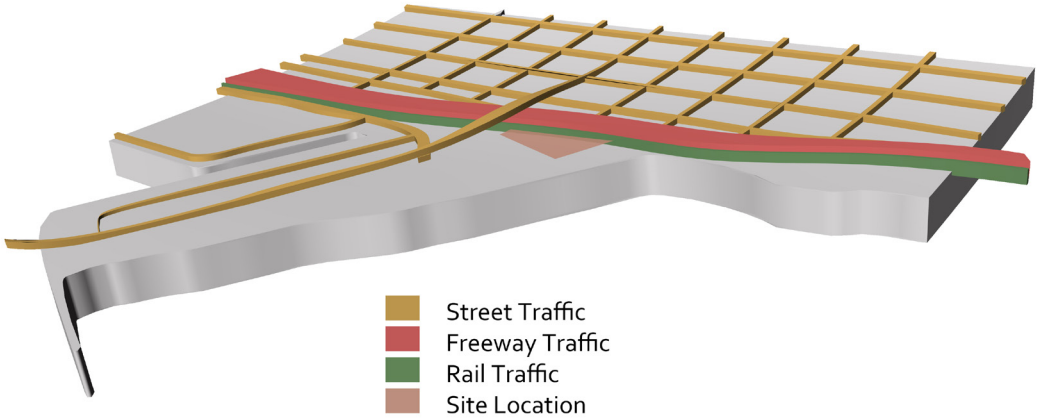
Utilities are present on the southeast corner of the site.

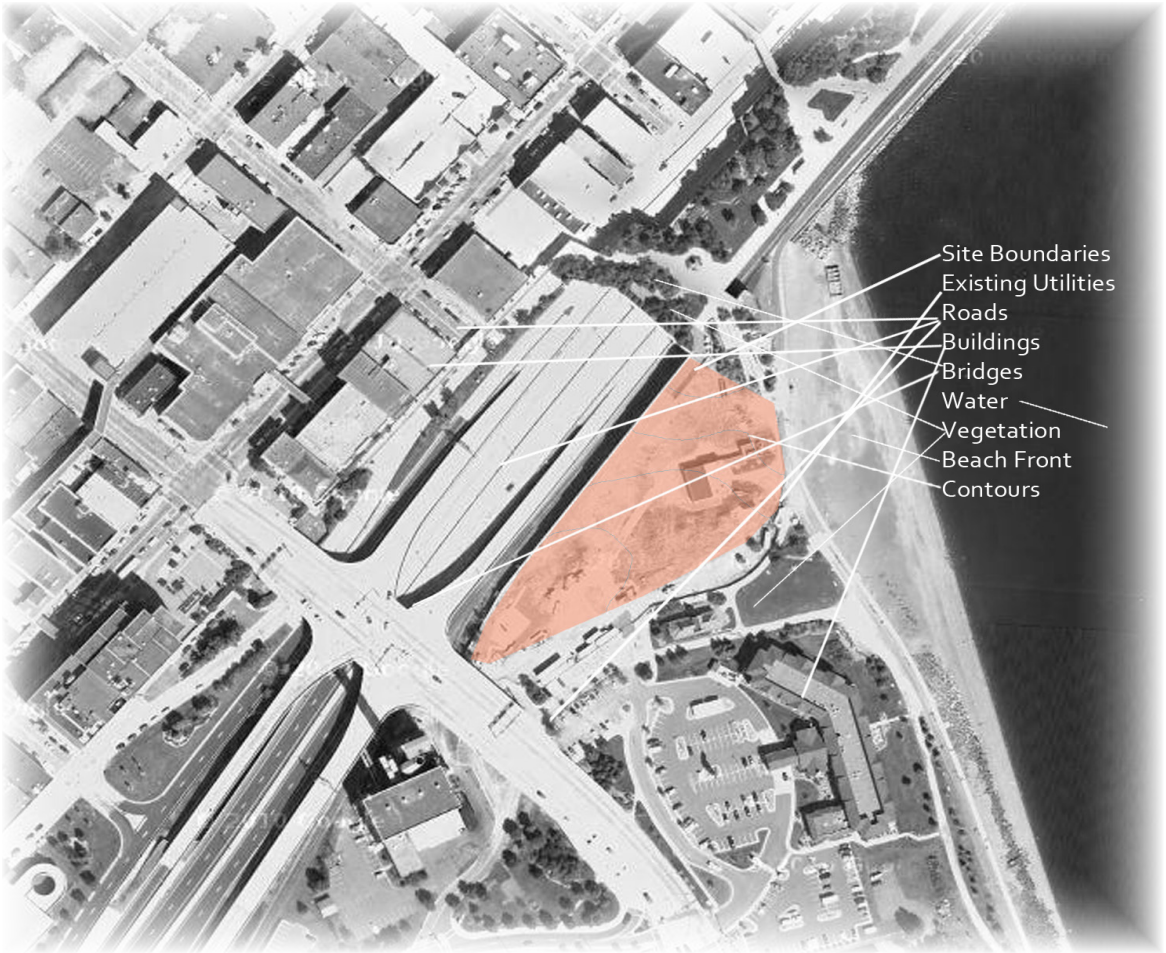
Visual Form

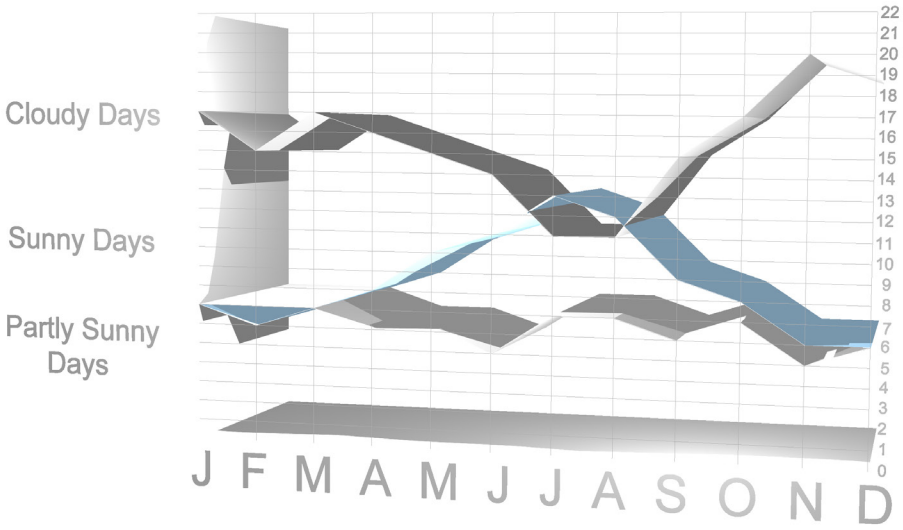
The site has two striking opposites viewable from it. To the north the granite hills rise to seemingly tower over the city, while to the east and south, the placid lake stretches flat to the horizon. These two juxtapositions help create a visual symphony from the site.

Site Character

The site seemed, from what could be observed around the construction, to have two types of character. One which is very active and busy along the lakefront, while the west and rear side of the site seems to be neglected and overlooked. This is due to the problem of generating interest. There are no interests on the west side to draw people to that area, resulting in a "dead" spot.


