Abstract

This installation became more than just about creating a public art piece for the city of Columbus, it reflects Columbus itself. Columbus has been known for its small-town atmosphere interlaced with modern architecture, a rarity in the practical and sometimes shortsighted Midwest. It’s an Indiana treasure most people are not aware of, tucked away in rich farmland away from the busy world. This abstract piece is an homage to the unique, yet practical, qualities of Columbus, exhibiting the values Columbus holds most dear.

One unique quality of Columbus is the presence of towers in its architecture. Besides major cities, most of the Midwestern buildings don’t get taller than four stories. Columbus has multiple towers, almost exclusively church related. This project reflects the tall proportions by getting lighter towards the top, pulling the eyes away from the ground, before it blends in with the sky above. Located in the Midwest, Columbus is also home to a lot of advanced manufacturing. This project utilizes computer based design and the machine’s abilities to create complex forms in metal, reflecting the future of manufacturing in the Midwest.

An important part of this project was to create something that reflected Columbus’s future, not its past. For many decades innovation has been the driving force behind Columbus architecture, looking to solve the problems of tomorrow today, and investing in the future. With that in mind the design does not reflect how Columbus, or architecture in general, is now, but how it can become in the future. The form is complex, thanks to the abilities of advanced manufacturing. Both the inner and outer skin are a unique shape. Although they are related to one another they are not the same shape. It is a common misconception in architecture that the inside and outside shape must reflect each other, that the volumes cannot differ from one another. Traditionally, building practices have made this a fact, but with the inclusion of the computer architects are able to conceptualize more complex forms that may not necessarily look the same on the interior or exterior. This practice is becoming increasingly more common, and creates a visually different feel than a traditional form.

This installation also utilizes an unconventional visual phenomenon as well. The moiré effect is when two perforated patterns cross at different angles, creating a new third pattern through its interlay. This relies heavily on movement, as the pattern changes when the point of view changes. It is most commonly seen in fences, especially in a moving vehicle. This visual aspect is rarely, if ever, intentional. By using two different perforated layers of metal for the skin, this installation uses the moiré effect to add another layer of complexity to the form, and also help blur the edges between the object and its surroundings.

This project was created for the Exhibit Columbus event in the fall. Commissioned by the city, the goal of the entire exhibit is to celebrate Columbus’s past and future through architectural installations located around the city. This installation will be located in University Village and represent Ball State University in this event. Notable architects from around the world are also invited to create installations that celebrate specific landmarks. Exhibit Columbus wishes to shine a little more light in their city, to show the rest of the Midwest and the world what an architecturally intelligent, community oriented city can look like. Columbus is rated as one of the best places to live, prompting them to want to share their knowledge with the rest of the world.
Acknowledgments

I would like to thank Josh Coggeshall, my thesis advisor, for mentoring me in this design project. Your support and encouragement have helped this project grow to something greater than anyone could create on their own.

I would also like to thank the ProjectiOne team for their help in conceptualizing the structure, and their advice on how to design it.

Thank you to the team at Ignition Arts for their expertise in public art installations and metals.

Finally, I would like to thank my fellow studio members who collaborated with me on this project. This truly was a team effort and could not be completed to such a complex level without everyone’s hard work and creative skills.

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This project has been a real challenge, and not just because it was the final project of my undergraduate career. As my advisor said many times, design builds can be very challenging. This one specifically, due to the shortened time and large group, was a real challenge. Exhibit Columbus is a large and soon to be prestigious event that attracts architects, designers, and historians alike to Columbus Indiana to celebrate its unique history. This installation is important because it represents Ball State at this event alongside other universities from the Midwest. It was an exploration not only in how to create an architectural installation but also the history of Columbus.

Columbus has a unique history; to complete this project successfully I needed to research it extensively. My studio took a trip to Columbus Indiana over a weekend so we could get firsthand experience of the architecture and talk to experts from the area. This opportunity was incredibly helpful in learning what Columbus was and its unique history. Beyond this, I used other academic resources on campus to complete my knowledge of Columbus and to create a database in which I can draw information from.

The design of the installation was long and laborious, but in the end very successful. I collaborated with many of my studio classmates at different times in the semester, helping to refine the form and structure of the final piece. My main focus was producing models for the studio, this is something I am particularly skilled at and is something that needed to be done. Although I was not directly involved in the design process, I found many errors in the design by simply trying to create a physical model of the design. The studio then used my feedback and the sketch model to refine the design further until we reached something we all could be happy with.

