elemental architecture as a method of cleansing freshwater in the wake of industrialization
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by

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ABSTRACT

Existing as a force powerful enough to shape the face of the earth, yet delicate enough to sustain the life within our bodies, water is an element with which humans have continuously sought balance. Water has eternally been a source of repetitive daily ritual: collection, hydration, and cleansing. Out of necessity and convenience, our cities have been built right up against shorelines and grown inland. With the rise of industrial architecture, the run-off of our irreplaceable resources is the fatal flaw of our technological advances.

Duluth, Minnesota is a shoreline city born from the lure of Lake Superior’s freshwater and our resultant reliance on industry. We siphoned our natural resources from the land and expelled their toxins back into the lake. Its fragility masked by its immense size, one of our largest sources of accessible freshwater suffered.

This trend is visible throughout countless shoreline cities, initiating a call for action to produce architecture that works alongside its surroundings rather than against them. This thesis proposes a lakeside freshwater research and conservation center standing between the industrial and cultural heart of Duluth, facilitating spaces for filtration and purification research while encouraging public involvement in returning freshwater to its purest form.
This thesis aims to provide a sustainable design for a freshwater research center located in Duluth, Minnesota. Our need for more sustainable architecture is rooted in the rapid expansion of industry and modern building technologies throughout most American cities. This thesis specifically addresses the city of Duluth, Minnesota based on its significant involvement in the shipping and rail industries and its strong connection to its natural surroundings – Lake Superior in particular. The negative environmental effects of industrialization, beyond Duluth, have had severe and long-lasting impacts on our soil, air, and water sources. The combination of industrial influences and proximity to the United States’ largest source of freshwater makes Duluth a prime location for a project that aims to create architecture that is respectful of a city’s aesthetic while ushering in a new era of architecture that rethreads connections to nature that we have lost through the consequences of industrialization. Through ongoing research and site visits to determine the specific needs and considerations of the city of Duluth, the research methods to be applied are modeling and correlation as well as descriptive research. These methodologies will help to strengthening the premise and overall goals of this thesis project: furthering our collective knowledge within the field of freshwater research while furthering the physical healing of industrial damage done to our environment while applying biomimetic architecture in site-specific and meaningful ways. The attainment of these goals will result in architecture that provides a space for both scholars and residents to have their eyes opened to the collective impact we have had on our freshwater. The end result is to educate and further inspire a population to take a stronger hold on the future and contribute to the health of the city of Duluth, and potentially beyond, in a more meaningful and conscientious manner.
As time has passed, our technological advances in architecture have created a certain aesthetic – particularly in industrialized areas like Duluth, MN – that feels disconnected from its surrounding context. This has resulted in a style of architecture that has proven to be detrimental to both the environment and the physical and mental well-being of its users. In an attempt to remedy these problems, this project addresses how re-emphasizing our focus to nature through architecture will resonate more closely with the users, creating more successful spaces, and result in more sustainable and efficient buildings.

The creation of a freshwater research center in the heart of industrial Duluth will serve as an example of architecture that responds to its specific context, culture, and climate in ways beneficial to its site and users.

GOALS

The goals for this thesis lie within its typology’s intentions and the experience of the users. The typology of a freshwater research center is meant to further our collective knowledge with in the field while furthering the physical “heal- ing” of damage done to our environment; Lake Superior in particular as it is a meaningful landmark for the region. There is an overlap between the intentions of typology and sustainable measures, but the use of biomimicry approach sustains usability in a specific way. Biomimetic architecture not only aims to create architecture with reduced impact on the environment, but also contribute to shaping spaces that are familiar and comfortable to its users. The replication of these forms allows the architecture to integrate gracefully into the context and create a meaningful space for visitors. Overall, the combination of these factors will create an experience for its users to make their own connections between the accumulation of small, temporary interactions with a space and the impact on its surroundings.

EXPLANATION

Currently, sustainability has become something of buzzword in the architectural community. We have recognized the necessity of it, but many of our efforts to achieve true sustainability have fallen short. Cookie-cutter buildings are being continuously produced to generate a profit or certain aesthetic rather than create culturally and environmentally significant spaces that inspire its users. Now is the time to usher in an era of architecture that directly responds to the environmental and cultural needs of a place. Duluth is an area that displays a strong culture as well as a need for environmental intervention. The stage is set for a powerful opportunity to use architecture to respond to the specific needs of Duluth while setting an example of connections between user, building, and site. This project approaches sustainability by yoking the application of solar panels or green roofs. The design of this research center aims to adjust the users’ view of freshwater in a way that exposes the damage done to Lake Superior and re-insist a sense of responsibility for our resources that will resonate beyond the experience of the building.

PROJECT JUSTIFICATION

The primary users being considered within this space are the employees – scientists, administrators, researchers, and the visitors to the building. The needs of the employees include function-al and lab research spaces where collaborative work is needed. This is balanced with private of- fices to accommodate individual work. Visitors to the building are included in observing parts of the research process as well as group spaces for presentations and collaboration. This offers an opportunity to draw in many demographics: residents and tourists of Duluth looking to learn about Duluth before leaving, teachers of all ages, and fellow scientists and researchers to share knowledge between one another.

PROJECT TYPOLOGY

This project is defined by a combination of typologies. Its primary function will be as a freshwater research facility to further progress in the rehabilitation of freshwater bodies – Lake Superior in particular – that have been damaged by the rapid industrialization of an area.Secondly, it will act as a conservation education center that allows for the permeation of public activity from exterior spaces to interior spaces to invite observation of the research process. This way, users can recognize how small interactions can accumulate to shape the larger picture.

PROJECT EMPHASIS

This primary emphasis of this project is to create architecture that respects the significance of industiralization while remedying its negative ef- fects – specifically within freshwater – through meaningful reintegration back into the site.
PLAN FOR PROCEEDING
This design plan outline touches on the most essential parts of the design and production process throughout this thesis project. The primarily methods of research – descriptive and modeling – are used within different stages of the design process. Each of these stages, listed under milestones, marks a progression through the design. Descriptive research will be primarily used during the contextualization stage while models will be used to test and solidify concepts during the development stage. The result of the production stage consists of the thesis book, diagrams and renderings on display boards, physical models, and an artifact encompassing the experience of the project. These components make up the installation and presentation, the final milestone of the thesis design semester.

i. Methodologies
   a. Descriptive Research
   b. Modeling & Correlation Research

ii. Milestones
   a. Schedule Stages Progress
      i. Conceptualization
      ii. Spatial Development & Modeling
      iii. Production
   b. Midterm Critique
   c. Installation & Presentation

iii. Deliverables
   a. Thesis book
   b. Construction Documents & Renderings
   c. Physical Building & Site Models
   d. Artifact

Figure 19.1
As outlined in the research paper, contextualizing the ideas behind this project required research into the following areas: building skins as transition from site to architecture, the effects of industrialization in areas like Duluth, and biomimicry as a starting point to solving some of the resulting issues. These concepts create a strong foundation for the necessity of designing a freshwater research facility within Duluth. As the design process progresses, these issues may need to be considered in further detail. This is particularly true regarding biomimicry and the building skin: as the particulars of the design emerge, so do the particulars of how to make it happen. Research into the logistics and technicalities of combining natural systems and man-made forms will be a necessity in ensuring the design is possible and successful.

As outlined in the research paper, contextualizing the ideas behind this project required research into the following areas: building skins as transition from site to architecture, the effects of industrialization in areas like Duluth, and biomimicry as a starting point to solving some of the resulting issues. These concepts create a strong foundation for the necessity of designing a freshwater research facility within Duluth. As the design process progresses, these issues may need to be considered in further detail. This is particularly true regarding biomimicry and the building skin: as the particulars of the design emerge, so do the particulars of how to make it happen. Research into the logistics and technicalities of combining natural systems and man-made forms will be a necessity in ensuring the design is possible and successful.
The production of this thesis project during the Spring 2017 semester can be broken down into three stages: conceptualization, spatial development & modeling, and production. The overlap between stages and recognizing the need for revisions allows for flexibility throughout the timeline.

**INITIAL SCHEDULE**

The first stage consists of researching and developing the needs of the building. The descriptive research methodology comes into play during this stage through the ongoing site visits and observations as well as the construction of the metaphorical artifact that ties into the overarching goals and programming of the building. There will be some generous overlap between the conceptualization and the development & modeling stage additional needs of the building are unveiled during the design process.

**CONCEPTUALIZATION**

JANUARY - FEBRUARY

**SPATIAL DEVELOPMENT**

The special development and modeling stage is the most intensive of the three. It is during this time where the building’s layout, form, materials, code requirements, and structural and mechanical arrangements are solidified. To keep on track with the set timeline, consistently looking back at the needs and requirements unveiled during the conceptualization stage will keep the project focused in order to achieve the goals in mind. The modeling and collaboration research method will be used as need to bring forth the most successful version of each aspect of the design. This is also the stage where initial physical models and explorations are translated into digital software in order to prepare for the design final stage.

