RIVERSCAPE METROPARK: EDUCATING THE PUBLIC ABOUT THE AQUATIC ENVIRONMENT

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ABSTRACT

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by Sarah Shavonne Barry

Most of the buildings people encounter simply reside in their environment with no way of being able to tell its story. They are placed in a complex landscape to fulfill a role for humanity–a passive state of being at best. A building as its basic existence must not only reside in its context and environment but should also reflect the health of that environment back to its inhabitants. Too many buildings contribute to the degradation of their context rather than contributing to it. Regardless of the individual building's contribution to its place, the inhabitants go about their lives, ignorant to either the building's impact or the subtle, often invisible changes in their environment. Such a concern takes place with the Great Miami River in downtown Dayton, Ohio. Although the river is an integral part of the city's fabric, many of the city's inhabitants are largely unaware of its current health. To reflect the river's health back to the city and create a sense of urgency around the issue, a research facility aimed to educate the public will be proposed, making the invisible conditions of the river visible and creates a safer, cleaner aquatic environment for all to enjoy.

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Acknowledgements

First, I would like to thank both of my previous thesis studio professors—Jeff Kruth and Kory Beighle—for helping me push my project forward when my next steps were unclear.

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I would also like to thank my mom for not only traveling to campus to watch me give my thesis presentation, but also for her encouragement throughout this stressful but tremendously rewarding process.

Finally, to my classmates, thank you for giving me design advice and for listening to all of my ridiculous jokes in studio, especially Kari, who oftentimes had to hear the same joke four times in a day.

My thesis would not have been where it is today without any of you.

Figure 1: Signature Loaf

Lastly, thank you to whomever at Lumion decided to include this loaf of bread in the selection of props. I have hidden this loaf in every rendering I've made since my junior year of undergraduate studies. What once started out as a joke turned into my signature mark, and it made the rendering process very enjoyable. It brought my cohort and I several laughs, and even my committee seemed to love it. Thankfully they didn't seem to think I was loafing around too much and for that, I am grateful. Otherwise, I may have been toast. It's a shame that bread puns have to be so crumby…I'm really on a roll…

Cheers to the final loaf!

Preface

My thesis journey began sometime in late January of 2021, where in time I was asked to consider what I wanted to explore for my final project. At the time, I had an interest in designing a temporary installation or small building that would be capable of performing physical reactions or deformations in response to various changes in its environment. As my research and journey evolved, so did my overall topic. By the end of May in 2021, I produced a document that detailed my thesis trajectory as I knew it which outlined the research I conducted up until that point. Now that the thesis process is coming to an end, it needs to be clear that although the initial document is no longer fully reflective of the end product, it will serve as the base for this written thesis. *After each section of the original document, I will provide an addendum explaining any changes in the process, where necessary, and will be italicized to distinguish it from the original work.*

[1] Project Description

This thesis proposal began with a consideration of my hobbies and interests, one of which is my passion for flying sport and traction kites. One of my kites is self-inflating with 18 ripstop-nylon cells, which eventually prompted me to think about how a design can respond to a stimulus. My kite does exactly this-when a certain amount of wind is present, the individual cells inflate. This led me to expand my thinking from kites and wind to potential applications in architecture. At first, the exploration included mostly inflatable architecture and kinetic facades, but has since narrowed to a specific technology that makes interactive architecture possible. Interactive architecture typically refers to a system where both people and buildings enter a conversation with each other in real-time. This differs from responsive architecture, which simply refers to a space that responds to the environment around it, but people are not able to influence its behavior. Currently, this thesis project will explore how the built environment and its users can engage each other in real-time through the use of sensors, processors, and actuators.

Advancing the scope of this thesis project requires me to decide how I want to approach interactive architecture, which likely begins with the physical exploration of the technology behind it. As mentioned in the abstract, rapid technological advancements have been made that increased its availability and minimizes the barrier to entry. In other words, nearly anyone has the ability to experiment with microcontrollers if they have an interest. One of these technologies is called Arduino, which is an open-source technology platform with hardware that is easy to use. Arduino boards are a specific kind of microcontroller that reads inputs (such as a button activation or sensor-gathered information) and translates it to an output (activating a motor, turning on an LED, prompting a color change). The boards can be fully controlled via computer scripts, and projects range from simple tasks to more complex ones. Arduino boards also claim to be targeted towards students without a background in electronics and programming, which will likely be relatively easy to use in this thesis proposal. Ideally, I plan to use the Arduino kits to create a physical model of something that can be applied onto the surface of a building, or something that can become integrated into a building system. This will only be possible after I educate myself about how Arduino works, as I have no prior experience, and after I have built a series of prototypes and explored iterations of each. Currently, I would like to explore how I can make a prototype that responds to temperature, light, or human movement, but the specific method or prototype design still needs to be defined.

[1] Project Description Addendum

The initial proposal of using a form of interactive architecture to provoke a physical response in the built environment based on changes in the environment served as the foundation for where this thesis would one day land. My interest physical building responses slowly lessened over time due to my own capabilities and limitations, but the goal of making a building that was either contextually aware of its environment or had a way to be reflective of its environment was still intact. Over the course of the second thesis semester, I moved away from physical building changes and began to consider what other forms of interaction in architecture could occur and forced me to define what exactly "interaction" meant. The first form of interaction I explored was at the start of thesis process, which was between a building and its primary inhabitants—people. As the second semester progressed, I also considered an interaction between humans and the environment. Here, I was interested in how architecture had *the potential to detect both human and environmental needs to deepen our connection with nature and how it would allow us to experience an alternate environment. I was also interested in the fact that most buildings simply reside in their context with no way to reflect their environment back to the people who use it, and that a building itself should become a storyteller rather than just being the venue for it. These interests helped me form my final definition of "interaction", which examined how the built environment can be reflective of a local aquatic environment.*

From here, I selected my site in Dayton, Ohio, which is RiverScape MetroPark. It is at the northern end of downtown and is situated along the Great Miami River. Although the river is an integral part of the city, many of the area's inhabitants remain unaware of the current health of the river. There have been legacy pollution problems with the water, but this seems to go unnoticed in everyday life. Several low-level recreational dams have been built across the river for the public to use for activities such as canoeing, kayaking, white water rafting, fishing, and sometimes even wading. In order to reflect the river's health back to the city and create a sense of urgency around the issue, I will propose a new research facility that aims to educate the public about the compromised river conditions. The new building will serve as both a social and programmatic hub where local scientists, researchers, and members of the public will have the opportunity to engage with one another. This in turn creates a programmatic hub for research, recreation, and education opportunities, which creates a unique experience for the building inhabitants. These four strategies—research, recreation, education, and experience—serve as the main categories in which people will learn about the river environment through the building. Each of these strategies has been assigned a color to make them easily recognizable in the final presentation. Finally, the last step in developing these four main strategies was finding a creative way to organize them. The final outcome was a new rendition of the periodic table, which will be elaborated upon in the methodology section. My final thesis question asks:

How can a building employ strategies to create urgency around the health of its environment to educate its inhabitants?

There are two main goals in which my thesis strives to meet. The first is to create a hub where scientists and researchers from the Miami Conservancy District and the public can meet and engage with one another. The second goal is to develop a palette of strategies to educate those who visit the building about the health of the Great Miami River.

[2.1] Key words:

Adaptive architecture, Arduino, intelligent buildings, interactive architecture, kinetics, prototyping, sensors, sensory environments, smart buildings

[2.2] Key Words Addendum

Aquatic conditions, bridge, cantilever, education, educational strategies, experience, flood, plinth, pollution, recreation, research, strategies, urgency, water

[3] Literature Review

One of the newest branches in architecture is called Interactive Architecture (IA), which generally refers to buildings that incorporate a trio of sensors, processors and effectors as part of their function. It encompasses aspects of building animation, but ultimately transcends this to give agency to both its environment and the people who experience it. The foundation of IA began out of the desire to create flexible spaces that meet changing demands with respect to evolving individual, societal, and environmental needs in real-time.

Interactive Architecture: What it is, and What it isn't

To clarify the scope of this thesis project, it becomes necessary to define what IA is. As I have progressed my research, it seems as though the words "reactive," "responsive," "adaptive," and many others are used interchangeably with "interactive" when referring to this area of architecture but implies a different meaning. Generally, IA facilitates a simultaneous relationship between human participants and the built environment and is a multiple-loop system in which one enters a conversation: a continual and constructive information exchange (Fox, 2009). These interactions occur in real-time, which means that to an extent, the resulting interaction had not been previously designed or created with bias. Instead, it occurs as shifts in the environment and human participants take place. Additionally, interaction is not just confined to the art world; it provides real and oftentimes very remarkable solutions for the workplace, leisure sector, retail, and the domestic (Lehman, 2017).

To further define what IA is, it also becomes necessary to define what it isn't. Without the interaction between human and building, or without a way for participants to influence the system, the design cannot be truly interactive. Because of this, architectural behavior can fall into one of three pertinent categories: the *prescribed, responsive,* and the *interactive.* In short, the *prescribed* includes architecture that follows a preconceived story, or unfolds over time. One of my earliest (and no longer completely relevant) precedent studies is the Beijing National Aquatics Center, which boasts an ETFE envelope that integrates projections into its facade at night. While the projected media changes, no other interaction occurs, therefore classifying it as *prescribed* architecture. *Responsive* architecture goes one step further and considers a space that responds to its environment, but humans have no way of impacting the way that the building absorbs information. Here, no direct interactivity can occur. The final category is the *interactive*, and the key to labeling architecture as interactive requires that both human participants and the built environment have a two-way, real-time conversation. An example of this is the Aegis Hyposurface, a faceted metallic surface that deforms in real-time based on changes in light, sound, and movement. It reads these changes through a series of sensors that input information into processors, which in turn actuate an array of pistons that controls the wall's form. The interplay between Aegis Hyposurface and the people who visit it is what categorizes the wall as a form of IA.

A Brief History

The concept of IA is nothing new; it was first conceptualized in the 1960s with the rise of people working in cybernetics, which is the science of communication between machines and living things. At the time, such architecture was often envisioned through science fiction (Kolarevic, 2015) since the technology required to produce this kind of work did not yet exist. This generation of designers and architects were heavily influenced by the broad availability of new materials, advancements in plastics and composites, and the sudden open access to information and technologies that provided education and unrestricted access to tools (Kretzer and Hovestadt, 2014). Two of the leading figures in interactive architecture was Gordon Pask and Cedric Price, whose names are mentioned across several books relating to IA. Pask is often credited with being the founder of IA with his concept of *Conversation Theory*, which was a comprehensive theory of interaction (Kolarevic, 2015). Price adopted principles of cybernetics to articulate the concept of what he calls "anticipatory architecture" (Kolarevic, 2015) and was devoted to making advancements in both computer science and cybernetics (Kretzer and Hovestadt, 2014). He also worked closely with Pask, and together, they were able to take the initial steps of creating an architecture that was physically capable of moving in response to changes in its environment. A third major figure, John Frazer, later expanded on Price's idea, arguing that architecture should be a "living, evolving thing" and outlines eight aspects of evolution that all produce change at a variety of scales, which he later uses as the basis for his work (Fox, 2009).

<u>Use of Sensors</u>

Using sensors is paramount to creating interactive environments. They allow information from the real world to be fed into a computer to be analyzed or acted upon in some way, such as light, motion, and temperature. The earliest sensors had a very limited scope of what they could detect and required someone to input their data into a computer for another person to interpret. As the technology developed, they became increasingly smart and have recently achieved an extremely high level of sophistication while becoming smaller, cheaper, and more responsive (Fox, 2009). Some sensors are limited to single-motion detection technology while advanced sensors are capable of things such as pattern recognition. Furthermore, there are two main categories of sensors-those that are contact-based or non-contact-based. Contact-based sensors rely on direct exchanges of information, such as physical human touch, or the presence of moisture, pressure, wind, or other environmental factor, whereas non-contact-based sensors rely on sensing a presence, and include infrared, sonar, gyroscopic, accelerometers, tilt, light, cameras, microphones, and so on (Fox, 2009).