Street Traffic
Freeway Traffic
Rail Traffic
Site Location


Site Boundaries
Existing Utilities
Roads
Buildings
Bridges
Water
Vegetation
Beach Front
Contours


Cloudy Days
Sunny Days
Partly Sunny Days
J F M A M J J A S O N D
22
21
20
19
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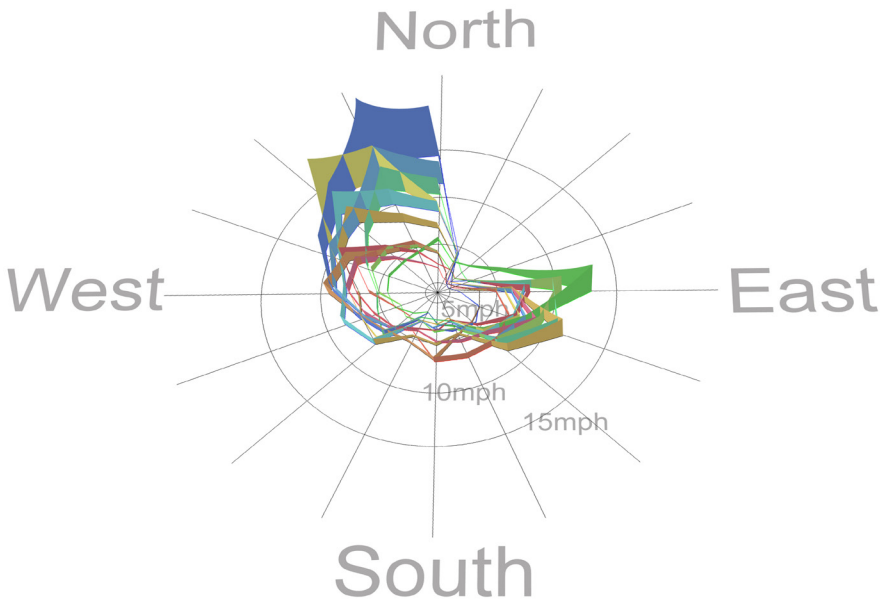
North
West
East
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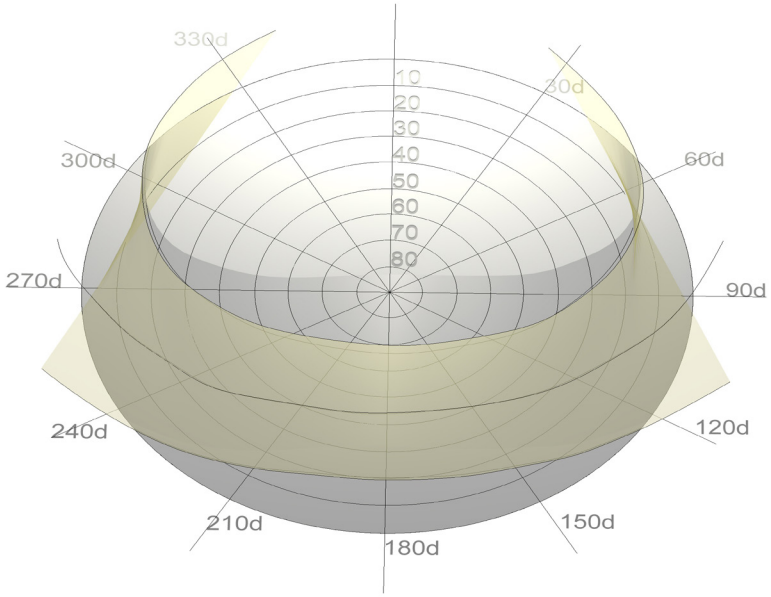
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30d
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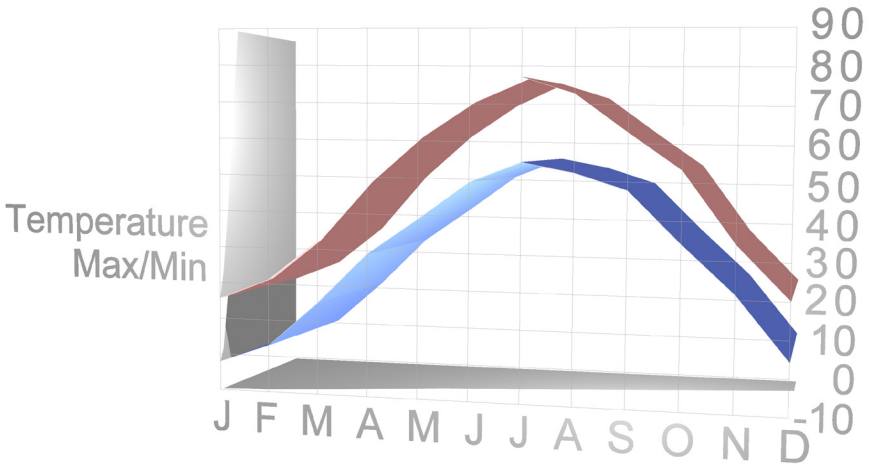
Temperature
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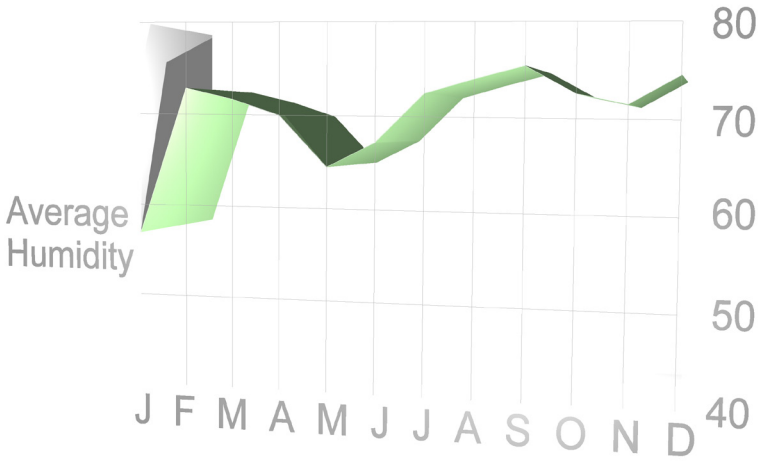
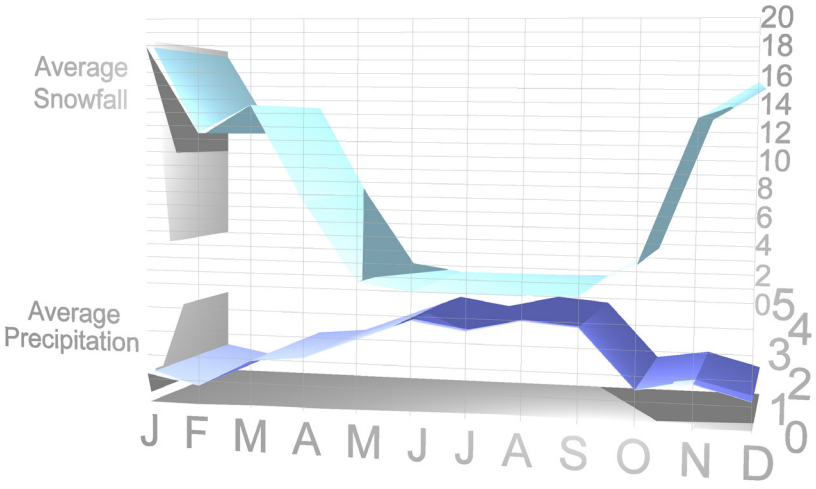
J F M A M J J A S O N D


Average
Humidity
80
70
60
50
40
J F M A M J J A S O N D


Average
Snowfall
Average
Precipitation
20
18
16
14
12
10
8
6
4
2
0
5
4
3
2
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J F M A M J J A S O N D

programmatic requirements

Library Physical Documents
15,000 square feet

This space will hold the physical books and other published physical content. The space will have various areas for reading and studying intermingled within it.

Library Virtual Information
15,000 square feet

This space will allow for both wireless internet access and public computer access. The space will also have a connection with the Physical Documents Space and also a connection with more study spaces.

Conference Rooms
800 square feet x3

Three rooms will be available for public, business, or other means to rent or reserve.

Directors Office
300 square feet -1
150 square feet -2

This will be for the director of the library and the director's assistants.

Auditorium
10,000 square feet

This space will be used for a variety of reasons ranging from performances to public meetings.