**& MODELING**

FEBRUARY - APRIL

**PRODUCTION**

APRIL - MAY

The production stage is where the final design is solidified and brought to life through the completion of digital models and renderings, a physical building and site model, and the plotting of final boards and installation displays. As the bulk of the design work comes to a close, focus will turn to detailing and polishing the result of the previous stage. The final product – boards, artifact, models, and book - will be presented to a panel of critics to complete the thesis design semester.
Figure 24.1
Introduction
In the evolution of architectural patterns and styles over time, countless cities have been forged through the rapid industrialization of a region. The resultant city is pollution-laden, disconnected from the environment, and lacks a sense of place. Not only has this kind of design created a need for more sustainable architecture, but it has produced a rift in the connections between site and building and between building and user. There exists a specific field of sustainability called biomimicry that applies the mimicry of biology and technology in an effort to reduce our buildings’ impact on the environment through imitation of natural systems and the application to building forms and building skins. In the face of industrialized cities, utilizing naturally-occurring systems to create highly integrated and sustainable building skins will result in architecture that gives as much back to the users and environment as it takes. This paper will discuss the negative effect of industrialization on a place, how biomimicry can act as a countermeasure to these effects, and the significance of building skins in applying these countermeasures.

Project Description
Duluth, Minnesota serves as an example of the city with a rich pre-industrial history of resources and connection to site. Lake Superior to the east provides connections to nearby ports and pathways to the both the Atlantic and Pacific oceans. Wheat, copper iron ore, and lumber were, at one time, in no short supply. When exposed to this kind of potential, it is in human nature to want to expand the boundaries of what we are capable of. Thus, the discovery of these resources bore the way for railroads, shipping ports, and automobile made. This brick and metal aesthetic quickly bled from the shoreline warehouse district into the rest of the city. The growth of industry simultaneously built and overshadowed the city. This project will explore the creation of a facility to be used for research and conservation purposes and will allow for interaction with the public. By using the concept of biomimicry we can explore our available resources in a meaningful way while allowing for the growth and sharing of knowledge that humans natural-ly desire. The site is located within a series of piers along the shore of the Duluth Harbor Bas-sin in the heart of industrial Duluth. In order to re-thread the connections between the city, the site, and its residence, biomimetic technology reflecting naturally-occurring systems in the area will be integrated to prevent the effects of further construction in an industrialized area.

Context of Importance
There is great significance in the area of biomimic-ry in architecture because we live in a world of excess. We over-consume our resources and over-design to counteract it. We have created designs that have proven that people thrive in buildings that embrace our natural surroundings, yet we continue to design buildings that fail to respect their site and our basic desire for san- lity, tranquility, and sense of belonging. Current-ly building pollution is accounted for a third of greenhouse gas emissions as well as 40% of global energy use (Sustainable Buildings & Cli-mate Change, 2009). We know this is a problem that needs to be addressed and the application of biomimicry will act as a countermeasure against environmental damage while contributing to solutions positively affect users’ well-being.

By using how nature has evolved to perform a task in the most efficient way as a model, we can create cleaner designs in terms of aesthetics and systems. Biomimicity teaches us how to cut out excess and unneeded parts of our surroundings. When so many cities have succumbed to the effects of over-industrialization, creating architecture that gives back to our envi-ronment and reconnects us to our surroundings is the key to reviving a healthier sense of place.

Effects of Industrialization
To better contextualize this project, the core issue must be identified. As people become more reliant on technologies that we’ve created - whether it be transportation, electronics, or mass production of goods - industrial areas blossom. Rapid growth of industrialization within a city often leads to architecture that appears mass-produced and generic in order to keep up with the influx of workers. Because of this, many industry-laden areas are more strongly impacted by pollution and lack a strong sense of place. In the case of Duluth, they have embraced their reliance on the shipping and rail industries and the brick-and-metal palette has become a large part of the city’s site. That this does not exempt them from the effects of industrialization. Moving forward into the 1900s, industry had a significant and long-lasting impact on the environment. The presence of factories, ports, and mills, businesses, such as the U.S. Steel company, in combination with increased population led the way to a more rapid depletion of natural resources and the pollution of the air, water, and soil. Many of these impurities were released into the community became antiquated by the 1960s and 70s (Stanger, 2009). During this time many permanently closed their doors, leaving behind shells of industry as well as an aesthetic that Duluth still adheres to. Currently there is an effort by the city of Duluth to continue to repair and improve the quality of the city’s surroundings to offset the effects of industrialization. A 2008 study of Duluth green-house gas (GHG) emissions shows that pollution from steam plant and commercial buildings increased 16% in just seven years, accounting for 75% of the GHG emissions within the city

Figure: 20.1
Biosimicry as a Solution

As we continue to produce buildings that express our expanding control over the environment through their form and materiality, we are becoming increasingly disconnected from the site. Particularly as we develop more technologically advanced building envelopes, a design can appear disconnect from the site and potentially alien its users. Often times our attempts at sustainability fall short because, as effective as they can be, true sustainability goes beyond solar panels and green roofs. Biosimicry serves to reconnect building forms with nature, and to allow us to look to nature – to the fundamental forms to deepen integration with the site.

That bioinspiration calls for an understanding of nature beyond replicating a form; the systems behind the form can be translated into a design. This can be accomplished on large and small scales ranging from simple to complex. For example, skeletal structures found in animals can be used as a springboard into architectural structure. The domed-shaped structures found in the marine snail shell can be a form in modern architecture but its functionality comes from looking closer than the exterior. The skull has multiple layers within itself that create the thickness needed to create a solid plate. This increases the strength and depth of the skull, creating a larger protective barrier, while reducing the overall weight of the skeleton (Phan 2011). This concept has been seen in architectural forms through the use of space-frame technology in creating stronger and more lightweight structural system that put less strain on a site and, in turn, the environment. We can take these natural forms that already exist more comfortably within their environments. Biosimicry gives us the opportunity to learn from being who have solved problems within a given region. Given humans’ natural gravitation toward spaces that are closely connected to nature – that is, allow access to air, sunlight, and movement – the application of bioinspiration can contribute to a new layer of complexity with the site. It allows us to look at the fundamental forms of nature and their underlying principles in nature. The skill in nature that allows us to translate the fundamental forms of nature into architecture is the translational ability of the human mind. We can use the fundamental forms of nature to explore and experiment. Nature’s ability to achieve structural integrity and efficiency is the potential for architecture. Our goal is to mimic what nature can do better than we can. Nature has solutions that we can use to improve our design process.

Building Skin as a Connection to Site & Users

In rethinking the connections between user, building, and site, the skin of the building becomes an essential component. The building envelope serves not to just project a design aesthetic to a place, but also to protect and shelter its users. Building skin serves to protect us from the environment, create specific indoor spaces, and in some cases, harness energy from the environment so it can interact with the user (Lohr and Altomonte, 2007). Development of “smart” building envelopes can regulate the amount of sound, light, and thermal transfer to the building’s interior. Further than that, technological advances have enabled us to use design systems that react directly to climatic influences from the site. Responsive or reactive architecture is particularly powerful in climates such as Dubai’s where climate conditions can swing drastically from day to night and from season to season. The seasonal differences allow us to more easily see the effect on a responsive skin. Advancements in the materiality of building skins are what have created the success of buildings like the Burj Khalifa in the diversity of Dubai’s climate, it is important to look at the capabilities of materials to respond to heating, cooling, and the presence of water. A responsive or reactive envelope that interacts with changing temperatures of a space is the manipulation of metal to create a hybrid called thermo-bimetal. Two layers of composite materials have allowed the thermal coefficients area laminated together so as to change temperatures hit a certain degree, one layer of metal is allowed to deform or pull away from the other at various levels of deformation (Sing 2011). This open responsibility for envelopes to provide dynamic shading or directly responsive ventilation to aid during warmer months. The oscillating opening-and-closing movement of the material is why thermo-bimetal is appropriately nicknamed the “metal that breathes.” On the other end of the spectrum, it is imperative that a building can also appropriately respond to negative events by being closed off or sealed. For example, the development of an exterior silicone wall coating allows for rapid re- pellent of water. Lotusian was created with the lotus leaf in mind: micro-peaks and valleys on a surface reduce the surface area that a water
molecule must travel across, resulting in quick shedding of water across a surface (“Advanced Building Materials”, 2012). This has potential in architectural applications in that it reduces the amount of time moisture is in direct contact with an envelope, reducing the risk of water damage or infiltration. Additionally, this technology provides the opportunity for greater control over the path of the water, strategic application of Lotusan could allow for the redirection of moisture into collection and reuse systems. The manipulation of a building skin is one of the most powerful ways we can simultaneously influence our perception of a building as well as our interactions with the environment. Instead of designing architecture that solidly divides us from nature, the materials and systems discussed permit us to integrate ourselves into the site rather than overtake it. These kind of considerations go beyond just the applications of solar panels or a green roof where they may or may not be appropriate; they are indicative of a more intentional design that takes individual aspects of the climate and environment into consideration. Used appropriately, these are the kind of methods that result in more well-rounded designs.