Today, they are used to solve real-world problems and have been introduced to the manufacturing and processing industries. Sensors have become increasingly self-aware, along with being aware of other sensors and even actuators that allow them to act on the information they collect. For the most part, this is accomplished through the use of microcontrollers (such as Arduino) and networking devices. They all require someone to input a code into the computer to interpret the data and to tell the computer or other reactive system how to respond accordingly. This sort of digital communication, especially wireless, has become a key part of sensing systems. As technological advancements and widespread availability progresses, wireless sensing technologies will dominate the evolution of ubiquitous communications and computing in the future (Bullivant, 2006).

<u>Arduino</u>

In recent years, the ability to create interactive environments and experiment with architectural prototyping has become increasingly available. This can be seen in the inexpensive, open-source microcontroller called Arduino (Cantrell and Holzman, 2016). It has the ability to connect to an array of sensors to detect environmental qualities such as light, temperature, sound, heat, and motion (Kretzer and Hovestadt, 2014). The information gathered in the sensors is sent to the microcontroller that can in turn activate lights, motors, and actuators. Many architecture schools offer courses in Arduino, where students are encouraged to experiment and explore their ideas by building prototypes that contribute to the realm of dynamic built environments. By using this technology or through a similar strategy, architecture has a great potential to become interactive and increasingly aware of their environment by sensing what is around them and adjusting accordingly.

Furthermore, Arduino has recently become directly integrated into common modeling and drafting tools such as Firefly for Grasshopper and Rhino. This direct connection creates links between sensing and activation with parametric modeling tools, going so as far as to remove the necessity for coding and replacing it with a visual script (Cantrell and Holzman, 2016). Since Arduino is an open-source product, the proliferation of numerous projects allows each successive design or designer to be built upon. This also becomes beneficial to beginners because they have the ability to not only learn and mimic other projects that have been completed, but they can also dissect another designer's project to understand their code, hardware solutions, and overall methodology, and increases the source of common knowledge (Cantrell and Holzman, 2016).

According to several online testimonials from novices like myself, Arduino's target audience is for those who have no prior experience with it, even when it comes to learning how to program or writing scripts. Projects can range from as something simple as blinking an LED module to creating small robots or making home automation systems. Unlike other soldering boards and microcontrollers, Arduino boards can be reused and taken apart to accommodate new projects, which will help control the cost factor during this thesis project. There are numerous Arduino applications both inside the architectural profession, and outside of it, meaning that experimentation can continue even beyond the completion of this thesis project. Several kits exist and each has different wires, boards, sensors, and other components that will require some research before any individual kit can be chosen for this project.

<u>Sociological, Psychological, and Physiological Implications</u>

Every environment has its unique set of physical qualities and affects how we experience a place depending on how people interact with it. IA takes this experience to another level because of its ability to impact the mood or behavior of its occupants. For this reason, architects and designers must think carefully about how a stimulus affects the building occupants because the human body naturally responds to its environment--it shivers when its internal temperature drops below a certain level, our vision is greatly reduced in the dark, and if the body becomes too stressed, we become prone to headaches and even migraines. Thus, designers must pay attention to not only the mind, but also human emotions and the body (Lehman, 2017). An IA environment can not only facilitate lifestyles and behaviors, but also influence them, and it is important to remember that our physiological and sociological interpretations of space are influenced by many factors beyond the spatial confines or interpreted definition of space and include lighting, acoustics, and smell (Fox, 2009). However, stimuli can be controlled in a strategic manner to uplift and enhance the environments that we occupy.

Beyond the design considerations for the human mind and body, designers must also be aware of people's changing lifestyle patterns. There has been a massive growth in people's level of computer literacy, and trends in the workplace are indicating that some individuals at various levels in the workforce are choosing to work less and work at home in order to devote more time to personal and family interests (Fox, 2009). To clarify, this was a pre-pandemic time and not a recent shift, although we have seen a greater number of people working from home as a result.

Technological advancements in IA also require occupants to learn about the system before its effectiveness can be determined, but Fox cautions that a conversation between users and the systems can make counterintuitive and inefficient actions explicit (2009). He also adds that While IA behaviors can be adapted to and facilitated, that they could be denied or even manipulated because of unanticipated reactions. However, Fox also acknowledges that a space needs to communicate in a clear temporal manner that allows the users with whom it interacts to engage with it holistically; the users should be able to perceive a changing spatial environment as opposed to individual actions in a system (Fox, 2009). This gives users a sense of stability in a changing space, and prevents them from feeling out of control of the system if they can't anticipate its next move.

IA even has the potential to have an emotional and collaborative effect on users. When users and systems clearly communicate with each other, users are likely to form an emotional attachment to the object. Fox presents a fascinating example in his book, saying that if a group of people have to learn how to interact with a new door to figure out how to open it, there would be numerous attempts to try different strategies to open the door. If one of those strategies were successful or the attempts were rewarded, Fox says that there would be a collaborative effort in solving the problem and a communal sense of success when the door opened. Here, the point is that IA applications with novel potential for change must be extremely explicit for the system to succeed (Fox, 2009). In a similar argument, Bullivant states that at every level, interactive design encourages us to leave our isolates selves and interact with a greater social group (Bullivant, 2006), perhaps for merely watching as a faceted metallic surface deforms in an art gallery or contributing to an interactive sculpture within a large urban scale.

<u>Economic Feasibility</u>

It wasn't until around the 1990s that IA was able to gain a foothold in the larger design profession, which was largely due to technological advancements and the widespread availability of such technologies. There was a shift in creating energy barriers to harvesting it and applying it to where it was needed, such as through blocking heat gain and minimizing heat loss. Double-skinned facades with vented air capabilities and oftentimes integrated blinds for shading purposes. At the start of the century, adaptive, kinetic or dynamic facades, active and high-performing building envelopes entered architecture's vocabulary--and practice (Kretzer and Hovestadt, 2014). Since then, much of this technology came in the form of inexpensive sensors and microcontrollers. Kretzer and Hovestadt say that this is exactly where we're at today: we can have any type of energy, any type of information, any type of operation at any point, anywhere in the world (2014). While this is true, nearly all of the major books pertinent to this thesis topic have stated that IA is somewhat an extension of those who occupy it, where both the design and level of interaction are not a one-size-fits-all approach.

One of the current goals of IA is the dream of large-scale interactive systems; despite the availability of the constituent ingredients, the number of large-scale installations employing distributed behavior in hardware and software is very small. The vast majority of systems are still controlled from a central computer that creates the desired behavior and that faces obvious issues of scale (Kretzer and Hovestadt, 2014). Despite advancements in technology and its widespread availability, IA has not been able to gain a strong foothold in the larger design profession. Some of this is attributed to a rather utopian theoretical approach, and while IA is currently limited to the academic realm and installations, some would argue that its future is not exactly clear. Some architects and designers believe that architecture will have to influence new paradigms in technology instead of the technology influencing our architecture. However, IA has very quickly reached a point where technological aptitude is surpassing visionary imagination (Fox and Kemp, 2009) and will continue to evolve until a seamless integration is achieved.

Fears, Limitations and Setbacks in IA

As interactive architecture begins to gain foothold in the profession, we must identify and work to address the current fears, limitations, and setbacks that the new field brings. One of the inherent qualities of IA is its automated computation and its potential to act with a mind of its own. Kretzer states that humans fear losing control of their environments because whenever one gives up or loses such control, things tend to end up messy, at least until a hero steps in and puts humans back in charge at the end of the story. He also addresses that micromanaging hundreds of inhabitants and potentially millions of adjustable elements (light fixtures, climate zones, and acoustic membranes to mention a few) would most likely cause significantly more problems than benefits (Kretzer and Hovestadt, 2014). Bullivant argues for a similar reaction, saying that if intelligent spaces were truly intelligent, humans might not like them because we want them to be intelligent, but acquiescent. She also states that the power of interactive environments is that they aren't purely predetermined because both the system itself and those who interact with it simultaneously learn from the experience and redefine their sense of place (Bullivant, 2006). Kretzer would agree with Bullivant, saying that despite the fear of giving up some control of our environment so that our buildings could come to life and balance its systems with people while maintaining efficient performance is a very compelling thought.

Kretzer and Bullivant aren't the only voices raising concern against the potential limitations of IA. Maria Lehman also voices her concern that today's architecture is not equipped or designed to deal with an influx of information because it has yet to process and present information to enhance user experience. As a result, problems emerge when our current technology makes people multitask, inadvertently causing them to work without their complete focus (Lehman, 2017). Too much information at the wrong time, from the wrong source can have debilitating effects. If unfiltered information travels without purpose, it is certain to confuse or overwhelm its observer. However, Lehman acknowledges that as architecture evolves, it will have to filter what kind of information it feeds to its human occupants to prevent an overload. One way to accomplish this would be for a building to sense what its occupants need, access the appropriate information, and present it in a goal-oriented manner, such as improving focus in the workplace (Lehman, 2017).

[3.1] Literature Review Addendum

While the literature review accurately reflects my thesis project in its earliest stage, it doesn't fully reflect where the thesis now resides. At the time of writing this addendum, there are two weeks left in the semester until graduation, which unfortunately does not afford me the time to revise the literature review to a high enough quality that I would be content with. However, I did some very brief research and found what I think would be a great starting point for the updated research. According to the EPA, "environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions".

[4] Precedents

The following precedents have been updated to reflect the final thesis project.

Across each of these precedent studies is a theme of educating the public about the environment, creating a destination or mini hub for activities, and exposing groups of people to one another, such as scientists and researchers with the public. Each of the precedents also have an immediate adjacency with a body of water (river or bay) and must navigate the ever-changing water levels on the site to keep the buildings fully accessible during floods.

[4.1] 11th Street Bridge Park

The 11th Street Bridge Park was designed by Jason Long of OMA along with landscape architecture firm OLIN. It is a pedestrian bridge park located in Washington, D.C. that aims to revitalize the original street structure into a new civic space for the community. It has been called an incredible opportunity to create a new space in the city while promoting the health of the river and the adjacent communities.

The design itself resembles an X-shape, which pulls a bridge from either side of the river to create a sheltered area where it intersects. This area hosts a café space and performance space, both of which have expansive views of the river environment beyond. Leading up to where the

Figure 4.1.1: Conceptual Overview

two bridges meet is plenty of open green space, and each side of the bridge uses the green space differently. On one end is a water and rain garden, while the other end has open plazas, lawns, and space for urban agricultural plots. There is also plans to include an environmental education center near the intersection of either bridge, which would provide both adults and children with ways to learn about the river ecosystem. Beneath the bridge is additional park space, a hammock lounge, and a dock for people to fish or launch canoes or kayaks from. Although this project is still in the conceptual phase, it is nearing completion and much of the funding has been secured, allowing construction to begin in the coming months. The extensive program paired with several opportunities for research, recreational, educational, and experiential activities, this would make the pedestrian bridge a popular location in the city, creates its own destination, and aligns well with the scope of my thesis trajectory.