I also focused my attention on creating some final pieces for the presentation of the design. This included a model base for a 1" =1'-0" model to sit on. This base helped exhibit the design qualities and helped the viewer understand the object's relation to the site as well. I also created a greater Columbus context model to help the audience further understand the location and design influences of the city at large. Both these pieces became integral parts of the final exhibition and helped visitors understand the design better.

This design celebrates the architectural history of Columbus. Columbus was not a city of the past, but one that looks to the future. Because of this, our design shows what architecture could be as opposed to that it stands today. The form is something that is as mysterious as it is rational, creating something that is slightly indefinable. This installation also uses advanced manufacturing to create the structure and custom perforation pattern, celebrating the Midwest's rich history in manufacturing. This installation is ultimately a celebration of the base principles of architecture and manufacturing, showing visitors what architecture could be in the future.
PROJECT 49,262
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HISTORY of COLUMBUS

Columbus was a normal Hoosier town until Cummins, Inc. owner, J Irwin Miller, created the Cummins Foundation. He saw the need for good architecture in the community, especially in schools, and used his company's funds to support the community. The foundation exits to subsidize architectural projects for the community, Cummins puts together a list of approved architects the city can choose from for their projects, then the foundation pays for the architectural fees. This allows the community to receive higher grade design for about the same cost as a normal building. The foundation funded many different projects, and prompted other business owners to hire better architects as well. This is how Columbus Indiana became a mecca of modern architecture. Some of the notable architects that built projects here are both Eliel and Eero Saarinen, and I.M. Pei. In fact, Columbus has some of the most notable buildings of these architects' work.

One of the first modern buildings to be built here was First Christian Church. Designed by Eliel Saarinen, it is one of the first modern churches in the United States. Completed in 1942, First Christian set one of the most notable standards of Columbus, the inclusion of the tower elements. Although there was much controversy over the building when it was first built, First Christian has now been accepted as an important part of Columbus and is loved by the community. It still functions as a church today, and is taken good care of by the congregation.

North Christian was built in 1964 by Eliel Saarinen's son, Eero Saarinen. Built more than two decades later, this church has a completely different feeling and aesthetic from First Christian. Yet some elements remain the same, for example the church still has a spire. It also uses unconventional design elements for its time, instead of a rectilinear floor plan, the church is an elongated hexagon. It also uses a more modern material, and a different lighting technique than First Christian. Instead of the bright airy windows and lots of indirect light, North Christian uses almost completely indirect light, most of the natural light in the sanctuary comes from the central oculus located directly under the spire.

Cleo Rogers Memorial Library was built by I.M. Pei in 1969. It also reflects many of the design ideals from its day, including an expansive plaza that reaches out toward First Christian Church. Many of Pei's design choices reflect the proportions and placement of elements in First Christian, tying both structures together.

First Christian Church, Completed in 1942.
Sullivan, Mary Ann

North Christian Church, completed 1964
Sullivan, Mary Ann
into a unified plaza. Even the placement of the Henry Moore Statue frames the tower of First Christian, and the wide expanse of brick on the façade of the library acts as a backdrop for the sculpture.

Kevin Roche also left his mark on Columbus. In 1984 Cummins Corporate Office Building was completed, adding a completely different element to Columbus. An old mill already existed on the site that eventually became home to Cummins Machine Works. Because of the historical significance of this building, it was incorporated into the master site. The design itself utilizes both indoor and outdoor walkways, framing the entire perimeter of the building in an ivy-covered portico. The interior uses lots of natural light and mirrors to lighten the interior space and give the illusion of a larger space than what is actually there. It is considered one of the more innovative corporate office buildings of its day, and still functions to day as Cummins headquarters.

Roche also built many other buildings around Columbus, another notable one being an addition to an existing Eliel Saarinen building. Built in 1954, the Irwin Union Bank was one of the first modern banks built in the United States. Its open floor plan and all glass walls were unconventional for the day and set a new standard for what banking could be in a community. Roche added an addition later, expanding the interior space. When the bank closed Cummins purchased it, converting the historic building into a conference center, which it still exists as today.