**Conclusion**

In order to begin creating buildings that have a reciprocal relationship with our environment and contribute to our overall well-being, design need to adopt forms and systems that more closely resemble efficient systems already found in nature. Biomimetic architecture gives us the opportunity to integrate into a site in order to prevent further contribution to environmental harm. This is most practically done through the manipulation of the building skin, which acts as a transition from exterior to interior and becomes the first connection we experience with a building. In the heart of an industrialized city, the marriage of biology and technology can be applied to create building skins that are highly integrated and sustainable, fulfilling our responsibility to give back as much to the environment as we take. As humans, our affinity for advancements - technological or otherwise – has the potential to define our place in the world and how we interact with it.

“We are called to be architects of the future, not its victims.”

-R. Buckminster Fuller
ANNOTATED BIBLIOGRAPHY


als. A presentation regarding building materials compiles information regarding classifications of materials, trends in sustainable materials, material properties, and a brief introduction to each material. Information about the materials drawn specifically for this report include how the material was developed, characteristics of the materials, and an explanation of the material’s interactions with a surface on a molecular level.


Janine Benys’ book unpacks in great detail the concept of Biomimicry: how systems and patterns in nature can be replicated within many fields of study to improve on systems we have already designed. Biomimicry is discussed as a method to more effectively feed and heal ourselves, energy and even conduct business, among other purposes.


The Energy Action Plan for Duluth proposes methods in which the city can reduce its energy consumption and resulting pollution from 2011 and onward. The report breaks down the current state of greenhouse gas emissions within Duluth before detailing energy reduction goals in the areas of water, waste, transportation, lighting, and infrastructure. Target dates and investment costs are detailed along with life-cycle costs that align with long-term goals.


Evans explains the deep connections between the built environment and our mental health. Various kinds of poor environments can result in depression, stress, and types of mental illness. On the other end of the spectrum, positive environments have the reverse effect on humans; we experience an improvement in our overall well-being. It also explained how residents of some regions or cultures can be more vulnerable to the negative effects of inadequate built environments.


This report studies new and effective technologies in the field of building skins and insulation. In particular, aerogel has been very successful in terms of R-values and the space it takes up in a wall system. It is also successful because of its versatility within interior wall systems as well as glazing systems. Performance reports within this study show that aerogel has the potential to replace certain standard insulation methods.


The manipulation of building envelopes is explained as an important role in the reduction of CO2 emissions as well as other pollutants. The building skin also serves basic functions that need to be simultaneously considered when designing for sustainability: shielding the interior and preventing unintentional bridging of the environment into the building. Further than that, responsive building skins are becoming a powerful and effective way for our buildings to interact with our environment.


Pawlyn discusses the application of biomimetic concepts specifically within the field of architecture. Biomimicry has past and potential applications within building structures, the manufacture of building materials, and creating zero-waste systems. More significantly, biomimicry is used to connect architecture to the site through energy production and harvesting, thermal control, and the management of water. Overall, biomimicry is developing into a powerful field of sustainability that has the potential to bring our designs closer to nature.


This study of Duluth details how the city developed and the industrial catalyst behind it—particularly, the involvement of steel pro duction. The working-class population relied heavily on this industry and the resulting business boom was an additional spur to Duluth’s development. But technological advancements eventually outgrew the industry, leaving the bones of the companies and a specific aesthetic that is still seen in the city today.


Sung’s article goes into detail about the material of thermobimetal and its many applications. The material-making process is explained as the lamination of two compatible metals that allow for deflection under heat. This physical change opens possibilities for responsive building skins that allow for ventilation and shading.


This report gives insight into the need for change in how we approach our reduction of resources consumption and the resulting GHG emissions. Options on how to improve energy efficiency and fossil fuel substitutions are offered in an effort to remedy these issues.
Vancouver’s Centre for Interactive Research on Sustainability (CIRS) encompasses many of the concepts this thesis aims to achieve. The straightforward layout houses multiple types of research facilities with varying degrees of public accessibility. The same concepts applied to this thesis allow for research spaces that are fully functioning but still allow the involvement of the public, creating transparency between the science and how it connects to the context (Lake Superior, infill case). Furthermore, the CIRS draws from its surroundings to power its systems in an effort to become net positive in terms of energy production. This relates to the concept of biomimicry in creating designs that give back more to the environment than it takes. The layout, use, and response to site make the CIRS a building worth modeling after and learning from.

Centre for Interactive Research on Sustainability | University of British Columbia, Vancouver, Canada

61,000 square feet

Multi-Use:
Private, public, and non-government research, “living lab,” meeting & auditorium space, public courtyard & atrium

Sustainable Measures:
100% daylight & ventilation for all users, living roof, operable photovoltaic shades, living solar screen, LEED Platinum and “net positive”

PRECEDENT NARRATIVE & ANALYSIS

This project is built upon the idea that architecture can be used as a way of remedying some of the adverse effects human interaction has had on our environment – freshwater in particular – while acting as a sustainable connection to nature. The following case studies each exemplify a goal this thesis attempts to achieve: sustainably accommodating spaces to further a specific field of research, applying biomimetic measures to create architecture that reflects its surroundings, and respond to an industrial aesthetic in a modern fashion.
The design of this pavilion looked to biologi- cal shapes and systems, specifically the under-water nest of the water spider, to inspire its construction and form. The use of natural- ly-occurring systems is a method of creating more efficient and successful designs, and in combination with an effective and low-impact material, this design achieves just that. These concepts can be drawn back into this the- sis project through the same kind of analy- sis of natural forms and digital interpreta- tions of them to create spaces that speak to nature and while being highly integrated.

<table>
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<th>Materiality</th>
<th>Lightweight composite carbon-fiber strands</th>
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<tr>
<td>Sustainable Measures</td>
<td>Low-impact building materials, integration of manufactured material with natural forms, application of naturally-occurring systems within the design</td>
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Although this thesis is not an exercise in reha- bilitation, the Museo ABC acts as an example of architecture that preserves a strong connec- tion to an industrial history while pulling the building into the current day and age through its form and materiality. What can be drawn and applied from this design, aside from the nod to industry, is the drawing of the general public into interior and exterior multi-use spaces that were previously seen as undesirable. As is this thesis’ site in Duluth, this building is caught between industrial and modern cultural areas. Being able to connect the two in order to cre- ate interactions from the users is the primary component of why this is a successful design.
THE IMBALANCE

As humans first began to build and settle, nature was a determining factor throughout the course of our lives. We regarded forces of nature as gods—something to be feared, revered, and relied upon for food, safety, and survival. But regardless of weather conditions or terrain, there has always been a constant element we have followed and pursued: the presence of water. Our ancestors have looked to water to complete simple, yet necessary, rituals that we still participate in thousands of years later: hydration, cleansing, and farming. At its onset, architecture was a necessity rudely built from the most basic resources and primitive technology. Under the influence of changing seasons and availability of food, our homes and communities could not be considered permanent. Settlements were under the constant threat of being uprooted. In the face of continual changes, we looked to water as a something steadfast. Societies settled near rivers, lakes, and shorelines out of necessity to sustain their lifestyles. Early tribes recognized the significance of the elements in their lives and regarded them as gods among men. Out of respect to their gods, indigenous Ojibwe tribes participated in the Rain Dance Ceremony. Through song and dance, fasting, and bodily sacrifice, they ensured that the coming year would bring enough rain to sustain themselves and their crops. The gravity of successful years prior was not lost on the Ojibwe. The Rain Dance also existed to give thanks for what nature provided to them, acting as the tribes’ way of giving back what they had taken and acknowledging their standing in the world.