Rest rooms
200 square feet x 6

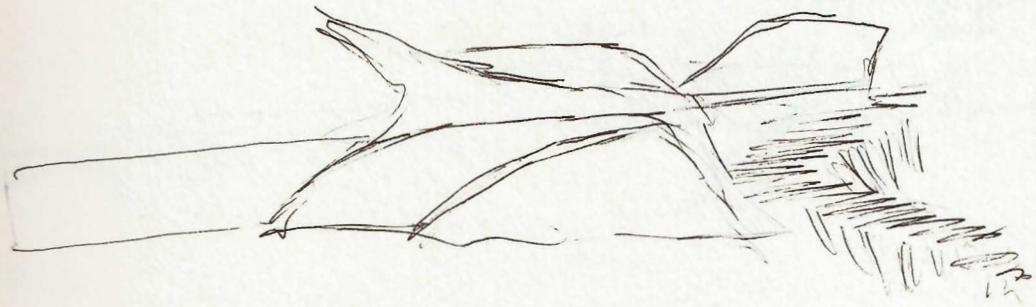
Circulation
1500 square feet

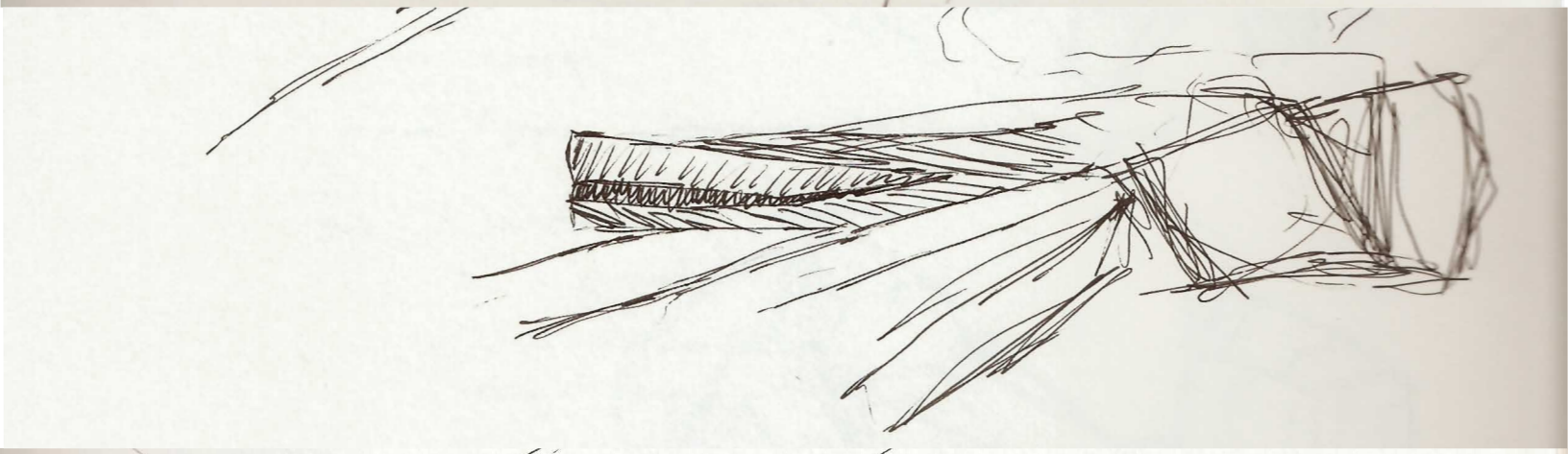
Maintenance
5000 square feet

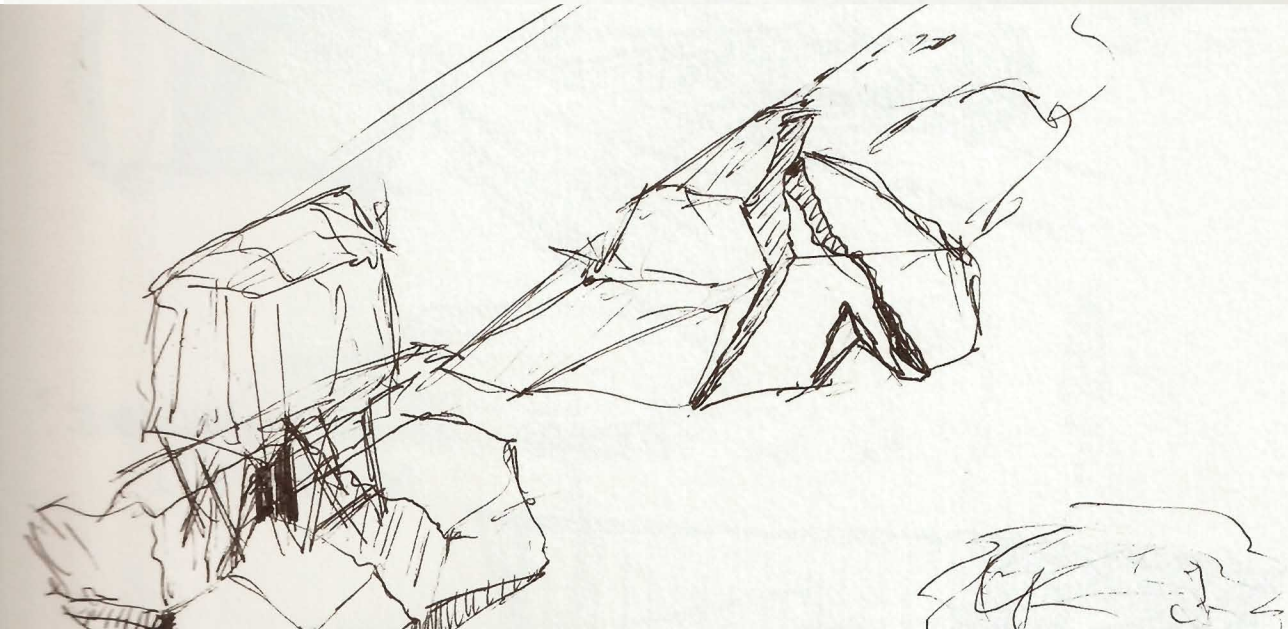
Outdoor space