[4.2] Water Institute Headquarters

The Water Institute Headquarters was designed by global architecture firm Perkins+Will in 2018 and is located in Baton Rouge, Louisiana. It is a research organization that stretches out

Figure 4.2.1: View from Shoreline

over the Mississippi River on a historical dock 35 feet above the water and is designed to remain fully functional during floods, which frequently leaves the shoreline completely submerged. In sitting 35 feet above the river, the building also sits above the highest anticipated flood line, so that when the water levels rise and the surrounding landscape is flooded, the building remains accessible and fully functional to scientists, researchers, and visitors alike. The organization is a non-profit center that conducts aquatic research on local systems and the coastal communities and aims to share its findings with others.

Being rectilinear in plan, the research center sits at the end of the pier but is surrounded by a continuous outdoor walkway all around the first level, which is mostly comprised of glazed walls. This creates expansive views of the river from both inside the research facility as well as from outside on the walkway. From an elevation view, the building is wedge-shaped and is shrouded with a metal screen to give it a sculptural feeling. This helps to mitigate unwanted solar heat gain and creates playful shadows and textures on the building throughout the day. It is supported by V-shaped columns that encircles the entire building. One of the other design intentions was to expose visitors to scientific and research activities, and to achieve this, a

Figure 4.2.2: Research Laboratory

research laboratory was placed on the first floor with large windows. This would allow visitors to peer inside and observe the activities beyond. Overall, the research center encompasses roughly 34,000 square feet and hosts an extensive program across three levels. The first level hosts office spaces and laboratories for the researchers, and the second floor has the main offices for the facility. On the third level is a large conference center where the facility can host a range of activities.

This was perhaps the most impactful case study to the development of my thesis project. Navigating the ever-changing height of the river and keeping the building accessible during floods was one of the biggest challenges of my project, which will be detailed in a later section. The idea of exposing research activities to the visitors from both inside and outside the building was a major strategy borrowed in my own design, as well as using an exterior walkway around the entirety of the first floor. Other strategies and programmatic uses borrowed from this precedent was the inclusion of a publicly accessible café, a multi-purpose area, separate workspaces for the scientists and researchers, and shrouding the primary building wing with a perforated metal screen.

[4.3] Klimatorium Climate Center

The Klimatorium Climate Center was designed by 3XN Architects + SLA Architects in Lemvig, Denmark, and was completed in 2021. The Klimatorium serves as a mini hub for storm surge, water, and climate research, which is open to the public. It also offers several outdoor recreational opportunities for visitors to explore, sense, and experience the natural context. The design of the building is kept simple; it is rectilinear in plan and the material palette was limited

Figure 4.3.1: Klimatorium Climate Center

to wood, concrete, and steel. A large wooden "wave" in the building façade rises above the main entrance and turns the building into its very own landmark. It serves as a tribute to the area's fishing boats, the area's cultural history, and local building customs. Furthermore, it serves as a gathering point and social meeting place on the interior and exterior of the building for the Klimatorium employees as well as any visitors.

The exterior of the building is clad with black-stained wood slats on the second level to give the building a simple and worn look, while also protecting it from direct sunlight. The first floor is encircled with a continuous wall of glazing that redirects your attention to the black slats above. Inside, one is greeted with a double height atrium space, with office spaces, meeting rooms, common areas, a publicly accessible café, and an exhibition area beyond. This palette of rooms encourages different user groups to engage with one another, meet, and collaborate. Additionally, visual connections, flexible frameworks, attractive meeting areas, overlapping functions, and activity-based design all contribute to reinforcing social relationships between building inhabitants. Given its proximity to the bay, an extensive and integrated flood protection system was built as part of the climate center, which is something that all three of these precedent studies share.

[5] Methodology

The following methods have been updated to reflect the final thesis project.

To move my thesis project from a concept to realization, I have identified several methods that will assist me in furthering my research. Some of these take a more hands-on approach than others, and some require a bit of traveling. These methods include selecting a site directly adjacent to a body of water, identifying potential problems with the water quality, conducting site visits, obtaining graphs and drawings from the Miami Conservancy District, monitoring daily water levels at my site, and developing educational design strategies as well as a way to organize them.

Site Selection

At the start of the thesis process, four different sites across Indiana and Ohio. The final site selection was RiverScape MetroPark on the northern end of downtown Dayton, Ohio, along the southern bank of the Great Miami River. This site was selected for various reasons; it

Figure 5.1: RiverScape MetroPark

struggles with water quality problems, and the site itself is already a popular destination in the city as roughly 300,000 people pass through the site each year. Sectionally speaking, the site has a drastic elevation change and features a 20-foot-tall earthen levee wall along the southern end. While the top of the levee protects Dayton against floodwaters, the levee base is in the floodplain, and anything placed here must be able to negotiate the inevitable flooding. Along the water's edge of the site is the Great Miami River Recreational Trail, which hugs the river for 77 consecutive miles between Middletown and Piqua. Another reason for selecting this site was its relative proximity. It was important to me to pick a site that I could go to, visit for an hour or so, and then come back within just a few hours so as to maximize my time.

Identifying the Problem

As part of selecting my thesis site, it was necessary to research any water quality issues in the Great Miami River at my site. To set up the problem, Butler County Water & Sewage released a statistic that over 40 percent of the rivers and streams in the Great Miami Watershed fail to meet Ohio's water quality standards. The river also has legacy pollution problems resulting from nearby industrial runoff and agricultural over-enrichment. Furthermore, there are several low-level recreational dams near downtown Dayton that does not allow enough water to flow through, which in turn holds back a higher level of pollutants. Finally, according to the Miami Conservancy District, there are high spikes in bacteria after it rains, but the levels usually recede within 72 hours. Overall, these issues are creating poor water quality levels and despite the Great Miami River having such a major presence in Dayton, there is a lack of urgency around the problem and the city's inhabitants need to be aware of such an issue.

Conducting Site Visits

Part of strengthening my thesis project includes visiting RiverScape MetroPark because it has a unique set of qualities that need to be identified and explored, especially the earthen levee wall. The site visits will likely occur in two stages, where the first would consist of familiarizing myself with the site as well as spending time observing how others use the park. The second stage would include making periodic trips to the site to photograph different levels of flooding at the levee base, especially after heavy periods of storms and rainfall. Making a series of visits over time allowed me to observe how people used the site during various times of the

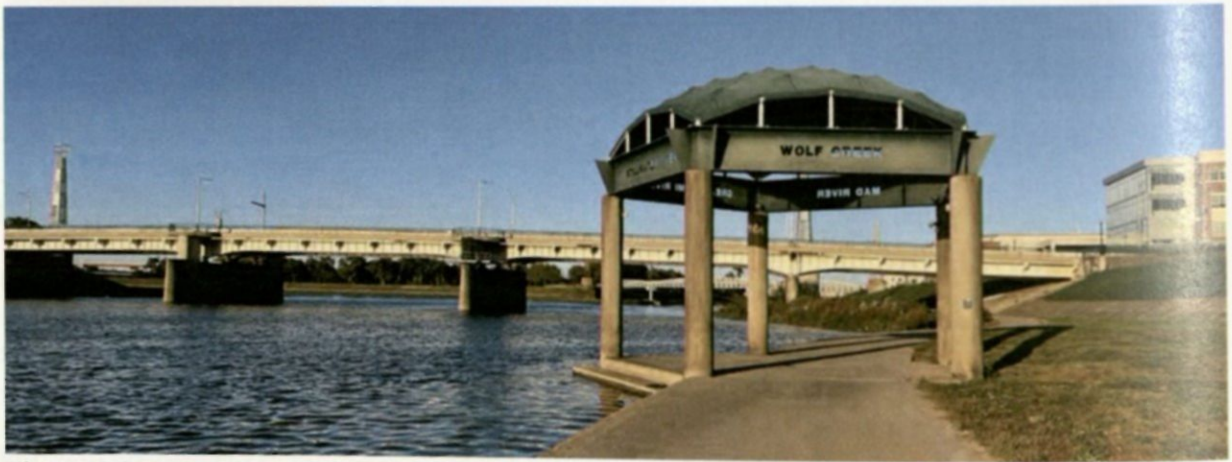

Figure 5.2: Levee Base

year, as well as what types of people came to the site along with the activities they did. It also allowed me to observe the changes in water height over time, which made me realize just how much of the site floods during the rainy season.

Obtaining Information from the Miami Conservancy District (MCD)

Soon after selecting RiverScape MetroPark as my site, a period of intensive site analysis began. During the process, I documented data such as the types of fish living in the river, created a detailed topographic map of the area in 2' intervals, and created a zoning map that showed where the light and heavy industrial areas are in relation to the site and other parks, indicating how much of the industrial pollution passes through my site as the river flows from east to west. Shortly after the first round of site analysis was completed, I wanted to reach out to the Miami Conservancy District (which was founded in 1915 to protect the Miami Valley from floods) to see if they had any graphs or maps showing the profile of the riverbed near my site. During my initial research, finding any information on the depth, speed, or section of the river was very difficult. When I reached out to the MCD, they were happy to provide me with a couple sectional profiles of the river that also indicated the water's speed.

Figure 5.3: Great Miami Riverbed Section Key

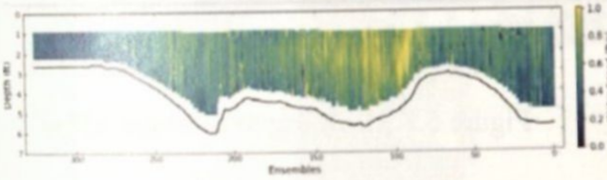

Figure 5.4: Riverbed Section 1

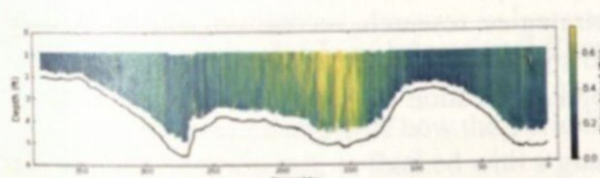

Figure 5.5: Riverbed Section 2

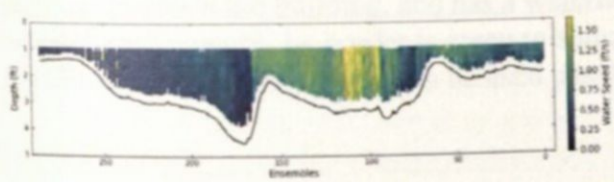

Figure 5.6: Riverbed Section 3

Monitoring Daily Water Levels

Given that RiverScape MetroPark sits directly adjacent to the Great Miami River and experiences frequent flooding of various depths, I needed a way to be able to track the water height on a daily basis over an extended period of time to recognize patterns and estimate a level beneath which most floods occur. The Miami Conservancy District made this a very easy step; they monitor current river conditions and provide information to both the National Weather Service and the United States Geological Survey to create graphs of the daily anticipated river levels. Over the course of October through December of 2021, and January through April of 2022, I saved a graph indicating the flood levels every week and at the end of each year, I used each of the weekly graphs to produce one larger image. An example of the final graph has been included in the appendix, which also indicates the action stage level of forty-one feet.

Developing Educational Design Strategies

During the early stages of the design process, I developed some early concept diagrams to show how I want to bring together scientists from the Miami Conservancy District, the public, and students from nearby schools in one building to start a conversation about the river

Figure 5.7: Building as a Social Hub

Figure 5.8: Building as a Program Hub

ecosystem. This would eventually create a programmatic hub for research, recreation, and educational activities that would in turn create a unique experience for the inhabitants. From here, this is how I developed the four main design strategies: research, recreation, education, and experience. They have each been assigned a color to signal what strategies are being used in the final presentation and documentation. Research is pink, recreation is green, education is orange, and experience is blue.