Populations expanded, cultures overlapped, and influenced one another, and the passing of time yielded access to a wider variety of building technologies beyond the tribes’ primitive structures. True to our human desire to learn and expand, our competency in manipulating and improving these technologies followed suit. The complexity of our architecture increased, permanence was solidified, and the significance of what we held dear remained. On a cliff-side overlooking the Aegean Sea stands the ruins of the Temple of Poseidon. This temple stands on the ground where the myth of Aegeus is concluded: Aegeus, founder of Athens, awaits the return of a ship carrying his only son home from battle. Upon the ship’s return and seeing that it was adorned in black sails indicating death, Aegeus threw himself off the cliff and into the water. He perished, and the sea became known as the Aegean Sea. The temple overlooks a bay that saw the arrival and departure of battleships returning to southernmost point of war-fortified Athens, marking a monument fitting to the god who determined...
of the mood of the waters. This temple rep-
resents the beliefs and stories that the fabric of Ancient Greece is built upon. The architecture speaks to reverence in which the Greeks gazed upon their deities. Just as the Egyptians found their gods within nature, our reverence to water was not only expressed in large ges-
tures, but small ones as well. Within a sacred crypt in Chartres, France resides the Well of Strong Saints, a legend told of “Our Lady Un-
der Ground” – a beautiful woman whom early generations of Christian pilgrims congregat-
ed to worship at the well. From this well they also drew water for ritual use, baptismal and medica-

cures. The site that held the Well of Strong Saints is now home to the Cathedral of Notre Dame de Chartres. Generations after its construc-
tion, the beliefs and stories surround-
ing the well had all but dissipated as we held no physical evidence of the site ever existing. It wasn’t until 1900’s that archeologists unearthed the remnants of where the well once stood. Carved from limestone, it had been im-
pacted with sediment so as to withstand the massive forces of the cathedral. An effort to preserve this place of congregation had resulted in fusion with the bones of the cathedral, making it inaccessible for those seeking its waters. The presence of sacred waters helped shape this cathedral in more than just a physical way – the well became a symbol of spiritual and cultural preservation, framed by the cathedral standing above it. However, years of decay and being shrouded by the stone foundation had left the well and the waters a shadow of the spiritu-
al fascination it had once been. By this point, there was a distinct separation in our relation-
ship with the elements that was reinforced through advancement in building technolo-
gy, as the foundation overshadowed the well.

THE SHIFT

The scale of these technological advancements expanded exponentially over time. We wel-
comed the Industrial Revolution, rapid produc-
tion of steel and glass spurred us to manipulate our built environment through machines and mass production. Our newfound reliance on steamboats, factories, and shipping and rail indus-
tries resulted in shorelines becoming prime real estate for new cities. The flourishing of indus-
try turned into the writhing of water qual-


ity as toxins were churned out into our lakes and rivers. Blinded by the allure of new tech-
ology, we began to disregard the health of our resources. Nature evolved from the most sig-
ificant influence on our lives into something that we physically conquered and reshaped. The Crystal Palace was constructed for the Great Exhibition in London, standing as dis-
play of mastery over our resources. After this point, architecture stood as a monument to it-
self rather than a response to the environment and users surrounding it. Waste and excess followed in the wake of gaudy architecture, and the ethos shifted in favor of man.

With a disregard for our surroundings in the wake of a revolution, we found a sense of re-
verence within our own technology – an all-em-
compassing and man-made element of our lives. Martin Heidegger, German author and one of the most prolific philosophers of the 20th cen-
tury, explains an equilibrium between man and nature through his concept of the Fourfold. Di-
vided into the categories of Earth, Sky, Divini-
ties, and Mortals, each piece of the fourfold is intertwined and influential to the others. The Earth represents our physical grounding in the world while the Sky represents a connection to forces larger than ourselves. Divinities de-
termine how we exist and interact in a place through their presence in it. Our role as Mortals in the fourfold is to recognize our temporary na-
ture as humans and be aware of how our actions influence the environment. Even as we have begun to recognize the ambivalence we have caused in our relationship with nature, our solutions speak more to our technological capabilities than the long-term impacts our construction brings.

Even as we have begun to recognize the discon-
nect we, the Greeks, have found with our nature, our solutions have turned into sweeping gestures of technology that speak more to the technology than the site. In ways that expand past just architecture, our technological advan-
ces have allowed us to reshape our lifestyles across the planet. Communication, dwelling, and trans-
portation have all advanced to the point that we can go about our days with relative ease. But we have also reached a point where our con-
sumption has lulled us into a false sense of security in regards to how this kind of lifestyle can be maintained. There are many things we take for granted. There has been a push during the past few decades to create an awareness and sense of duty for people to take responsibility for the impact our lifestyle has had on the surroundings we once held so dear. As mentioned, architec-
ture has had a powerful effect on the balance be-
tween us and environment. As buildings become responsible for more and more of the damage being done to the environment, designers are en-
couraged to consider more “sustainable” mea-
sures in their designs. There are local regulations that vary from place to place and larger-scale initia-
tives such as the Leadership in Energy and Environmental Design (LEED) certifications
that can make a building less impactful to its site. Unfortunately, we have produced buildings that seem sustainable on paper but still fail to strengthen connections between user and design. The Bank of America Tower in New York City, New York boasts all of the technology and qualifications to be titled a LEED Platinum building – the highest certification LEED offers. Unfortunately, hitting as many parts of the “sustainability,” “checklist” as possible became priority in this design without taking the context into consideration. Currently, the tower emits more greenhouse gases and consumes more energy than comparable-sized buildings in the same area. In this case, along with many others, sustainability has become a title to be flaunted and technology to be showcased rather than a measure of the building’s meaning and success in its interactions with the site and users. The way we look at sustainability is flawed. It goes beyond creating buildings with solar panels and low-flow toilets. Truly sustainable buildings not only refrain from further damaging our environment, but represent a clear connection to the culture and history of a place that can be recognized by residents and visitors alike. In another of his works, The Question Concerning Technology, Heidegger speaks of Technology – including modern technology as we know it – and its contrast, Techno. Technology is seen as a way of directly being and interacting with the world, oftentimes as a means to an end. This is glaringly clear in how we have developed our architectural technology to perform in a very specific way, even in different circumstances. Techno has become very focused and systematized in how we create and apply it. This type of design works in contrast to how nature has evolved to respond to and thrive in a specific place. On the other hand, Techno “does not lie at all in the making and manipulating of the same,” but encompasses a wider sense of being at home in its context. Techno can speak further through art and poetry to bring forth a greater meaning of some fundamental human nature to us.

Due to this over-industrialization of many cities, “sustainability” measures have generally been accepted as the new norm. Gadamers goes on to say that is our responsibility as humans to “direct our attention away from ourselves back in the direction of the vast, balance-sustaining rhythm of the natural order.” This is a call for action to create designs that help return us to an equilibrium that is more sustainable for man and nature. Our focus regarding architecture and our lifestyles has been reduced to a rather narrow view that no longer looks to the past for reference nor anticipates our future needs. Our reliance on technology has turned the idea of “sustainability” into a buzzword to throw around when placing solar panels on an office roof. Harvesting energy is an important factor in sustainable building as a way of anticipating future
needs, but does not ensure that a building will stand the test of time or cultural significance. True sustainability is not a formula repeated from one building to the next. We need to go through the healing process of attentional and site-specific designing that allows people to recognize their place in the site and bigger picture. We recognize that the idea of sustainability has become so saturated in the field of architecture that it currently not reach its significance. In order to rebuild the lost connections with nature, the idea of sustainability must be boiled down to its most important elements. According to 20th architectural authority author Donald Kusne in (Why No One Can Be) Against Sustainability, the idea of “sustenance” encompasses what is most striven for within sustainable and successful design: nourishment, security, happiness, and tranquility. There exists a particular tangent of architectural sustainability that is specific enough to encompass the idea of sustenance while tying us closer to nature. Biomimics directly translates into “imitate Life.” This mantra encourages the inspiration of an architectural design to be drawn from naturally-occurring systems in an effort to create designs that are not only more efficient, but make clearer connections between the architecture and its surroundings. Nature’s ability to perform a task in the most efficient and elegant way offers itself as potential for not just more sustainable architecture, but architecture that speaks a language users understand. Seeing and recognizing these systems in a design allow users to recognize the architecture in a more personal and meaningful way. This kind of architecture stands out in a way different from many examples of modern sustainable architecture. It is not overbearing or alienating in its form. It is understandable and inviting. It draws inspiration from familiarity. It seems clear that the shift in the equilibrium between man and nature has been pushed to a point of speciation of destruction – in terms of our environment. In Building Dwelling Thinking Heidegger also speaks of the concept of “freie” meaning “free” and “preserved from harm and danger.” In this sense, to free something is to save it. We are not meant to restrict growth and expansion – just as human nature is not meant to be stifled from pushing its boundaries. Biomimicry attempts to remedy these dangers not by further mastering of the earth, but by allowing the solutions nature has already found to come forth in our designs – the freeing of nature’s essence. Woven into the hillsides of Vals, Switzerland lies a bathhouse designed by Swiss architect Peter Zumthor. Between the stone stone and concrete palette and the sloping underground entrances, this bathhouse encompasses graceful integration with the site and the expression of the place’s essence. Within its interior, an atmosphere is created from the slow, ramped approach into the baths while the light, steam, and water reflect off one another. This way, the interior and exterior of the architecture work in tandem to create a smooth transition from the sweeping hillsides to the very individual experience within the baths. This architecture acts as more than just a room to be filled, but a catalyst for interactions and an extension of its surroundings. Redirecting our ambitions in technological advances to move forward in tandem with natural forms that creates a powerful marriage of biology and design. This will allow us to integrate back into nature while still introducing strong cultural symbols to a place.
THE ARTEFACT

There is an inherent, primal way in which we are drawn to water. It is almost as if we can feel the weight, the gravitational pull of it, that goes back to the days of our ancestors. From the myriad splashes of a ritualized cleansing to the invisible pulse that drives it through our bodies, the weight of water is essential and eternal. But within the lightest drop and softest splashes lies the potential to extinguish us. Without it, we cease to exist. In excess, we are buried, left without breath. Since the beginning of time humans have attempted to strike a balance between the two in order to thrive.