Undefined

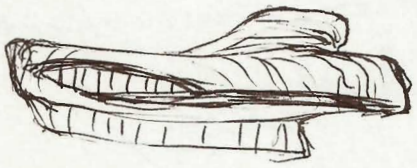
Totals 50,700 square feet

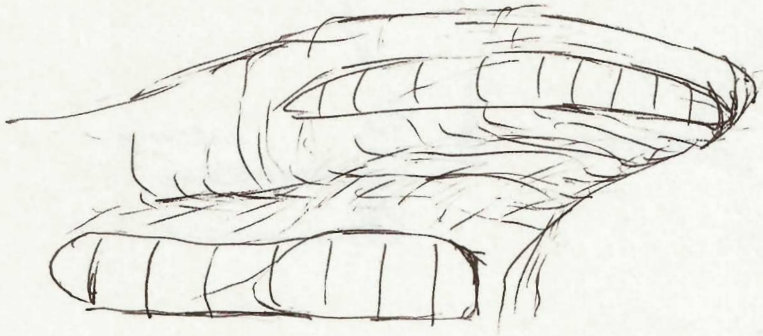
design process

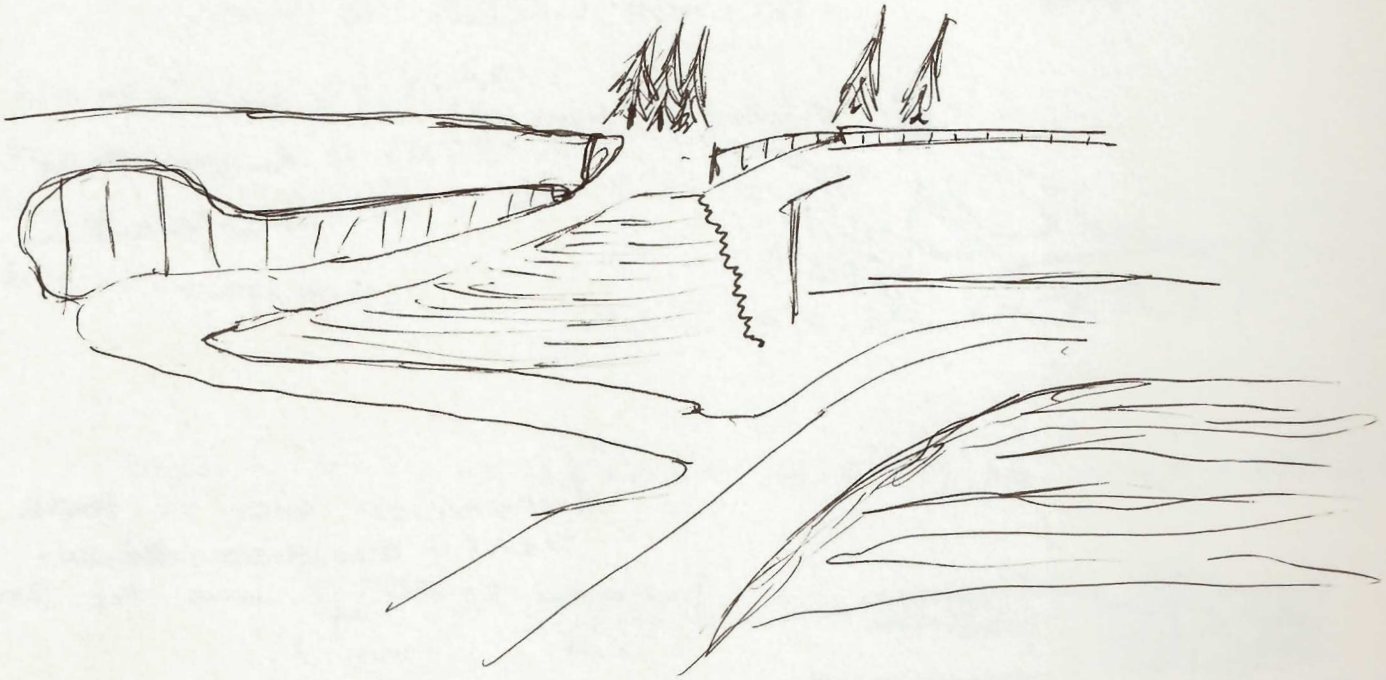


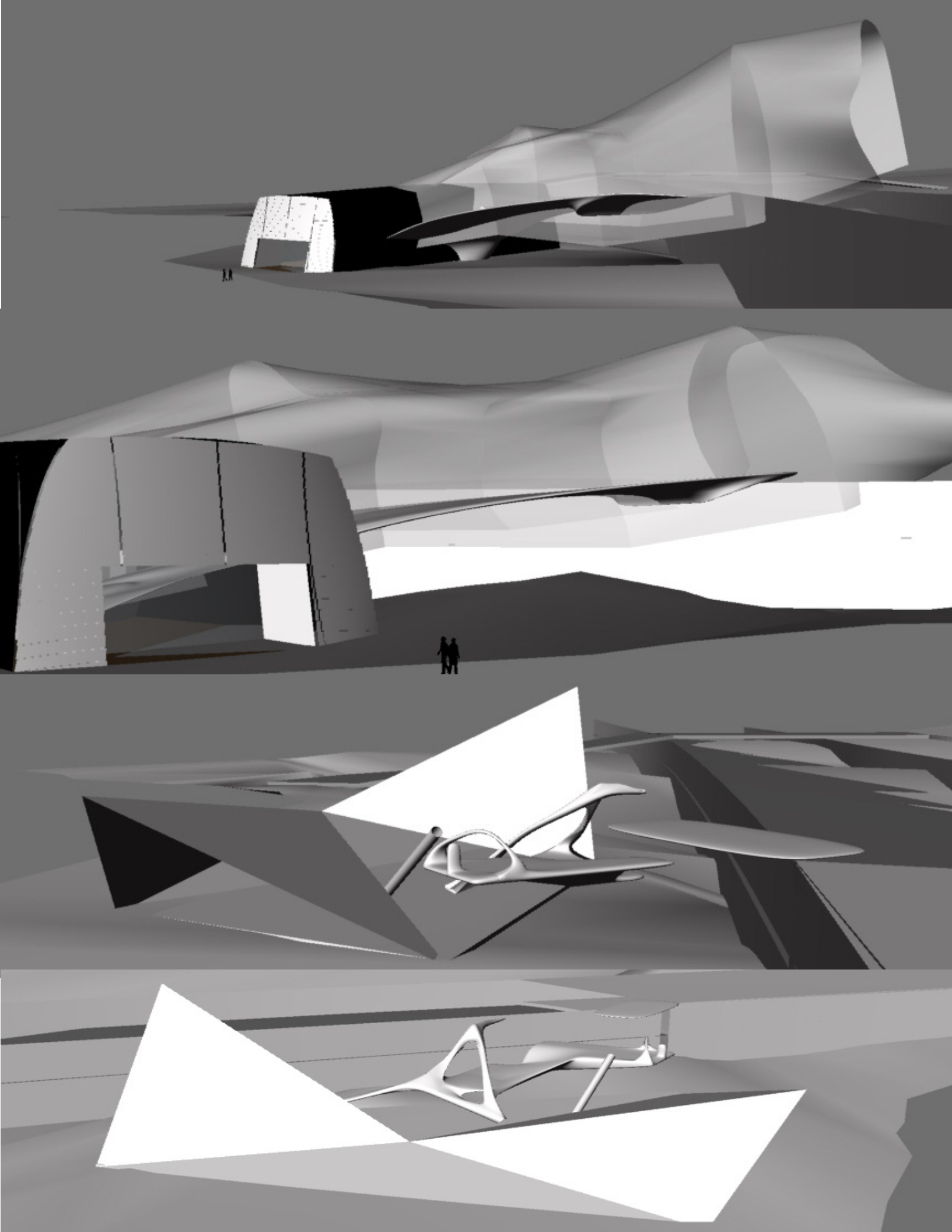