Periodic Table of Educational Elements

The last major step was to develop a way to organize my educational design strategies, which borrows ideas from the periodic table of elements. Throughout the development of this thesis project, I have created a tile, or element, for each of the rooms or strategies from my final building that allows a person to learn about the river ecosystem. As for the organization of the overall table, it is organized from left to right in seven columns by who experiences each strategy. This could be a scientist, an individual, a small or large group, or city-wide. It is also organized in three rows by how a person will learn—by performing a hands-on activity, by walking through a space or looking at artwork or information board, or by looking at the building from far away—from top to bottom. Each of the elements has a colored border that alludes to either a research, recreation, education, or experience strategy. At the final thesis presentation, fourteen individual elements had been developed, which have been included hereafter.

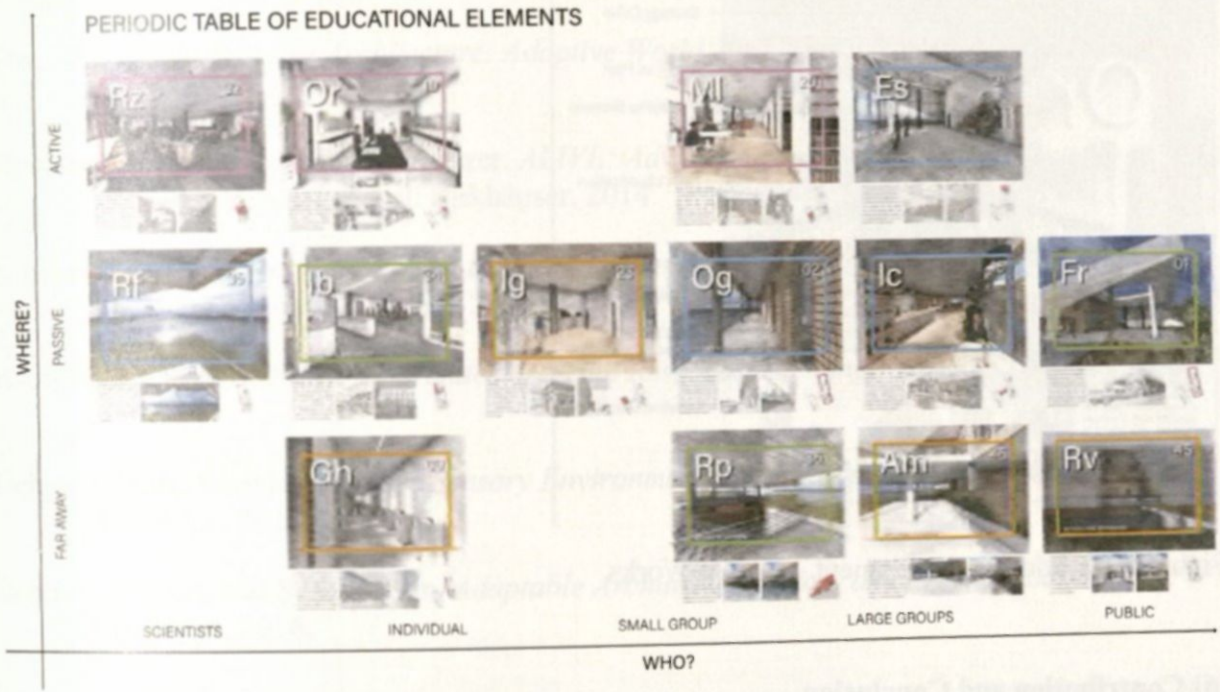

Figure 5.9: Periodic Table of Educational Elements

To give an example of how the Periodic Table of Educational Elements works, a research lab, second from top left, is flanked with a glass wall along the main gallery hall and allows visitors to peer inside and observe the research activities beyond. The element's border is pink to signal that it is a research strategy and is located near the top right to signal that it is used actively, or hands-on, by scientists. Another example is a large, covered plaza that greets visitors as they approach the building, and has a waterfall feature to metaphorically submerge them in the aquatic environment. Its border is green to signal a recreational strategy and is located at the middle right to indicate that it can be used passively and by everyone.

As for the layout of the individual element, each tile has seven main pieces of information. First, a conceptual rendering of the room or strategy is used as the background for each element and inlaid from this is a colored border to signal one of the four design strategies. Inside the colored border at the top left is a letter combination, which is an abbreviation of the element title at the bottom left. The number at the top right corresponds to a number on one of the three building floor plan legends. Along the bottom of the tile is a brief description of how a person stands to learn about the aquatic environment through that specific tile, followed by a few precedent images and a diagram at the bottom right indicating where the room or strategy is located in plan.

Periodic Table of Educational Elements:
How it Works

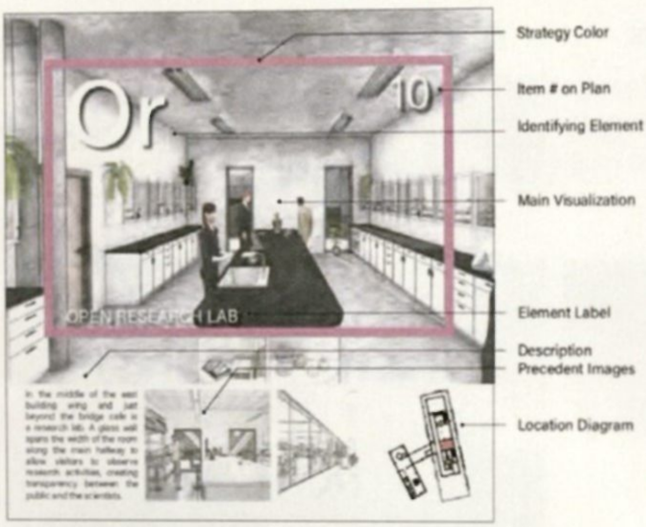

Figure 5.10: Educational Element – How it Works

[6] Contribution and Conclusion

Currently, the water quality issues seen in the Great Miami River near RiverScape MetroPark seem to go unnoticed by many of Dayton's inhabitants. Most of the problems stem from industrial runoff and agricultural over-enrichment, putting increased levels of phosphorous and nitrogen in the water. Creating a sense of urgency around the problem was the driving force behind this thesis, which helped develop the two primary objectives; the first is to create a hub where scientists and researchers from the Miami Conservancy District and the public can engage with one another, and two, develop a palette of strategies to educate visitors about the health of the river environment. While I acknowledge that a building itself cannot directly solve the water quality issue at hand, it can be designed with several strategies to educate its occupants and create urgency around the problem. In developing fourteen strategies (educational elements) across four categories—research, recreation, education, and experience—it is my sincere belief that the content in the periodic table demonstrates that I have achieved the goals of my thesis.

[7] Bibliography (from [3] Literature Review)

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[7.1] Image Citations

Figure 4.1.1: Stott, R. (2014). *1/29*. photograph, Rotterdam.

Figure 4.2.1: *Water Institute Headquarters Exterior*. (2018). photograph, Chicago.

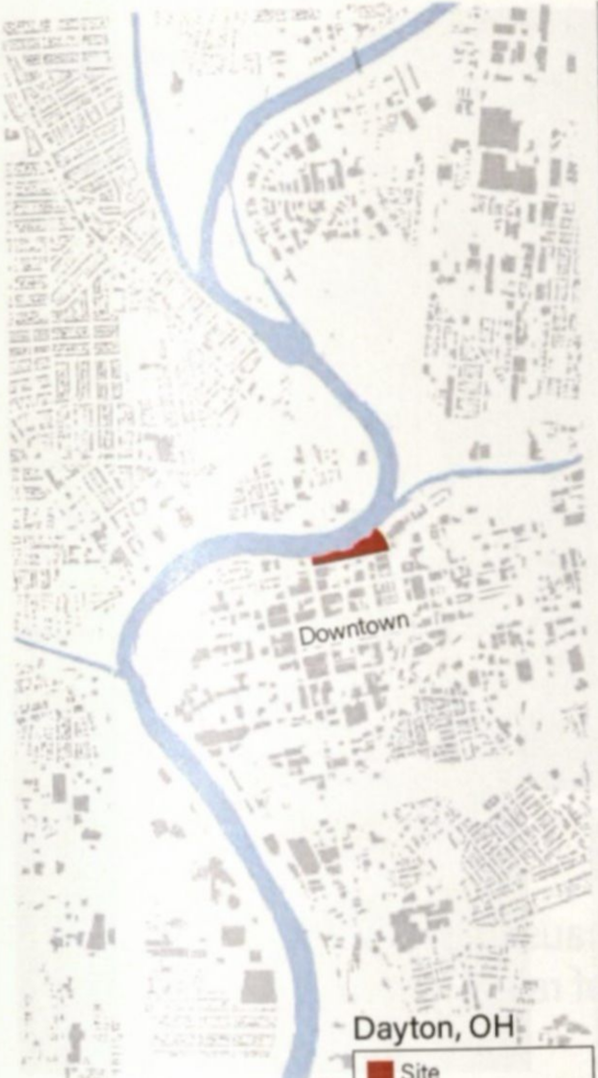
Figure 4.2.2: *Water Institute Headquarters Research Lab*. (2018). photograph, Chicago.

Figure 4.3.1: *Klimatorium Climate Center*. (2020). photograph, Lemvig, Denmark.

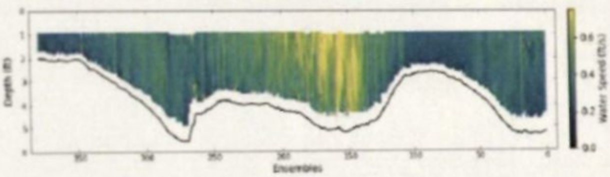
[8] Appendix

Final Rendering

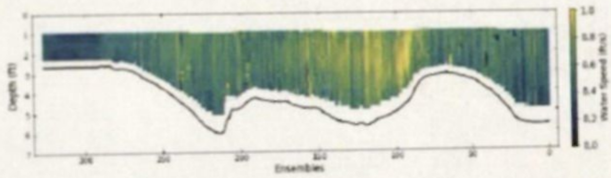
Site Context (Board 1/7)



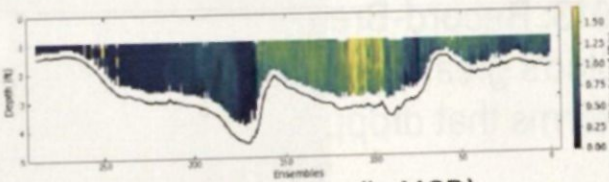
Great Miami Riverbed Section Key



1. November 2019 (Dwg Credit: MCD)



2. June 2020 (Dwg Credit: MCD)



3. August 2021 (Dwg Credit: MCD)

Graphs are courtesy of the Miami Conservancy District's hydrology team
Equipment issues caused the 2021 data to be taken further downriver than in previous years

Site Historic Information (Board 1/7)

1913: Record-Breaking Flood

Ohio's greatest natural disaster was caused by a series of major storms that dropped between 8"-11" of rain within a 3-day period

1915: Miami Conservancy District

Founded to protect the Miami Valley from floods by constructing 5 dry dams and a series of levees