The freshwater research center strives to return cleanliness and purity to our water while inspiring a sense of appreciation and responsibility within its users. Similarly, this artefact aims to re-instil a sense of reverence to water that has been overshadowed by technology and industrialization. Thousands of pieces of warped paper were transformed through the soaking and evaporation of water, leaving a “fingerprint” in their place. Just as the accumulations of the simplest drops of water contribute to a larger body, the individual shape of each paper adds to the complexity and mystery of the whole. What is left is a surface that is as mesmerizing as the surface of water, created through the passing of time and ritualistic creation of each individual piece. The program of this thesis provides a solution to the misuse of freshwater in a similar way: through the devotion of time and very particular methods of cleansing to allow us to once again see freshwater in its purest form.
Figure 48.1

Figure 48.2

Figure 48.3

Figure 49.1
Paul Ricoeur’s text, *The Function of Fiction in Shaping Reality*, speaks of the creation and recreation of reality through our works, existing either as images or as fiction. He suggests that as a fiction a work may exist as a collection of images, each referring to a subject and building upon one another in order to create a reality that will, in turn, usher in a recreation of our own realities. Ricoeur echoes Nelson Goodman, saying that this mode of creation can “‘make’ and ‘remake’ the world.” Here we can find an overlap in the worlds of art and architecture in that they draw upon the familiar and relatable in order to evoke an experience or deeper understanding of the topic at hand. A concept that is reinforced through multiple mediums that refer back to a singular reality embodies the creation of the artefact, and this essay will explore how these ideas have manifested themselves in both the artefact and past works.

A set of eleven Renaissance-inspired works by Leonardo da Vinci, a series entitled Deluge, depict tumultuous scenes of thunderstorms, tempests, and maelstroms over a landscape. The entire series was created on paper with a combination of black ink and chalk, relying on a marriage of clean lines, simple geometry and crosshatching. The dynamic nature of this series lies in the depth and complexity created from a layering of simple forms to captivate the viewer. Gestural yet detailed, the depictions of the storms speak to the power of storms past, such as the biblical flood, as well as the potentiality of an apocalyptic future, as Charles Nicholl points out in his text *Leonardo da Vinci: The Flights of the Mind*. In this way da Vinci displays these forces of water as an eternal force on our past, present,
and future, while activating a participation of the imagination from the viewers. Nicholl goes on to describe the atmospheric qualities of the series:

“Some of the drawings have an almost hallucinogenic quality, as if he were passing through some kind of interior shamansic void. But then as you continue to look at them, and into them, you perceive that they contain also a kind of peace. They become metemeric. Their curvilinear force-fields resolve into mandala-like forms. You regain a sense of the surface of the drawings: marks of black chalk on rough white paper, interweaving, ‘fantastic’ fetched back from the abyss.”

However, this series goes beyond an image-like representation of the power of water. One drawing in particular, titled “Deluge of Tools” introduces another element: tools and pieces of technology join in the downpour falling to the earth. According to Frank Fehrenbach’s The Paths of Function, this piece shines new light on the state of the relationship between nature and culture in a way that was uncharacteristically pessimistic for the Renaissance Era. Text captioning the page translates into, “O human misery, to how many things are you enslaved just for the money,” alluding to an underlying attitude of greed in respect for the wealth of advancements being produced during this era. These symbols within the work not only directly reference the familiar but illustrate a reversal of the common perception, framing a new reality that countered the common mindset of rebirth and rejuvenation during the Renaissance.

Similar to da Vinci’s critique of a cultural norm through the Deluge series, this artefact exists under a similar concept. Under the veil of industrial and technological advancements hides the contamination of something precious. This artefact is an extension of the cultural premise that industrialization is having continuous ramifications on the quality of our freshwater. Like da Vinci’s Deluge, the artefact relies on the accumulation of simple forms to illustrate the weight and complexity of the whole. Thousands of pieces of warped paper were transformed through the soaking and evaporation of water, leaving a “fingerprint” in their place. Just as the accumulation of the drops of water contributes to a larger body, the individual shape of each cannot be duplicated. What is left is a surface that is not unlike Nicholl’s comparison to the mesmerizing mandala, created only through the passing of time and ritualistic creation of each individual piece. The installation naturally gathers viewers to its “shoefine,” embodying the individual and communal ways in which one can experience a body of water.

Not only an extension of a cultural premise, the artefact and the language in which it is framed present elements that point to a subject, even in its absence (Fig. 6). Recorded audio of the movement of the paper mimics that of crashing...
waves, creating a distorted reality reminiscent of being near a body of water. Ricoeur explains of the representation of world through our works, explaining that these works simultaneously reorganize the world while the world reorganizes the works. He speaks in particular of images and fictions that “refer to reality.” An image conjures a representation in our mind’s eye, even in the absence of the subject. He states, “Resemblance persists in closeness. This is why to see similarity is to see the likeness in spite of the difference.” The artefact does not exist as a direct image, rather a symbolic representation that speaks to the gravity of the cultural issue: creating an environment intentionally deprived of water where the viewer can sense the magnitude of what is missing. Both the Deluge and this artefact stand as a critique of an attitude of disregard that exists within their particular cultures. It seems that this is the goal of the artefact: to refer to a particular work or reality, evoking a similar experience to the program – in this case, a freshwater research center – but not as a direct image. Rather, this happens in conjunction with other “modes of giveness,” as Ricoeur states: through visual and physical mediums, the presence of metaphors, and the language in which it is presented and bound together. In this way, the gap of understanding from one perspective to another is bridged. Ricoeur puts it simply in that this is how “new realities become open to us and old worlds are made new.”
Zdzisław Beksiński was one of the most prolific Polish surrealism artists, working primarily with drawing or oil paints and favoring near-apocalyptic, convoluted, and nightmarish imagery. You can see a progression of style throughout his artistic career within his works: early pieces are characterized by a heavy, jarring palette and thin-laid details while the later years depict more monochromatic and sculptural imagery.

For all the negative and generally oppressive atmospheres that Beksiński favors, there is a curiosity and sense of positivity that is alluded to within many of his works. True to his affinity for mystery, most of his pieces bear the name Unidentified, included the one being addressed in this essay. The work in consideration falls later in Beksiński’s career, showcasing a subdued palette that is reminiscent of a dream world rather than a nightmare. This particular piece features a monolithic and vaguely-architectural stone behemoth that is shrouded by chiming clouds above and dense fog below. His use of thick oil paint creates a stark contrast between light and shadow, jagged rock and atmosphere.

Beksiński’s mysterious style tends to raise questions for the viewers, leaving them intentionally unanswered. Within the painting, one face of the stone tower has been sheared off, leaving a façade that is uniform save for a horizontal crev-ice carving across the face, emanating a bright light from within. The fissure acts as a reveal of something simple and elemental that is housed within a scared form. Ethan Dodd’s writing of Zdzisław Beksiński explains how these elements, particularly the clouds and fog, “obscure the objects and forms that are in the painting. It is almost always a dark colour, resembling shadows and parts of dreams that we can’t quite recall when having awakened. It’s as if Zdzisław purposefully leaves parts of the painting as blank spaces prompting our mind to fill them in and a more personal response to it.”

In this case, what Beksiński chooses to reveal and conceal within the work allude to multiple outcomes: Is the pure form on the verge of crumbling into the abyss masked by the fog? Or is the light emanating from the crevice working to reveal something more pristine? Is the pure form overpowering the chaos or vice versa?

It is here that something to be reconciled. The use familiar imagery draws from the back of our minds: dream-like qualities that are recogniz-able, yet not quite reality, that leave your imagina-tion to fill the gaps between what leads us to either outcome. Dodd says, “Whatever the case, there is a sense of hollow, haunting beauty within the piece.”

Similarly, this thesis project hints at possible out-comes in the case of the quality of our freshwater. Just as the work discussed above, the viewer is pre-sented with several potential realities: continuous ruination or steps toward purification. However, the artefact works in a more tactile, physical way. Both works emulate standing on the cusp of event: the making or breaking of something longer-than-life. Approaching the edge of the artefact, the same reveal of soft, simple forms shrou-ded by a stark, complex framework occurs.