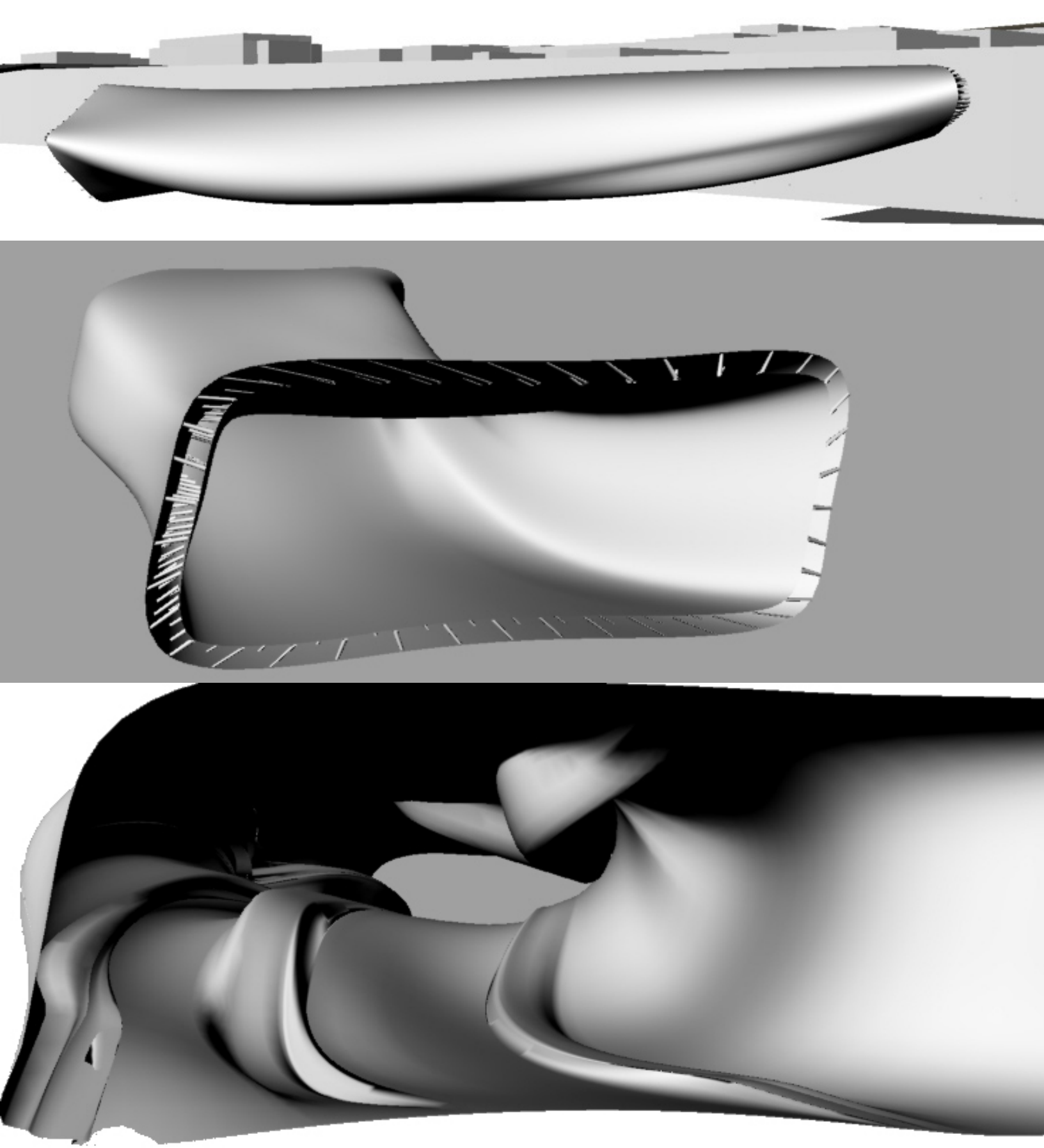


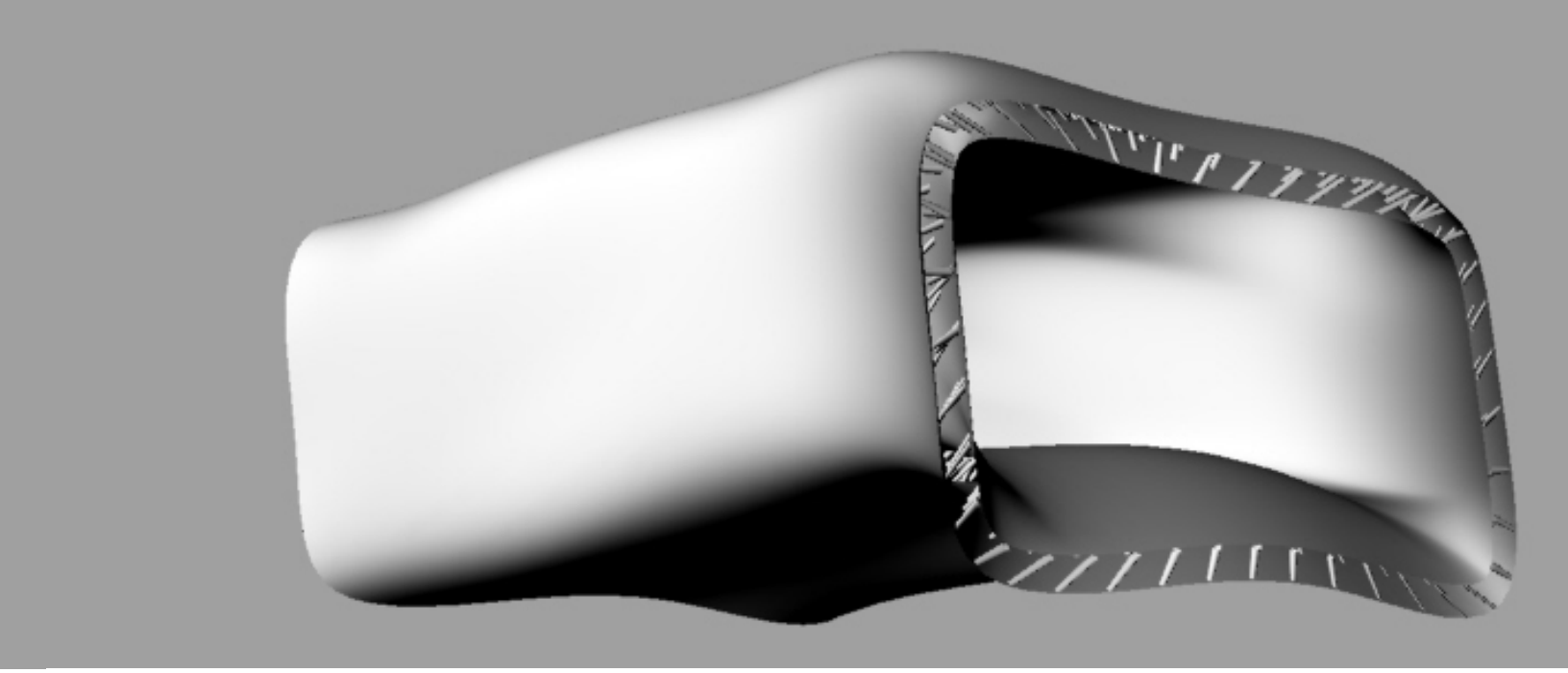


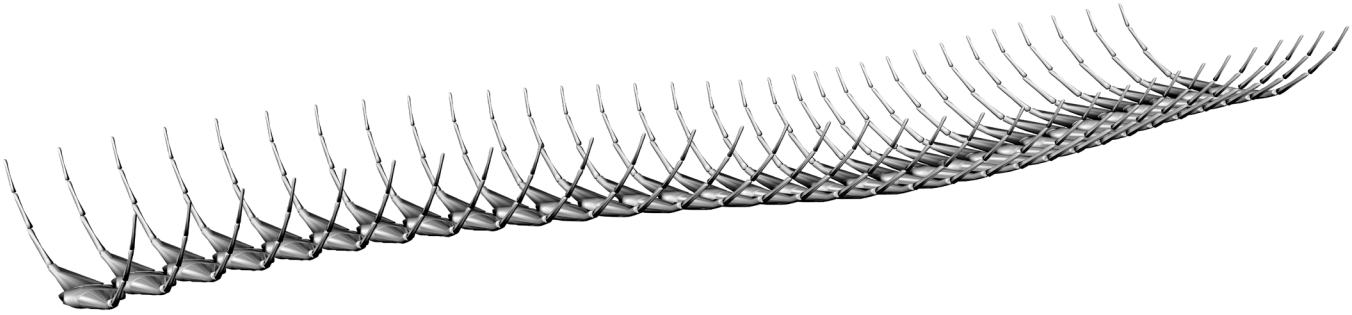


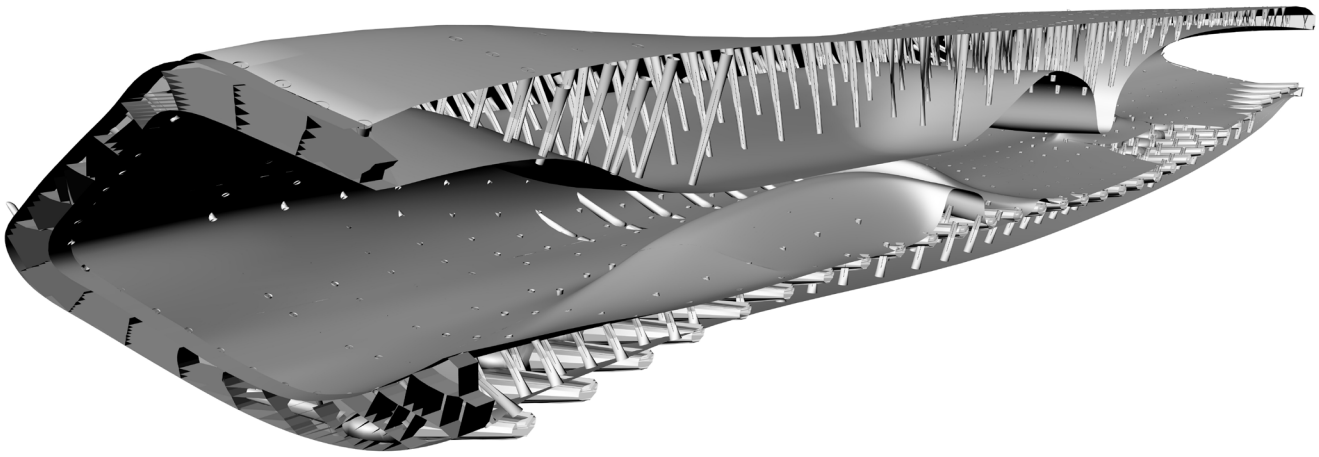


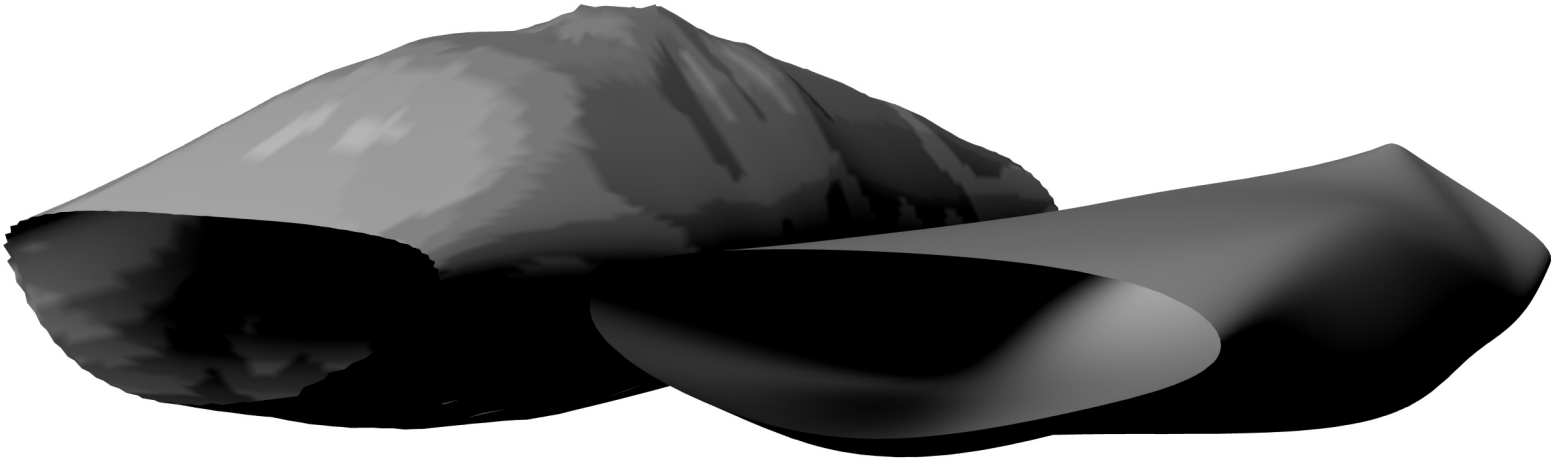




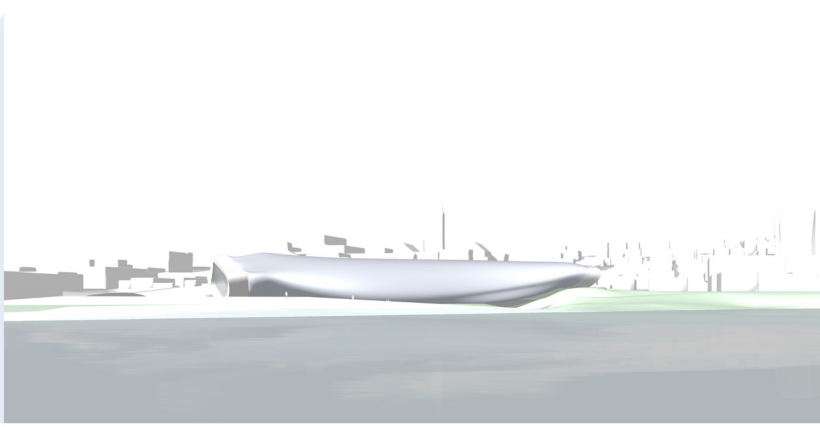