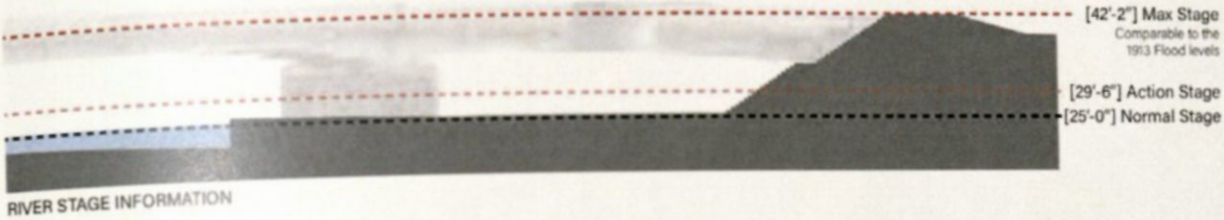
1919-1922: Dam Construction

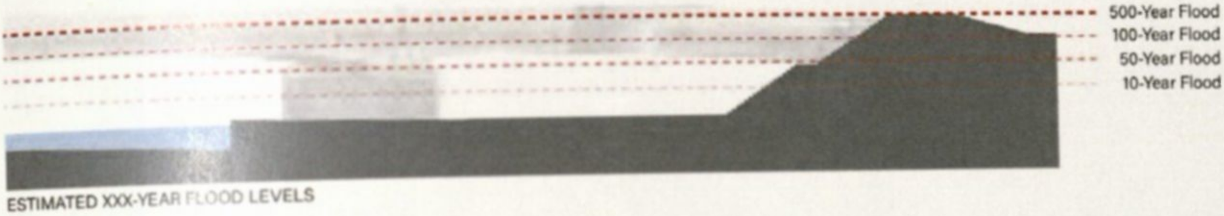
1982: RiverScape MetroPark Founded

Unusable due to the steep levee walls

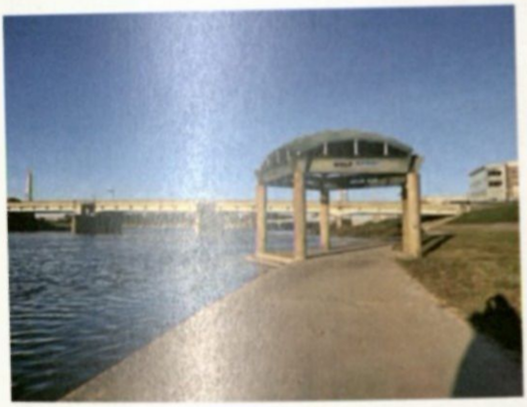
2001: RiverScape MetroPark Opens

Existing Levee Sections (Board 1/7)





Existing Site and Flood Conditions



Typical Day (no flooding)

Minor Flooding (+1'-0")

Moderate Flooding (+4'-0")

Heavy Flooding (+6'-0")

Industrial Zoning versus Parks (Board 2/7)

Topography (Board 2/7)

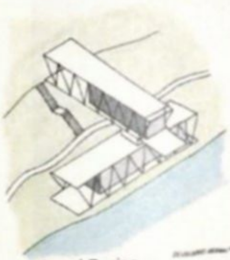
Floodplain (Board 2/7)

Education (Board 2/7)

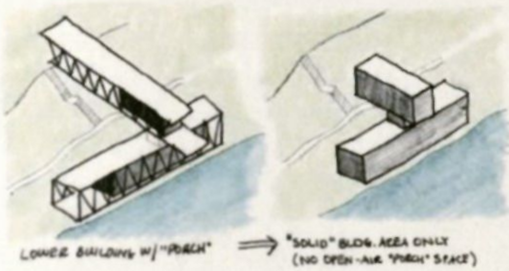
Transportation (Board 2/7)

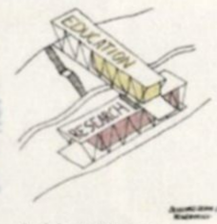
Design Process (Board 3/7)

Fall 2021

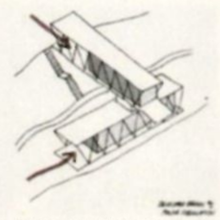


Developed Design

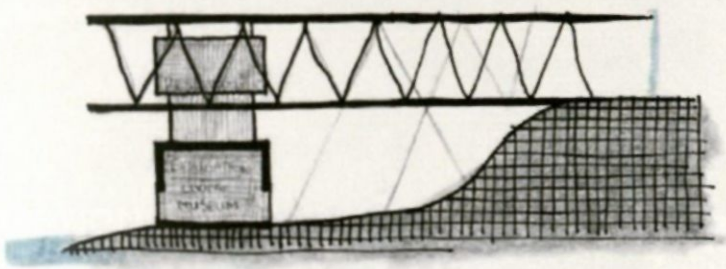




Anticipated Program

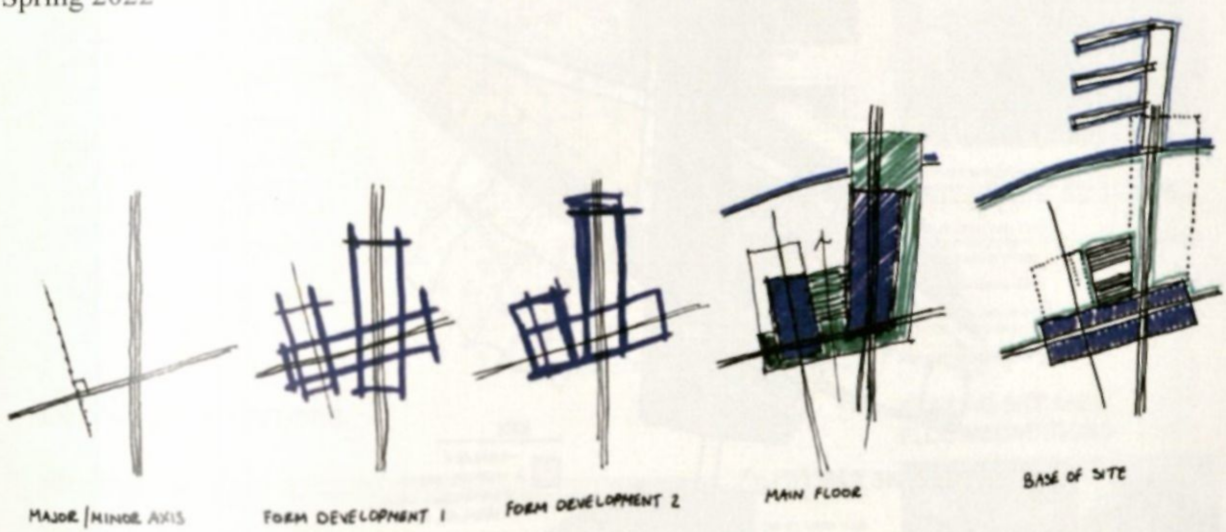


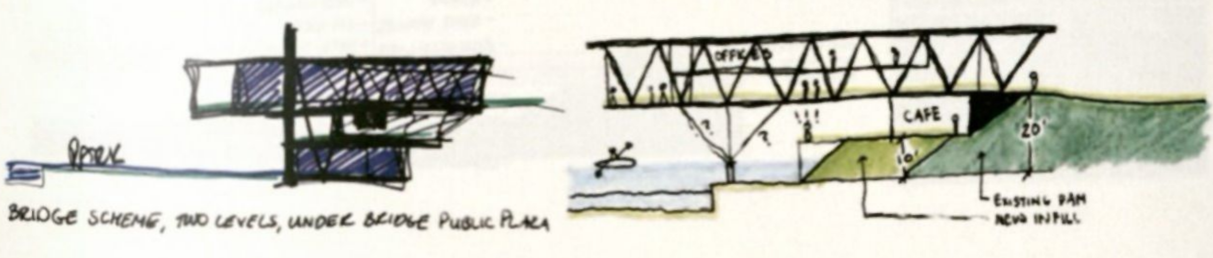
Anticipated Major Circulation



Anticipated Design in Section

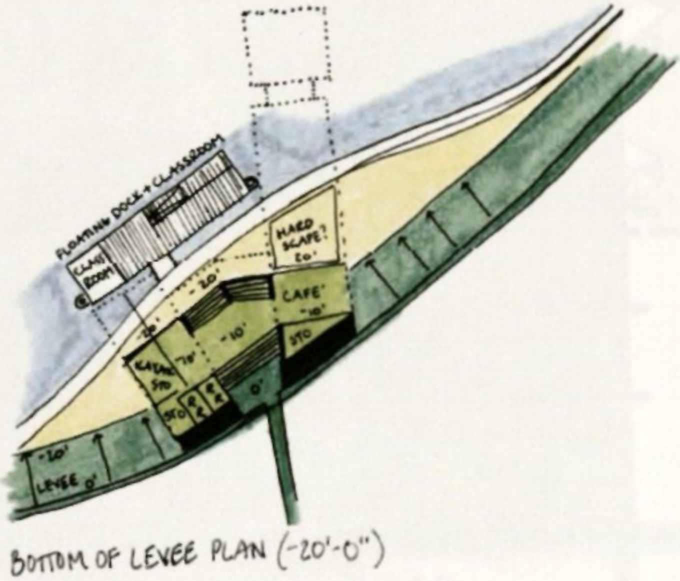
Spring 2022

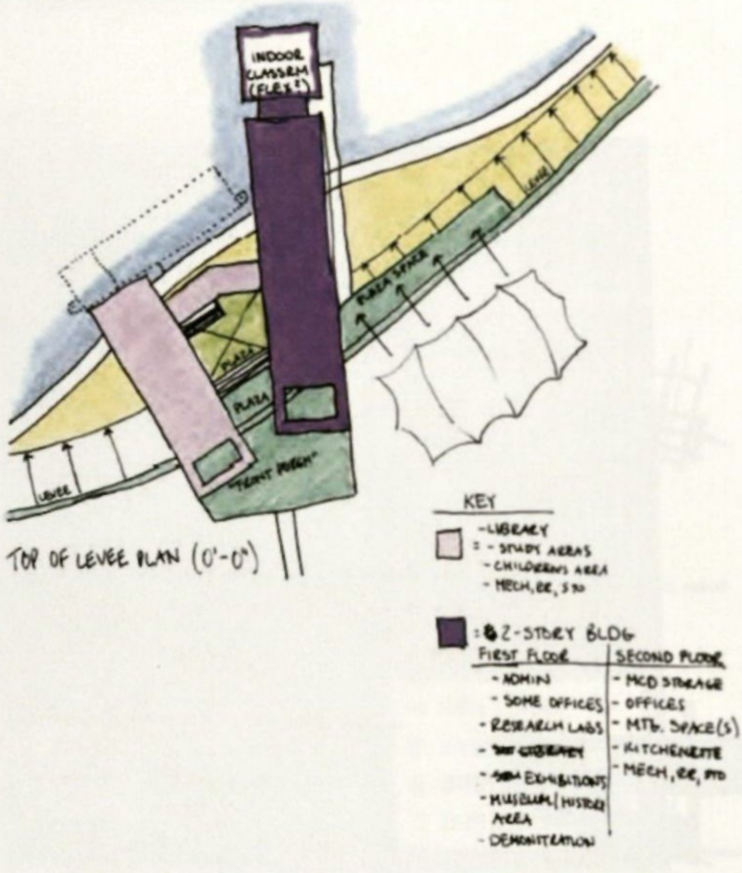




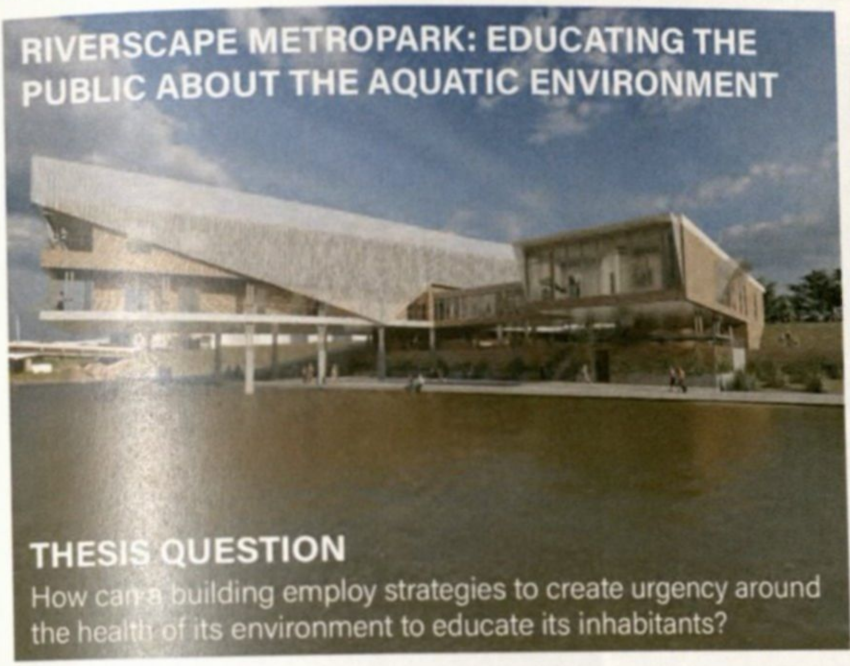
Design Process (Board 3/7)

Spring 2022 (Continued)





THESIS INTRODUCTION

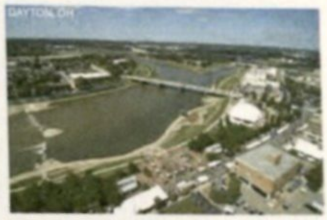


RIVERSCAPE METROPARK: EDUCATING THE PUBLIC ABOUT THE AQUATIC ENVIRONMENT

THESIS QUESTION

How can a building employ strategies to create urgency around the health of its environment to educate its inhabitants?