Imagination recognizes the absence of water in the artefact. Its constant presence in our lives is something so commonplace that we have begun to unknowingly see through it. Just as how Beksiński’s work presents multiple outcomes through what is hidden, it is in our newfound blindness to it that the realities are exposed. In the case of the artefact, stand-ing at the edge of the event is meant to re-in-still a sense of reverence and, in turn, responsi-bility toward the pure form. The programming of the thesis offers what Beksiński’s work and the artefact cannot: an opportunity to channel this sense of responsibility through participa-tion working toward the desired outcome.
DAEYANG GALLERY & DULUTH’S FRESHWATER RESEARCH CENTER

A Hungarian-Canadian composer named Ivan Ashid is the creator of a musical score that inspired the creation of Steven Holl’s Dae-yang residence and gallery. Entitled “Sympho-
ny of Modules,” the score was reinterpreted through a sketch made directly on the sheet music, accentuating the geometries within the piece that would eventually become the foot-
print of Holl’s architecture. Standing in Seoul, South Korea, the Daeyang Gallery is a sym-
phony in of itself, orchestrated through tec-
tonics, materiality, and the manner in which the surrounding water interacts with them. The three pavilion spaces, footprints informed by the sketch and connected through a man-
made pond, serve as places of entry and dwell-
ing, brought together through a subterranean ex-
hibition space. In an interview with Steven Holl, he explains that the Daeyang is meant to merge domestic life with a sense of music, painting, poetry, and sculpture. Each space is oriented toward a horizon created by the pond, extend-
ed into the building through placement of light-
well and changes in materiality. Holl continues, “The pond of water is not contained. It connects out into the neighborhood and to the landscape.” Externally, the building wears its interactions with the environment through the patina of copper panels that rest at water level. Upon en-
try, bamboo garden spaces and an elbow-level view of the pond horizon are merged through reflected light from modular panes of glass onto red wood interiors. Submergence into the low-
er-level gallery space is indicated through move-
ment across slow ramps, allowing users to expe-
rience the pond at eye level for a moment, and a transition to monochromatic materials. Plaster and marble act as a backdrop for the meticulous and surreal play of sun and water brought in through lightwells. Movement within the space is echoed as sound resonates across each sur-
face. This way, each level conjures a moment of introspection for the individual while simultane-
ously drawing attention to and beyond the pres-
ence of the pond’s horizon. Holl states, “You are on the inside, but the focus is on the outside.” Similarly, Duluth’s Freshwater Research and Conservation Center was conceived through both cultural and geometric origins. Just as one experiences the artefact, the architecture aims to place its users between the micro and the macro, between introspection and involvement. The experience of the artefact at surface level encompasses the ancient and ritualistic way we have always approached water; cognizant of the
importance of individual pieces. On a smaller scale, how we experience the artefact is defined by the microscopic interactions between each paper. Reinforcing the repetition of this form through the symmetrical layout of the shoreline brings to light the complexity within. The architecture aims to frame the rich simplicity of the whole by exposing its essential innerworkings. Just as glaciers once painstakingly carved the earth, the significance of subterranean private research labs carry a similar weight. The events within the labs, exposed through floor reveals, allude to the complexities and unknowns of a body of water – a distorted reflection of what we find to be clear above surface level. Like Duyang’s pond, the presence of Lake Superior acts as a plane of mediation between levels. General public and scholars alike filter through the ground floor, a meeting point between science and culture embodied through the sharing of knowledge that occurs between common spaces and auditorium. Overhead, the individual is elevated in the pursuit of growth and understanding while both experiencing the archives and looking out over the lake and down into the complexity of the research labs. Externally, the merging of Duluth’s public lake-walk into and through the site blurs the lines between environment and architecture, embodying a moment of convergence. Again, “The pond of water is not contained. It connects out into the neighborhood and to the landscape.” Precipitation is welcomed across - not diverted from - the building and into the site. Water’s cyclical nature is manifested within the transformation and erosion of materiality as well as the flourishing of foliage within the building and site. Just as the artefact works through multiple scales, a symphony of form repetition, the architecture works to frame our interactions with water from the micro to the macro, providing a moment of clarity that the two are not separate.

Figure 10.1
As the typology of this building is divided into two categories - research facilities and conservation education – there are specific programming requirements that need consideration. Research facilities require a balance of private and semi-shared spaces. Research laboratories and library spaces need a higher level of accessibility between employees while offices require a more privatized environment. Education spaces also require varying degrees of public accessibility at certain times, but they also allow for more versatile use of the spaces. The auditorium allows for presentations between academics and scholars while classrooms accommodate less formal meetings for students, whether young or university age.

The success of this building is largely dependent on the balance between the two kinds of spaces: allowing for effective circulation and use of the spaces for the employees while encouraging educational and non-intrusive interactions with the public. Additionally, the exterior public space plays an essential role in the success of the building. Not only are visitors encouraged to observe the research and testing occurring within the building, but observe what surrounds the building. Seeing Lake Superior through the harbor and recognizing why freshwater research is significant to the area will allow visitors to make the connection between the two and gain a new level of understanding as to how their small interactions with the world can contribute to the bigger picture.
<table>
<thead>
<tr>
<th>Use</th>
<th>People</th>
<th>Capacity</th>
<th>No. of Units</th>
<th>Area per Unit</th>
<th>Net Area</th>
<th>Qualitative Comments</th>
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<tr>
<td>Administration</td>
<td>200</td>
<td>1</td>
<td>3000</td>
<td>3000</td>
<td></td>
<td>Open atrium; access to reception, coat check, café</td>
</tr>
<tr>
<td>Lobby</td>
<td>2</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td></td>
<td>Two kiosks; open circulation</td>
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<tr>
<td>Check</td>
<td>1</td>
<td>1</td>
<td>200</td>
<td>200</td>
<td></td>
<td>Access to reception; increased privacy for personal belongings</td>
</tr>
<tr>
<td>Administrative Offices</td>
<td>8</td>
<td>8</td>
<td>120</td>
<td>900</td>
<td></td>
<td>Access to lobby area; private for employees; daylit</td>
</tr>
<tr>
<td>Directories</td>
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<td>1</td>
<td>360</td>
<td>360</td>
<td></td>
<td>Access to lobby area; private for employees; daylit</td>
</tr>
<tr>
<td>Employee Lounge</td>
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<td>15</td>
<td>1</td>
<td>700</td>
<td>700</td>
<td>Privacy for employees</td>
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<tr>
<td>Conference Space</td>
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<td>300</td>
<td></td>
<td>Semi-private; fairly accessible from circulation areas</td>
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<tr>
<td>Cafe</td>
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<td>35</td>
<td>600</td>
<td>600</td>
<td></td>
<td>Limited seating; open to lobby</td>
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<tr>
<td>Restrooms</td>
<td>8</td>
<td>2</td>
<td>600</td>
<td>800</td>
<td></td>
<td>Semi-private; access from lobby for employees &amp; visitors</td>
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<td>Mechanical</td>
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<td>1000</td>
<td>1</td>
<td>600</td>
<td>600</td>
<td>Private; Access to labs/storage for drivers/viewers</td>
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<tr>
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<td>10000</td>
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<td>Site Facilities</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visitor Parking</td>
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<td>1</td>
<td>50000</td>
<td>0.7</td>
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<td>Interior Observation Spaces</td>
<td>20</td>
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<td>Exterior Observation Spaces</td>
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<td>500</td>
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<tr>
<td>Small Auditorium</td>
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<td>2000</td>
<td>2000</td>
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<tr>
<td>Classrooms</td>
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<td>1800</td>
<td></td>
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<td>330</td>
<td>8600</td>
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Table 64.1

**INITIAL PROGRAM**

**LAND USE REQUIREMENTS**

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<th>Land Use Area</th>
<th>People</th>
<th>Gross Building Area</th>
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<th>Footprint</th>
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**INITIAL PROGRAM**

**SPACE LIST**

**Use**

**People**

**Capacity**

**No. of Units**

**Area per Unit**

**Net Area**

**Qualitative Comments**
FUNCTION
Overall, this research center serves three primary functions. First, it in an investment in freshwater research – Lake Superior in particular – in an effort to begin countering the negative influence years of industrialization has had on the North Shore. Secondly, the center aims to connect visitors and employees alike through interactions created within interior and exterior observation spaces. The scale of what is being observed spans from small scale within the research labs to large in the vistas of Lake Superior. These layers of perception allow users to become aware of how their interactions with their surroundings can impact it on any scale. Lastly, the center contributes to the general public’s awareness and knowledge of this cycle of sustainability through education spaces.

FORM
The form of the research center will primarily draw inspiration from Duluth’s industrial aesthetic and the significance of Lake Superior in its materiality and placement of open observation spaces. Additionally, the goal is to create clear connections from interior to exterior spaces while acting as an extension of the shore-side Lakewalk pathway that connects many of Duluth’s most culturally significant areas and attractions. Internally, the center will be defined by the balance and progression from its varying degrees of public and private spaces.

ECONOMY
There are several logistic and economic benefits in the construction and design of this center. As stated, this is an investment in a significant field of research within its context. In combination with the use of biomimetic technology to lessen its environmental impact, this building offers the opportunity to be a powerful and positive impact on the community by giving back as much as it takes by encouraging more sustainable thinking.