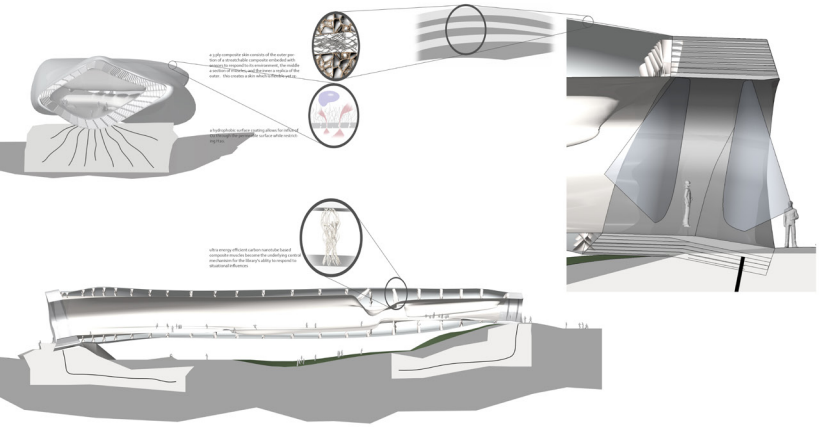


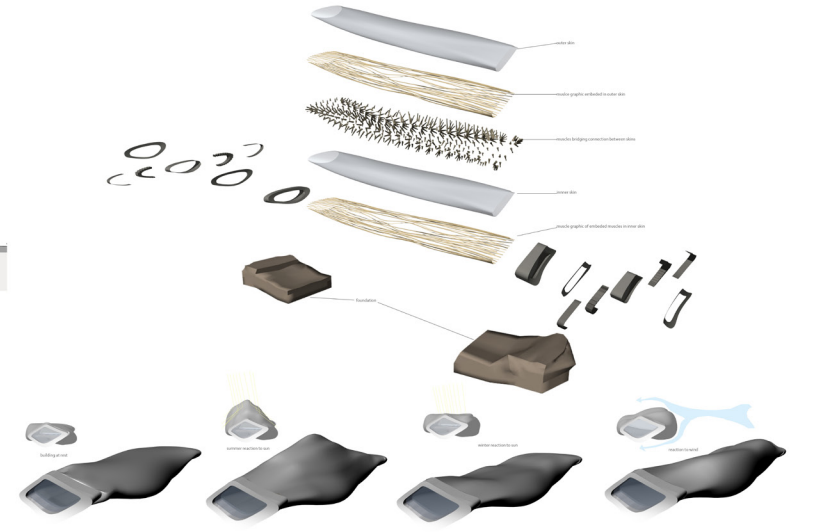


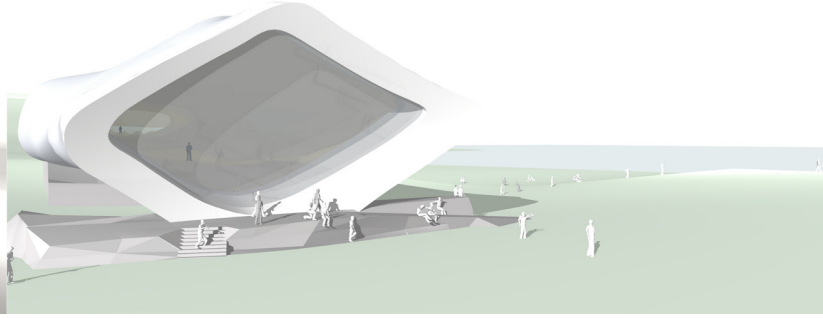


digital library of duluth









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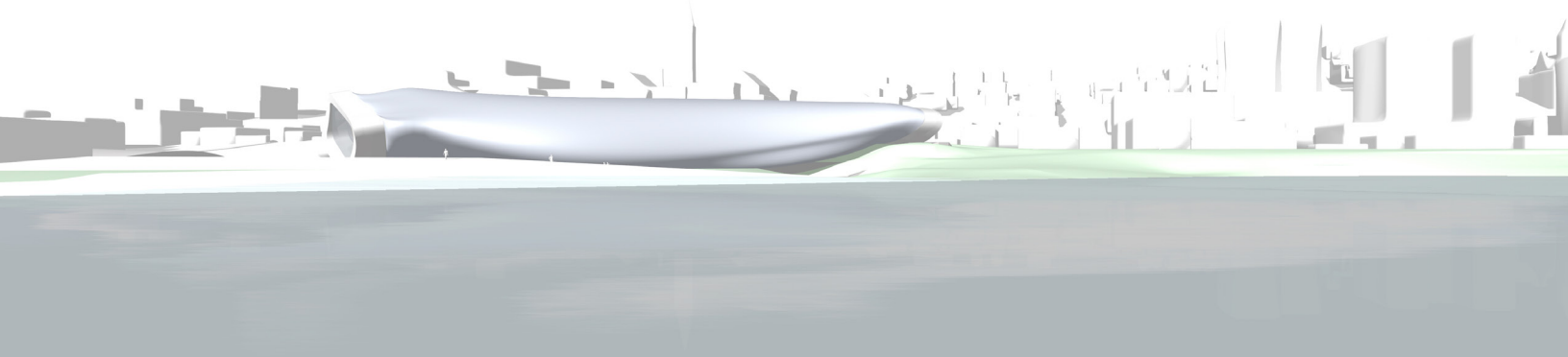