RIVERSCAPE METROPARK



ABSTRACT

GOALS

- Create a hub where scientists and researchers from the Miami Conservancy District (MCD) and the public can engage with one another
- Develop a palette of strategies to educate visitors about the health of the river environment

THE PROBLEM

Within the Great Miami River Watershed, over 40 **percent** of streams and rivers fail to meet Ohio's water quality standards

Butler County Water and Sewage

The river has "legacy **pollution**" problems from industrial runoff and agricultural over-enrichment; low level dams in the river that do not provide flood protection are **holding back pollutants**

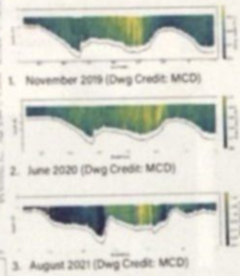
Journal News, Butler County (2018)

Bacteria levels spike **after rain,** but recedes within 48-72 hours

The Miami Conservancy District (2016)

SITE CONTEXT

Great Miami Riverbed Section Key



1. November 2019 (Dwg Credit: MCD)
2. June 2020 (Dwg Credit: MCD)
3. August 2021 (Dwg Credit: MCD)

HISTORIC INFORMATION

1913: Record-Breaking Flood
Ohio's greatest natural disaster was caused by a series of major storms that dropped between 8"-11" of rain within a 3-day period

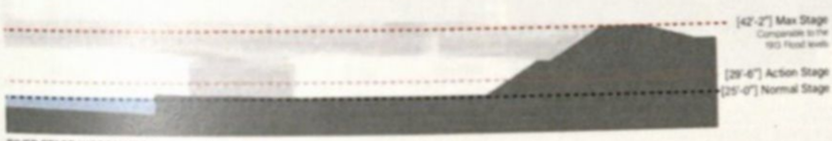
1915: Miami Conservancy District
Founded to protect the Miami Valley from floods by constructing 5 dry dams and a series of levees

1919-1922: Dam Construction

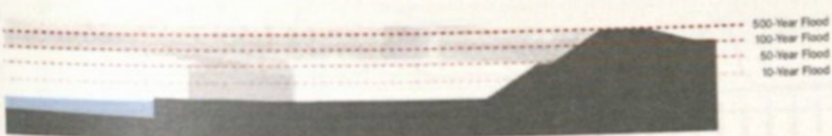
1982: RiverScape MetroPark Founded
Unusable due to the steep levee walls

2001: RiverScape MetroPark Opens

EXISTING LEVEE SECTIONS

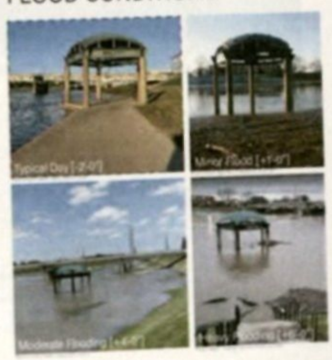


RIVER STAGE INFORMATION



ESTIMATED XXX-YEAR FLOOD LEVELS

EXISTING SITE AND FLOOD CONDITIONS

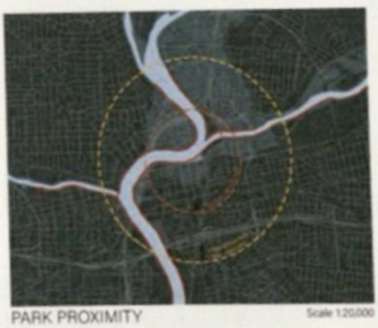


SITE ANALYSIS AND DOCUMENTATION

SELECTIVE ZONING MAP (PARKS AND INDUSTRIES) Scale 1:20,000

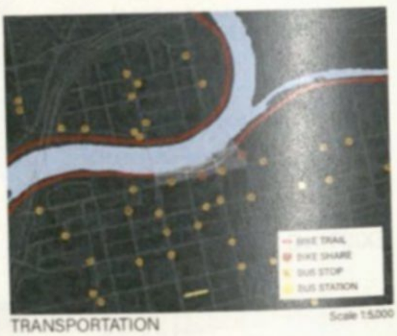
TOPOGRAPHY - PROXIMITY Scale 1:2,500

FLOODPLAIN Scale 1:5,000

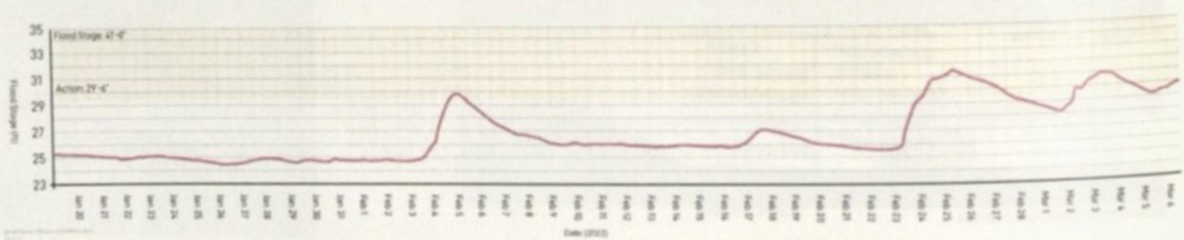


PARK PROXIMITY Scale 1:20,000

EDUCATION Scale 1:8,000



TRANSPORTATION Scale 1:5,000



DESIGN PROCESS

PRECEDENT STUDIES

11th Street Bridge Park
Olin + OMA
Washington, D.C.
2014

Elevated park and civic space for the city that promotes the health of the river and its adjacent communities. Two bridges meet from either end in an X-shape, providing shelter for a performance space, cafe, and plazas while creating a destination of its own above the river.

Water Institute Headquarters
Perkins + Will
Baton Rouge, LA
2018

A research center that is functional during floods and has an exterior walkway to allow visitors to peer inside and observe research activities. A perforated metal screen wraps around the building to mitigate solar heat gain and to add a sculptural touch.

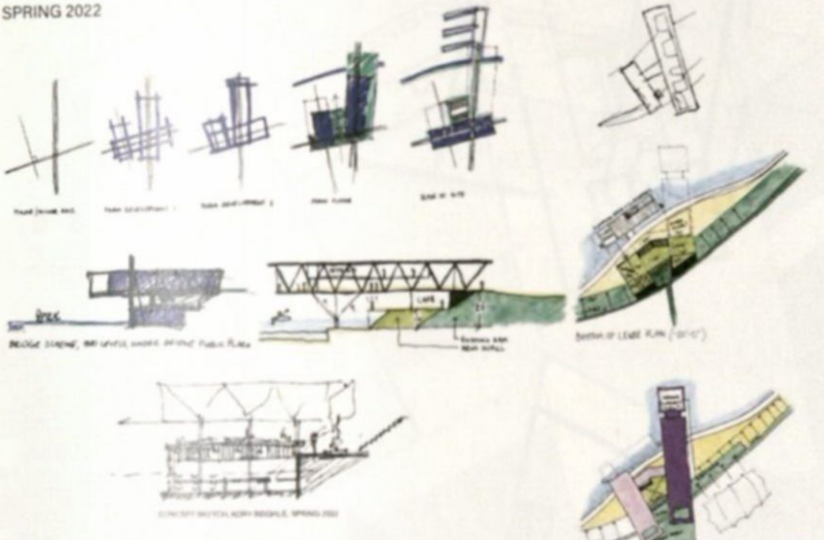
Klimatorium Climate Center
3XN Architects + SLA Architects
Lemvig, Denmark
2021

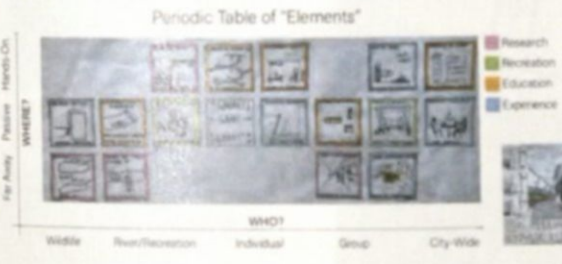
The Klimatorium is a public mini-hub for storm surge, water, and climate research. Inside, users are encouraged to interact, meet, and collaborate with one another via common rooms, exhibition areas, and a publicly accessible cafe space.

DESIGN PROCESS (NOV. 2021 - MAR. 2022)

FALL 2021

SPRING 2022





EARLY CONCEPT DIAGRAMS

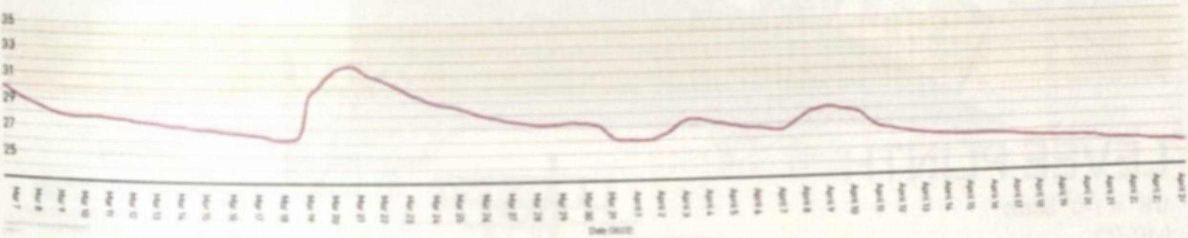
BUILDING AS A **SOCIAL HUB**

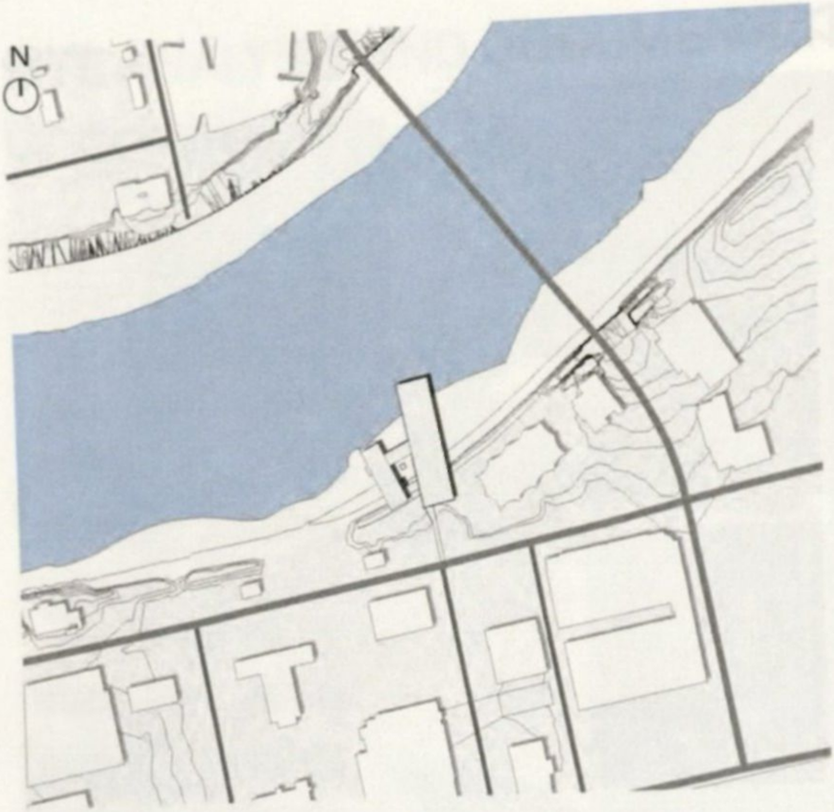
BUILDING AS A **PROGRAM HUB**

BUILDING STRATEGIES

RENDERING PROCESS

Hidden in every render I've made (since junior year) is a loaf of bread. It was once a watermark, but is now my signature touch.