The time to begin creating a more sustainable architecture is now. However, given the nature of its typology, this design requires a flexible timeline to achieve a high level of design and construction quality in order for it to uphold its technological and cultural influences.
SITE NARRATIVE & ANALYSIS

Determining an effective location for this site required consideration of several primary factors: proximity to the general public, proximity to Lake Superior, and proximity to an area heavily influenced by industry. The site lies at 904 West Railroad Street in Duluth, Minnesota, existing as a gravel pit and truck turnaround. To the south lie several industrial staples to the area: the Georgia-Pacific paper manufacturer, the Duluth Timber Company, and many unloading docks for the incoming and outgoing shipping industries. To the north of the site lies downtown Duluth and the cultural heart of the city: Canal Park, featuring restaurants, shops, breweries, and local attractions such as the Duluth Lakewalk. The lakewalk spans more than 3 miles along the shore of Lake Superior and connecting Canal Park’s primary beach and the Aerial Lift Bridge by harbor. The path passes by the Duluth Visitor’s Center, the William A. Irving ship exhibit, the Great Lakes Aquarium, and the Bayfront Festival Ampitheater. It currently comes to a stop at the Pier B Resort, providing an opportunity to extend into the site to encourage public interactions.

Being located between such industrial and culturally significant areas, while being intersected by a popular public path, makes this site a strong location for the needs of a building with multiple private and public typologies.
EXISTING SITE CONDITIONS

The site currently exists as a gravel lot and truck turnaround. The only standing structure is a small garage on the Northeast corner of the lot. It is under-utilized as it offers potential for social and cultural influences.

One of the site’s biggest selling points is the proximity to Lake Superior. Recreational, cultural, and practical uses will make for a stronger freshwater research center typology. South of the site lies an industrial-era lumber mill that immediately connects us to another significant part of Duluth’s history and culture.

The site’s proximity to downtown and Canal Park area offers the opportunity for increased foot traffic from various sources into public spaces in the design while connecting the building to the cultural heart of Duluth.
A wind rose of Duluth’s yearly averages shows that northeast and southwest winds are the most predominant at speeds typically between 8-10 MPH. West/northwest winds blow consistently slower than the primary winds, as do north and southeast gales. Consistent winds offer the potential for the presence of turbines or collection systems. In areas like Duluth, the presence of snow build-up and accessibility must also be considered in the design of a year-round structure. As the site is a pier, the interaction of wind and water with the edge of this area also factor into the design as far as foundations or retaining walls and setbacks from the water.

Duluth’s latitude and longitude indicate that summer sun paths are more direct and over head while winter sun paths are lower on the horizon and make for shorter days. Considerations for these factors include proper application of shading devices, whether static or dynamic, and orientation of windows to best accumulate natural diffuse light at different times of the year. Shade from surrounding structures, such as the resort and hotels to the northeast. Shade and shadows on the site will dictate placement and use of public space.
TRAFFIC PATTERNS & ROAD ACCESS CONCLUSIONS

BAY ACCESS
A pier site offers the opportunity for boat access to the building during warmer months of the year. Currently there is moderate traffic from large ships and sailboats that fluctuates during the year. Design considerations for this opportunity would have to factor in the blocking of visitors’ view into the bay.

INTERSTATE 35
Consistently high traffic and high noise, Interstate 35 intersects the area near site. Although not an access point, the interstate impacts the noise levels and interrupts the hillside aesthetic that can be seen from the site. This calls for a response within the design for noise pollution control.

WEST RAILROAD STREET
The primary vehicle access point to the site is from West Railroad St. This road typically has low to moderate levels of traffic even though it is a direct route in the downtown waterfront area. Because of the manageable levels of traffic, this road acts as an ideal method of access to the site for employees as well as visitors without the need for drastic modification.
The primary objective within the architecture is to invite the public into a space that exposes the ramifications of our actions on our environment. This is particularly significant within the context of Duluth as Lake Superior is one of the defining features of the city and one of its most popular attractions. The existence of a freshwater research center continues the aspects of the lake that are celebrated. This project does not aim to prevent the celebration of the lake, rather refocus the public’s attention toward the health of the lake. In this way, the building approaches sustainable architecture in a way that extends beyond the building itself. The research behind this project critiques the modern approach to sustainability through the application of cosmetic systems that do not speak to a building’s context. This is addressed within the architecture through extension of the lakewalk into direct proximity of the labs that attempt to heal the body of water that the path attempts to beautify.
The occupancy type of this thesis project is primarily classified as Group B: Business as a research and conservation laboratory. Given the rigid architectural needs of a laboratory space, the close adherence to codes and regulation have a large impact on the design of the building. Limitations regarding occupancy, square footage, and the circulation between space—as outlined throughout this section—are largely defined by code regulation and provide a guideline for the core layouts of the spaces between floors.

**OCCUPANCY TYPE**

*Group B: Business - Research Center*

Sections 304.2

2+ stories and equipped with an automatic sprinkler system

**CODE & PERFORMANCE CRITERIA**
PROCESS MODELS

ITERATION 1

Figure 80.1

Figure 80.2

Figure 80.3

Figure 80.4

Figure 80.5

Figure 80.6

Figure 80.7

Figure 80.8

Figure 80.9

ITERATION 2

Figure 81.1

Figure 81.2

Figure 81.3

Figure 81.4

Figure 81.5

Figure 81.6

Figure 81.7

Figure 81.8

Figure 81.9

ITERATION 3

Figure 82.1

Figure 82.2

Figure 82.3

Figure 82.4

Figure 82.5

Figure 82.6

Figure 82.7

Figure 82.8

Figure 82.9
DESIGN SOLUTION

Figure 83.1
The subterranean level accommodates the unknown of what happens below the surface—the technical and scientific approach to cleansing our freshwater within the laboratories. Research labs call for more specialized and privatized spaces that don’t interfere with the circulation of the visitors.

Figure 84.1
Community & Interaction

Ground Level

In between the scientific and the introspective lies the ground level, a point of mediation between the two. The lakeswalk is extended within the building, inviting the general public within. Where the lakeswalk meets the primary entrance, a point of convergence is embodied within the sharing of knowledge within the auditorium, providing a space for conference and presentations. Encounters between the visitors and employees are encouraged throughout the café and areas of open circulation within and next to the lakeswalk.
Introspection
Upper Level

The second floor houses the more intimate and introspective experience with the pursuit of knowledge and growth through the library stacks, archives, and the overviews that isolate the individual. Technology areas, conference rooms, and observation areas offer varying degrees of interaction through the pursuit of knowledge, whether utilized by visitors or the employees.
This section perspective gives us a clearer look into the events transpiring within each level of the research center. From the northwest, the lakewalk is extended across the channel between two piers and into the ground level slightly below grade. This offers an opportunity to allow a lightwell along the path to let natural light into the subterranean labs. At the same time, a series of three reflection pools create moments of pause along the path while allowing addition natural lighting into the lower level. Overhead, the individual is called out and isolated within one of the three second-floor observation area that reflect the position of the reflection pools, standing as two opposing moments of looking toward the complexity within and out at the simplicity of the whole. Additionally, the geometry of the roofline, in combination with diversion channels, are conducive to the shedding and return of precipitation onto the site.

Figure 90.1
Within this northwest section we can more clearly see the difference in elevation between the lakeside path and the open communal spaces of the ground floor. This difference in elevation also acts to pull the body closer to surface level of lake superior and better aligns our line of sight with the reflection pools. There are several instances of displacement occurring between the site and the architecture. The reflection pools hold a thin layer of water, a small fraction of the great lake is held up against, while allowing a distorted view into the unknown of the lab spaces. Further than that, just as glaciers carved and shaped the face of the earth, the mass of the subterranean labs uproots a significant amount of soil. This soil is mirrored back on to the site where it houses the mechanisms for a living machine and the vertical wetlands that it feeds within the community areas.

A living machine is on-site water purification system that cleanses the water through a series of tanks embedded in the earth filtered through a series of wetlands. In this case, vertical bio-walls allow algae within the reflection pools. These immersed by the wetlands, the water can be drinkable or be used as non-drinking water. Two moment of biosimilary – allowing Nature’s systems to coexist productively with the technology we’ve produced – is repeated along the lakeside three times. At each reflecting pool the individual is offered a moment of being within the cycle: comparing the water of the pool to the simple expanse of the lake, a distorted view into the labs, and a view of the displaced soil that allows for the growth of the interior green walls.
ENTRY

The main entry is comprised of a sloped limestone ramp that embodies a sense of submersion into the space as you approach the lake walk and descend closer to surface level. Vertical slate walls drawn from local sources reflect the bedrock of Duluth while acting as a simple frame to draw attention toward Lake Superior. Further than that, the weight of these walls not only act as a canvas to host the reflections from the lake, but also as trombe walls that help hold a steady interior temperature within the space as time passes throughout the day. These materials act as a nod to the Notre Dame cathedral that precedes it as well as a nod toward Duluth’s aesthetic.