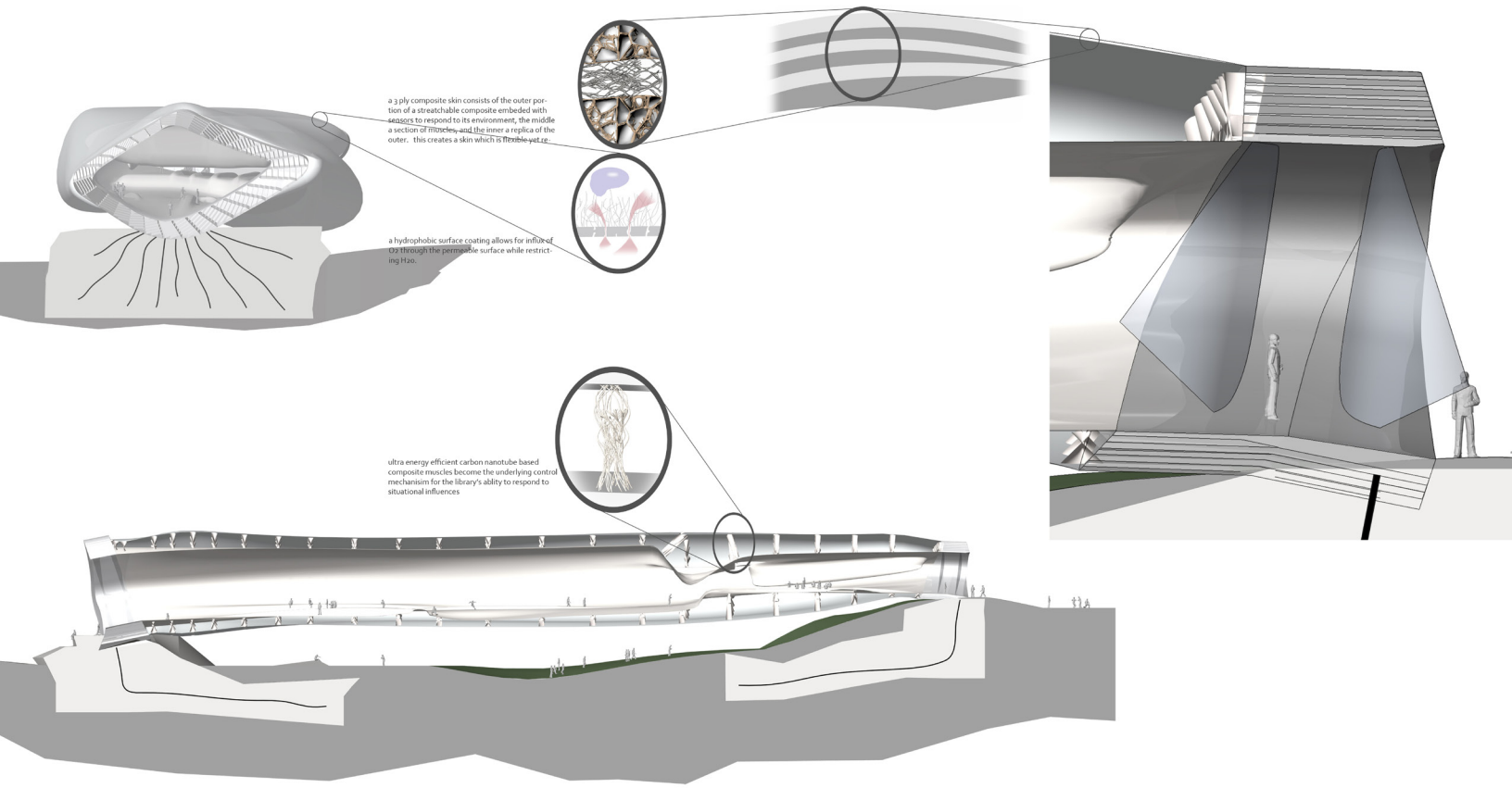
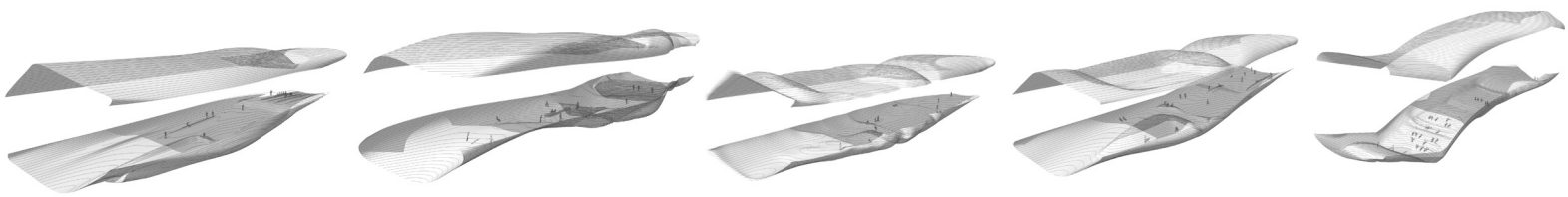
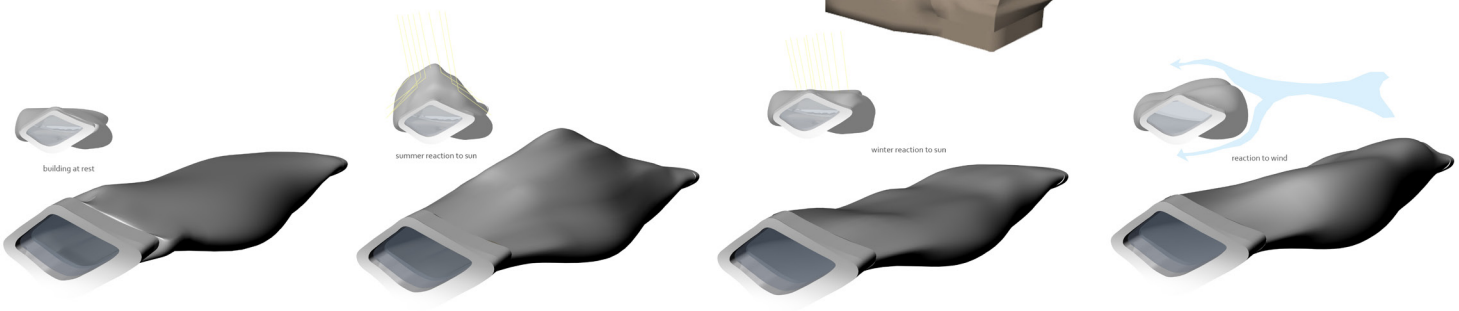
Daniel Hillukka. Professor: Mark Barnhouse. Software: Rhinoceros Photoshop