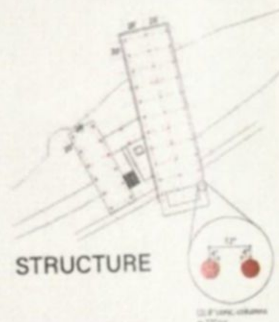
SITE PLAN

1/64" = 1'-0" Scale
(0'-0")

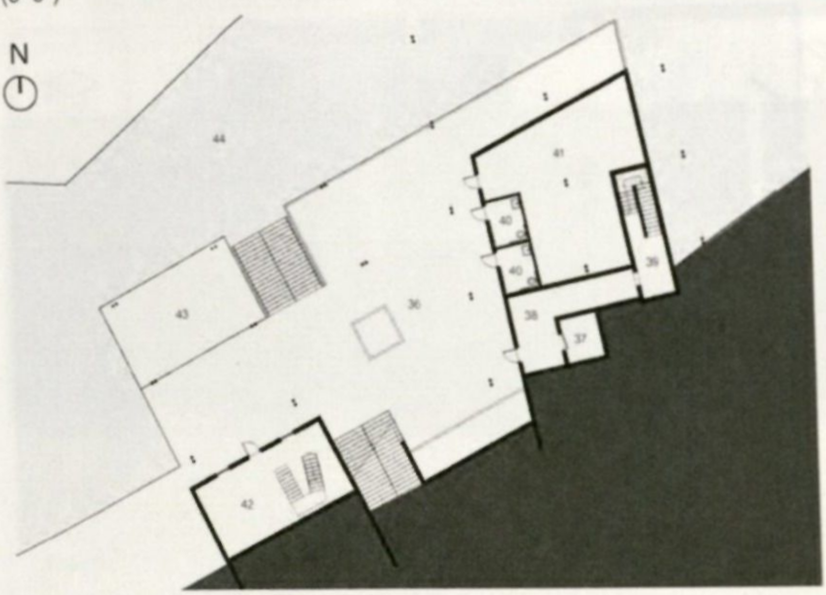
10-YEAR FLOOD (+5'-0")

50-YEAR FLOOD (+10'-0")

100-YEAR FLOOD (+18'-0")

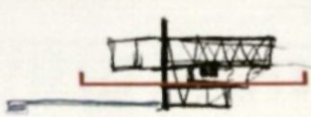


STRUCTURE



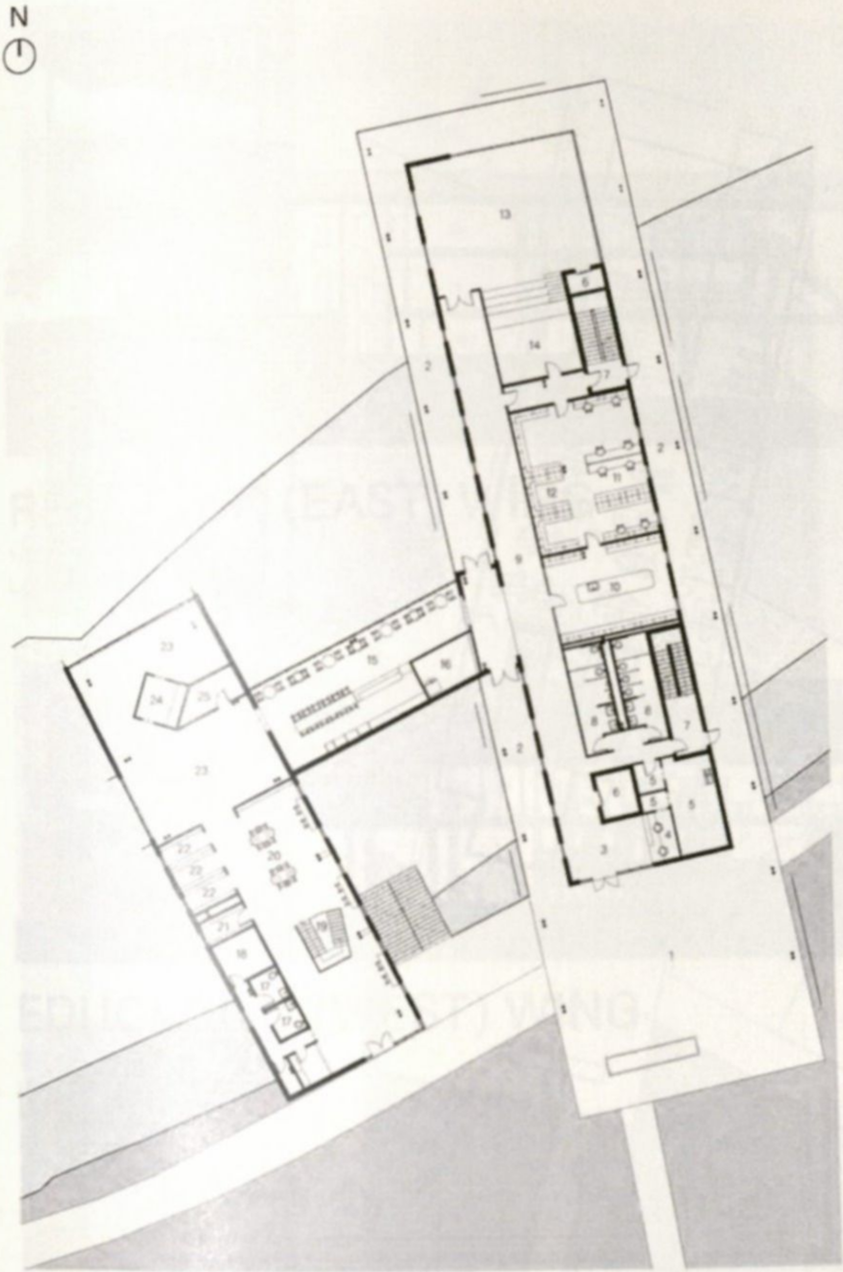
LEVEE PLINTH

1/8" = 1'-0" Scale
(-10'-0")



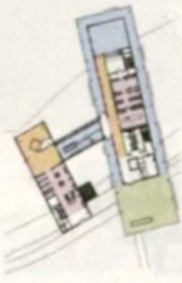
Legend

36 Plinth Lookout
37 Elevator
38 Elevator Lobby
39 Egress Stair
40 Restroom
41 Mechanical
42 Up to Library
43 Kayak Storage
44 Levee Base



LEVEL 1 PLAN

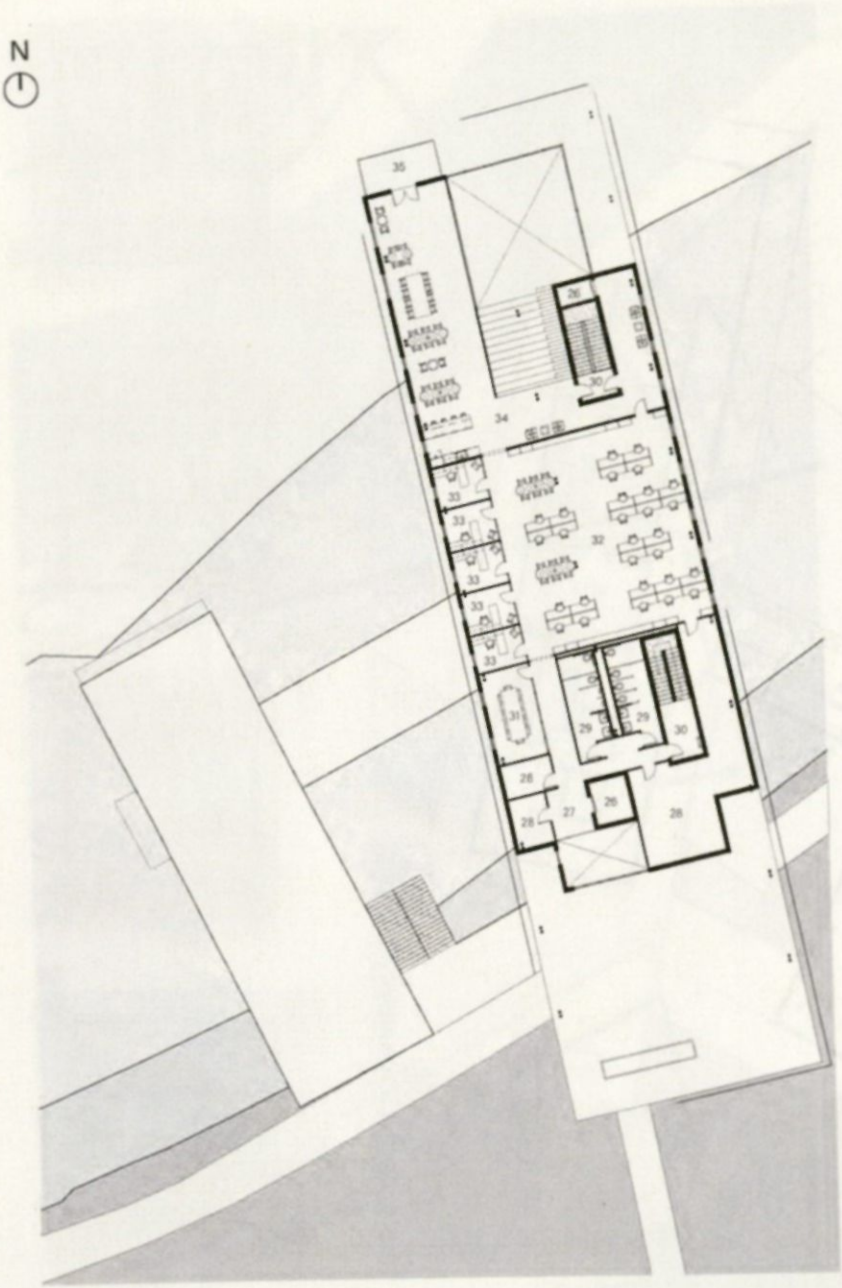
1/8" = 1'-0" Scale
(0'-0")