AUDITORIUM

Acting as the meeting point between the public lakeswalk and the entrance from the site, the auditorium offers a glimpse of the individual and the complex. Overhead, the individual is isolated and pushed out over the water, putting them in place that allows to look out beyond themselves, back at the patina of the corten steel, and framing them alongside the elements.
LABS

The labs embody the most primary use of the research center, although what happens within is not readily always readily apparent to the visitors. The view from the lightwells into the labs can be compared to looking into the depths of deep waters – we can only recognize it at surface level, but the particulars allude us. However, recognition and exposure to these events is one of the reasons for drawing the public in the space. Drawing the necessity of cleansing fresh-water closer to our day-to-day lives through the experience of this building reminds us of our responsibility to be mindful of our resources.

REFLECTION

Here we can see an example of how the reflecting pools create a moment of pause between the user, the architecture, and the site. A simple plane of water is both help up against the great lake while diverting your attention down into the lab spaces. This way, the viewers are caught in a moment between the micro and the macro, between the simple and the complex.
PATHWAY

Looking down the path of the lakewalk, we can see the culmination of materials and interaction between user and architecture. The ground and upper levels play against one another through the use of frosted structural glass floor panels. This allows for the muted distortion of light to reflected the shadows and movement within the archives above.

INTROSPECTION

Finally, we see the individual in a moment of introspection within the second floor observation area, drawn slightly away from the interactions of the library archives. As the architecture cantilevers out, we are brought closer to the horizon, blurring the lines between the floor that is being stood upon and the expansive surface of lake superior.
PERFORMANCE ANALYSIS

SITE & CONTEXT
One of the primary focuses on this thesis is to create architecture that comfortably settles into physical site and the city of Duluth overall. Existing along the shoreline of the Duluth Harbor, this design reflects the aesthetic of many downtown buildings that are connected through the Lakewalk. Duluth is reflected within the materiality in two ways. Industry is worn on the exterior; Corten steel that boasts the character of water in positive and negative ways. On the interior, natural slate and limestone from local quarries brings the bedrock of the city out of the earth and into the view of the users. View and pathways from the architecture were designed to bring into focus Lake Superior. The project was designed around using the context and aesthetic of Duluth to reframe a beloved landmark in a way that makes apparent its issues that are often overlooked by the general public.

GOALS & EMPHASIS
The primary objective within the architecture is to invite the public into a space that exposes the ramifications of our actions on our environment. This is particularly significant within the context of Duluth as Lake Superior is one of the defining features of the city and one of its most popular attractions. The existence of a freshwa- ter research center contrasts the aspects of the lake that are celebrated. This project does not aim to prevent the celebration of the lake, rather refocus the public’s attention toward the health of the lake. In this way, the building approaches sustainable architecture in a way that extends beyond the building itself. The research behind this project critiques the modern approach to sustainability through the application of cosmetic systems that do not speak to a building’s context. This is addressed within the architecture through extension of the lakewalk into direct proximity of the lifts that attempt to heal the body of water that the path attempts to beautify.

Figure 100.1


Halbe R. Subaquatic Water Spider Nests


Halbe R. Subaquatic Water Spider Nests


A.1 Professional Communication
Without the physical existence of this design, the architecture lives through its written and visual representations. Throughout the design process, the architecture has been designed and represented through many mediums. Some of the architectural experiences were discovered through the examination and written comparisons (pg. 50-57) between art and architecture. Architectural encounters happened within the creation and display of the artifact (pg. 46-49), embodying interpretations of the research while simultaneously creating a display that is unique in itself and within the final design. The final design is also represented through more traditional methods of representions and diagrams that are meant to put together the preceding ideas within the architecture without reducing it to merely images. The accumulation of these multiple modes of representations becomes the experience of the architecture.

A.6 Use of Precedents
The overarching premise within this project of freshwater as a cultural and historic relic through- out the course of human history naturally lends itself to a heavy reliance on precedents. At the fundamental level of the architectural experience, the buildings researched explore sustainability that goes beyond standard prescribed methods, including biomimicry and response to climate influences, and the preservation of an industry-heavy culture. The Vanier Centre for Interactive Research, ITEK’s pavilion space, and the Museum Design Center (pg. 34-37) each embody a critical element in the meta-principle of this thesis. As research progressed, the exploration of artwork as archi- tectural precedents unraveled what would become the individual experience of the architecture. In the attempt to understand the architectural experience, Da Vinci’s Dewechathe (pg. 50-55) serves to unravel this complexity within the accumulation of simple forms, which are clearly seen within the artifact. This translated into the architecture through the framing of the complex- ities within the lake and Superior through the repetition of simple geometries. In the case of Bekkum’s Constitu (56-57), a reality becomes apparent that challenges the standard perspective. The architecture aims to achieve something similar in the framing of Lake Superior as something damaged rather than a perfect form.

B.1 Pre-Design Ability

**USERS** (pg. 15)
The success of any architecture lies within creating the experience of the building to the needs of the users. This research center is defined by the needs of scientists working within the labs and offices as well as the visitors entering from the Lakewalk. The needs of these users comes from the research of buildings with similar typologies, discussed in the precedents, as well as placing yourself in the shoes of the visitors within the context of the city through site visits.

**SITE & ANALYSIS** (pg. 66-77)
Similarly, the selection of the site comes from not just the needs of the users, but the needs of the city. As Duluth is defined both by its industrial history and strong connections to its natural surroundings, the placement of the site between these two creates a stronger bond between the architecture and site as well as between the architecture and user. Further than that, the analysis of site conditions puts em- phasis on the influence of both the surrounding infrastructure and climate of the need to allow the architecture integrate itself.

**SPACE REQUIREMENTS** (pg. 64-65)
The primary focuses of interior spaces are divided between the technical and the experiential: the science-focused lab and archives alongside the cul- turally-focused Lakewalk and community spaces. Potential spaces explored, whether or not included in the final design, are expanded upon in the original- programming and outline technical sizing as well as the qualitative qualities of each space.

**CODES** (pg. 78-79)
Given the technical nature of the typology, ad-herence to standard codes is necessary within this design. Restrictions addressed most thoroughly include the maximum square footage and building height allowed for the area and the typology. ADA requirements within restrooms and ramps, as well as occupancy limitations and exit sizing for ease of egress.

C.2 Evaluation & Decision-Making

**PROBLEM IDENTIFICATION**
The creation of this thesis lies in the pinpointing of a relevant issue that can be addressed through architecture. This project aims to carry the weight of the significance of freshwater as something essential and once coveted, yet through the passing of time has become overlooked in some regards. This is made clear through the historic and cultural research (pg. 38-45) that exposes freshwater as something that exists as an element pure enough to exist within us, yet fragile enough to need inter- vention. Understanding the scale of both and how they influence us day-to-day creates a relevance in this topic that can be carried beyond a singular site within Duluth, Minnesota.

**SETTING CRITERIA**
The thesis project is identified in several ways. Initial programming (pg. 62-67) sets the stage for potential spaces and both quantita- tive and qualitative features. The overarching goals of the thesis encompass the positive and profound influence the architecture aims to have on the site and the users alike. And again, the extensive ex- ploration of several types of precedents outline the technical and experiential qualities that this thesis strives to live up to.

**ANALYZING & PREDICTING SOLUTIONS**

The resultant architecture and its success is ana- lysed in two ways that supplement the physical existence of the space. First, through the perfor-

mance analysis (pg. 101) that explains how the site, context, and goals are addressed within particular aspects of design. Second, in a less technical way through the successful representation of the renders (pg. 82-99) that are meant to encompass an experience created through the research of preced- ents and the creation of the artifact.
DESIGN STUDIO EXPERIENCE

2nd Year
Fall 2013                     Cindy Urness; Teahouse
Spring 2014                  Joan Vorderbruggen; Dwelling
                            Dance Studio

3rd Year
Fall 2014                  Ron Ramsay; Agincourt Addition,
                            Elder Wickersham Auditorium
Spring 2015               Mark Barnhouse; NDSU Library,
                            Research Laboratory

4th Year
Fall 2015                     David Crutchfield; Urban Lush High Rise
Spring 2016                   Paul Gleye; Brussels Urban Redesign

5th Year
Fall 2016                       Stephen Wischer; Thesis Contextualization
                            and Artefact
Spring 2017                   Stephen Wischer; Architectural Thesis Design

Cindy Urness; Tea
Joan Vorderbruggen; Dwelling
Dance Studio
Ron Ramsay; Agincourt Addition,
Elder Wickersham Auditorium
Mark Barnhouse; NDSU Library,
Research Laboratory
David Crutchfield; Urban Lush High Rise
Paul Gleye; Brussels Urban Redesign
Stephen Wischer; Thesis Contextualization
and Artefact
Stephen Wischer; Architectural Thesis Design

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