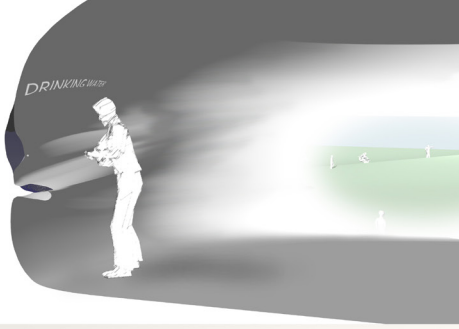

a 3 ply composite skin consists of the outer portion of a streatchable composite embeded with sensors to respond to its environment, the middle a section of muscles, and the inner a replica of the outer. this creates a skin which is flexible yet re-
a hydrophobic surface coating allows for influx of O2 through the permeable surface while restricting H2o.
ultra energy efficient carbon nanotube based composite muscles become the underlying control mechanisim for the library's ablity to respond to situational influences

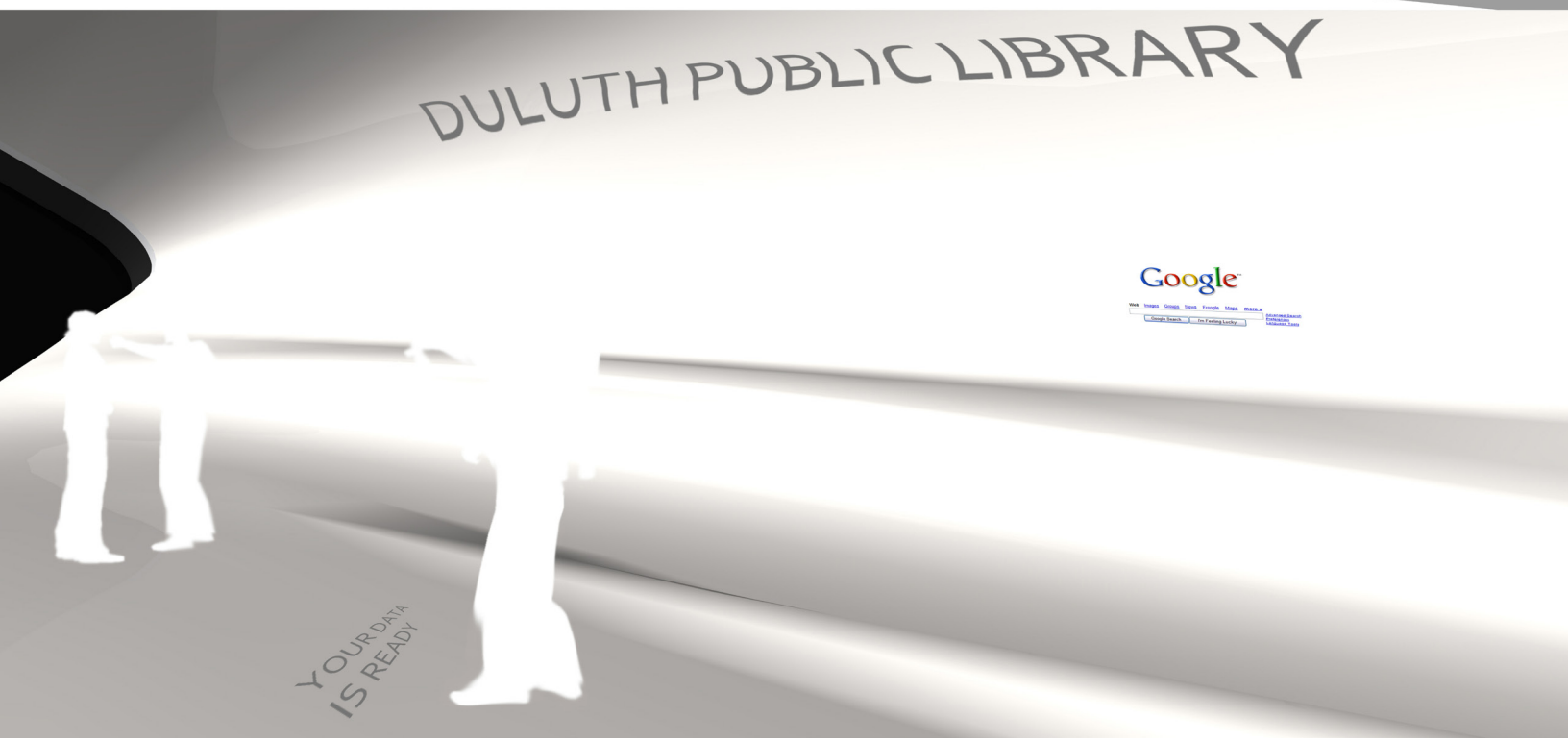


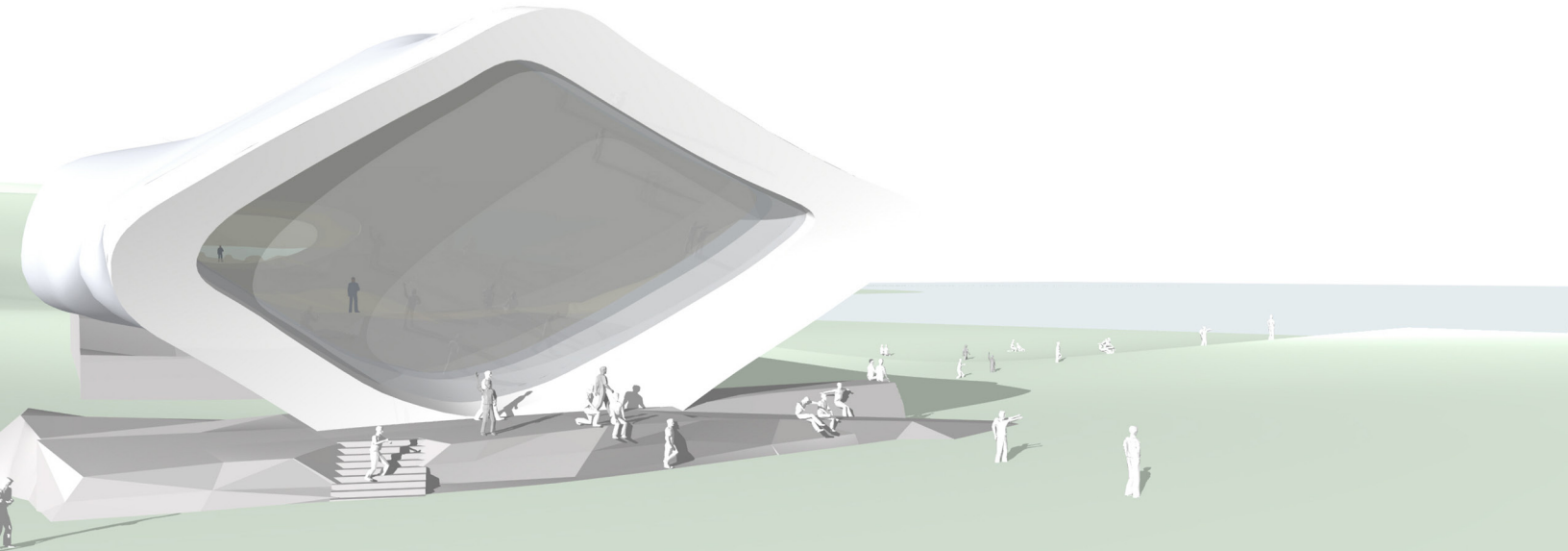
outer skin
muslce graphic embeded in outer skin
muscles bridging connection between skins
inner skin
muscle graphic of embeded muscles in inner skin
foundation


building at rest
summer reaction to sun
winter reaction to sun
reaction to wind

Drinking water is to be harvested from rain fall, it is then transfered to the inner skin via minature tubules which form to move the water via peristalsis. It subsequently pools in the middle of the innner skin to be used as drinking water.







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US History (2010) www.u-s-history.com

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Architecture is a science arising out of many other sciences, and adorned with much and varied learning; by the help of which a judgment is formed of those works which are the result of other arts.

Marcus V. Pollio