Legend

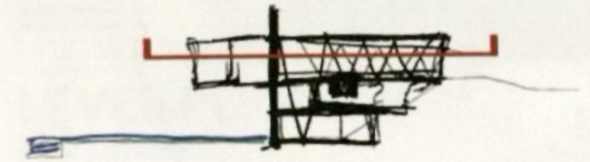
1 [illegible]
2 Outdoor Gallery
3 Lobby
4 Reception
5 Admin/Sto
6 Elevator
7 Egress Stair
8 Restroom
9 Gallery Hall
10 Open Research Lab
11 Private Research
12 Lab Storage
13 Event Space
14 Event Space Sto
15 Public Cafe
16 Cafe Storage
17 ADA Restroom
18 Mechanical
19 Feature Stair
20 [illegible]
21 Private MCD Stacks
22 Open Public Stacks
23 Indoor Gallery
24 Video Room
25 Gallery Storage

N



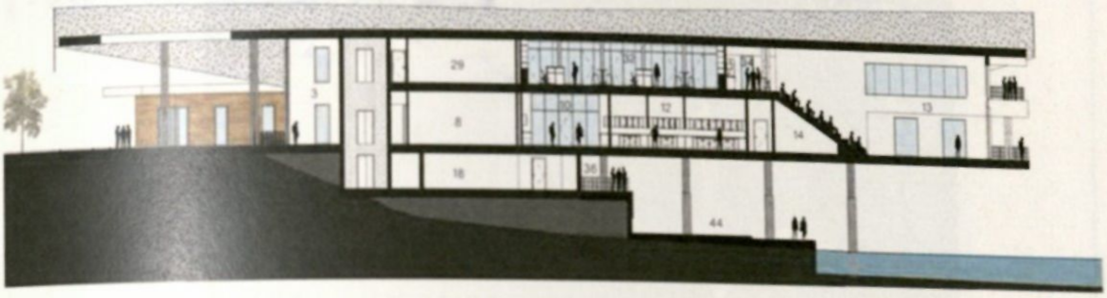
LEVEL 2 PLAN

1/8" = 1'-0" Scale
(+14'-0")



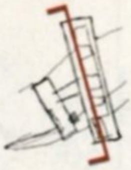
Legend

26 Elevator
27 Elevator Lobby
28 Office Storage
29 Restroom
30 Egress Stair
31 Conference Room
32 MCD Open Office
33 MCD Private Office
34 Breakout
35 Viewing Deck



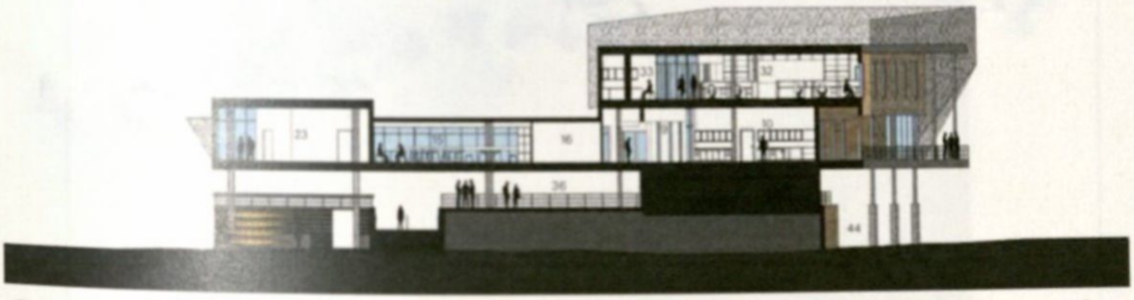
RESEARCH (EAST) WING

1/8" = 1'-0" Scale
Looking West



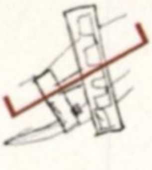
EDUCATION (WEST) WING

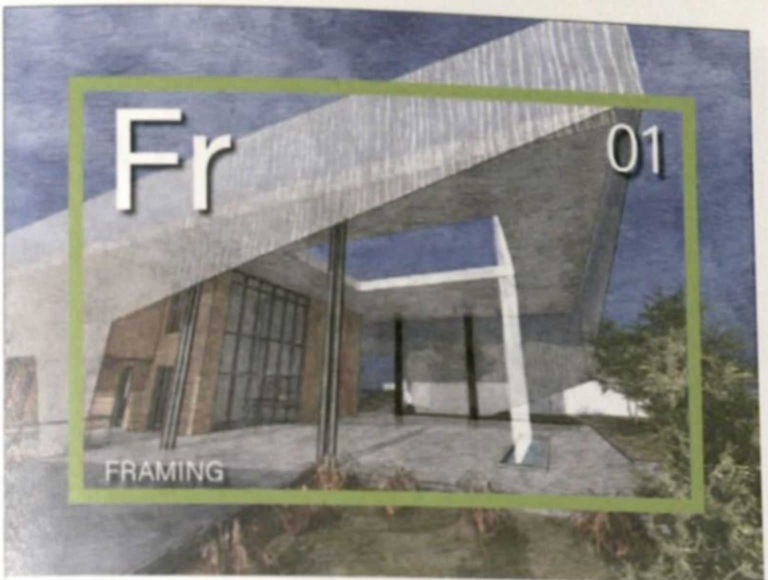
1/8" = 1'-0" Scale
Looking East



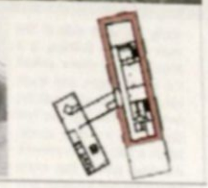
CAFE BRIDGE

1/8" = 1'-0" Scale
Looking North





At the very end of the eastern wing is a flex room capable of hosting a variety of functions. It features a panoramic view of the Great Miami River and has a grand stair that leads up to the second level. This space can be used by anyone for demonstrations, lectures, and even formal events.



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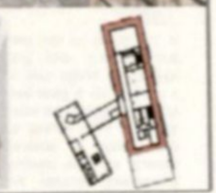


Gh
09
GALLERY HALL
Along the west side of the main research building is a large hall that spans almost the entire length, and leads visitors to the flex room at the end of the building. The hall doubles as a gallery space, which would feature artwork and other pieces that relate back to the river environment.


Or
10
OPEN RESEARCH LAB
In the middle of the east building wing and just beyond the bridge cafe is a research lab. A glass wall spans the width of the room along the main hallway to allow visitors to observe research activities, creating transparency between the public and the scientists.

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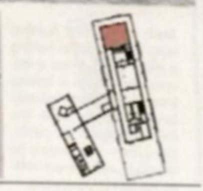
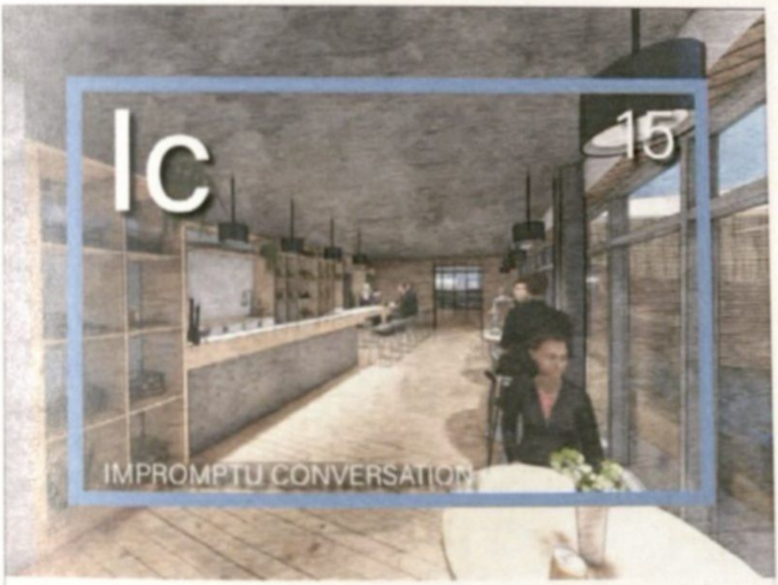
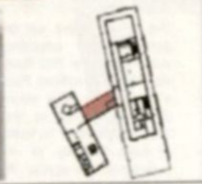




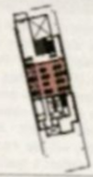
Between the two main buildings is a skyrbridge, which hosts a cafe as its primary function. It serves as a common ground where the scientists, researchers, and the public can interact. The cafe can be accessed by the exterior walkway even after the main building closes.



Much of the west building wing is dedicated to hosting a micro-library. It has a few open stacks and a locking area where more valuable literature can be kept. The library is open to the public, giving them the chance to converse and interact with the researchers/scientists.

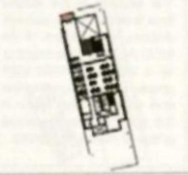
This gallery space will be dedicated to educating visitors about the 1913 flood, the Dayton Riverfront Plan, and displaying other works of art pertaining to the Great Miami River to foster an understanding of its importance in everyday life and culture.

The majority of the second floor is dedicated to research stations for members of the MCD. Although it is meant to be a relatively private work space for the researchers and scientists, the space is left open for the occasional group of visitors to explore.

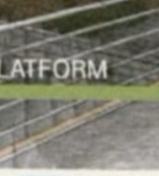


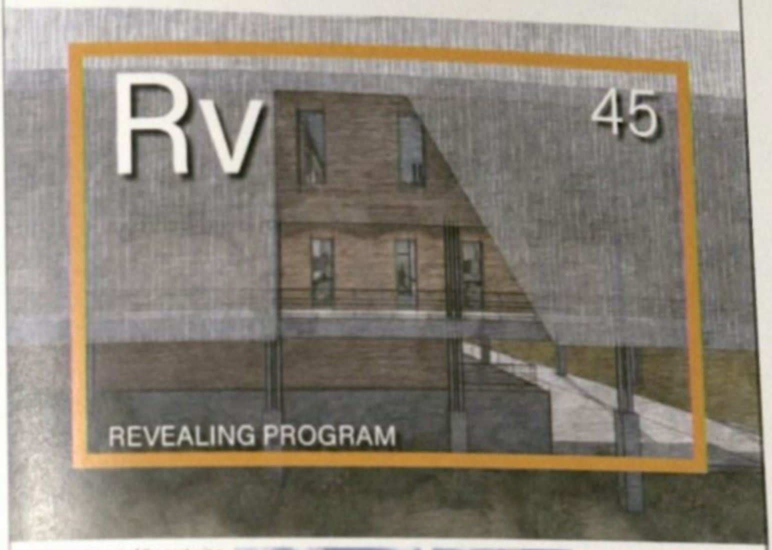
Between the grand stair and the MCD private work office on the second level is a breakout area. On a typical day it will be used primarily by the researchers, but during special events such as presentations or formal events, it remains open for use by the flex room below.

The viewing deck at the end of the second story offers a panoramic view of the Great Miami River. It offers people a unique vantage point from which they can observe the river environment in hope that they will feel inspired to help maintain a quality river ecosystem.

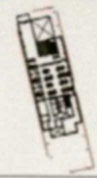


Built at the midpoint height of the levee wall, the plinth is an elevated space that would otherwise be unusable during floods. It also serves as a large observation deck and offers expansive views of the river beyond. The building, levee top, and base can all be accessed from the plinth.





Around most of the east wing and parts of the west wing is a perforated metal wrapping. It hides and reveals certain program elements by closing or opening near entries, paths, and windows. The metal wrapping is perforated in a wave pattern to resemble the river's surface.



At certain levels, there are design strategies or material changes to indicate various floods levels (1-, 5-, 10-, and 100+ year) and to visually "submerge" visitors in the flood zone. Materials below the plinth are designed to either be visually "worn" by floods, or easily replaceable.