One of the most notable buildings in Columbus is the Miller House and Garden. Designed by Eero Saarinen in 1953, it served as the Miller’s home for many decades before being donated to the Indianapolis Museum of Art. It was built to serve as the Miller’s family home year-round and a place where they could raise a family and entertain guests close to where they worked. It is one of the few single-family homes that Saarinen built and showcases his very unique style of architecture. It is a very modern home with lots of natural light and light colored materials, giving the space a very airy feel.

Columbus has many other modern buildings and continues today to push the boundaries of architecture. These historic buildings have influenced many others in the area, giving Columbus a unique blended feeling in which both traditional and modern architecture blend together, enriching the community as a whole. The Exhibition will celebrate these historic landmarks with different installations by notable architects that create installations at these various sites that celebrate their historic significance and unique architectural qualities.
University Village is located in an ideal place for its purpose. 5th street in downtown Columbus is considered the architectural street of the city, ending in Cummins Engine Plant. University Village is located between Lincoln Elementary School and Central Middle School in a place that is highly trafficked by both school's participants. Each university site is located along a long sidewalk that also doubles as a student drop off and pickup for Lincoln Elementary school. Visible from the street as well, it has high visibility allowing citizens to see the art piece and its location. Because of this prime location, the design focuses on creating the illusion of movement to attract attention, and utilizes a bright color scheme to contrast with the neutral brick of both buildings.

Ball State's site is the most northern, away from the street and closest to the entrance of Central and Lincoln's parking lot. This trapezoidal shape, roughly 50-foot square, has very few obstructions above and below ground, making it ideal for placing a temporary structure on. It also has little obstructions from sunlight, which allows the play of light and shadow to be an important part of this project. Since it is outside, careful consideration about materials is crucial for its survival over the four months it will remain up, driving our choice to use perforated metal instead of a less durable material.
Starting this project my studio divided into smaller teams to generate more ideas faster and to get a better understanding on what could potentially be built. Working with another one of my studio members, we created a concept completely different than the final design. Our initial concept focused more on the structural ability of metal, and creating complex geometry out of a singular surface. This train of thought led to dividing the surface into triangles, giving the form a natural rigidity and structural shape. This also allowed the surface to be bent at specific angles, creating a more complex geometry. Instead of focusing on a final form, we focused on creating a form through a set of specific rules. By specifying a range of angles, how many sides needed to be touching, and other constraints a variety of forms could be created, allowing us to choose what worked best for the space.

The first iteration sat completely on the ground, using only the surface as a structural piece. It covered a large surface area, growing out of the ground and forming an enclosed canopy, shielding its occupants from the exterior. We also created a custom perforation pattern that added another layer of complexity and specificity. This special pattern also created a very unique moiré effect that was interrupted by the shadows of the occupants inside. The space inside was variable, some areas high enough for an adult to stand comfortably in and some areas so low only children could sit underneath the overhang. This variation in space created an experience that was interactive with the form and different for each individual. It also engaged the children at a different level than the adults, creating a specialized experience for them as well.

After the first review we received some constructive criticism that helped us develop the design further. The first issue was structural stability; if every joint on this surface was flexible, it would be nearly impossible to set up without the surface collapsing in on itself. When it was complete the surface may have been structural, but like an arch it required every member to be in place in order to support its own weight. Another issue was how it attached to the ground. It touched the earth in only a couple of places, making it difficult to specify exactly where it could be mounted to the earth. The final issue that was brought up was safety. There were many sharp protruding corners around head height that someone could easily injure themselves, which is not a positive aspect to a public art piece. We had the chance to go back and look at the design again to try and solve some of these issues.
The second iteration remained mostly the same except for a few key changes. The first one was to solve the connection to the ground issue and the rigidity with a single design move. By incorporating pipes, this allowed us to define exact points on the ground where it would connect and created places for the surface to be supported. This also allowed more of the surface to be elevated, creating a larger space underneath the canopy. The next change we did was remove the custom perforation. After discussing it, we decided that using a standard perforated metal sheet would cost significantly less than having a custom perforation made, and a very similar moiré effect would still be generated. This design was more conceivable to build, but had a completely different aesthetic from the first one. By simply including the pipes, it gave the surface a more dynamic appearance. By removing it from the ground, it looked less like a part of the earth and more like a figure floating above it. The pipes also gave the form a more anthropomorphic feeling, almost as if it was an alien creature frozen on the surface than a natural shell springing from it.

The review of this design was very different but we received much of the same feedback. Although the pipes did support the surface and make it easier to attach it to the ground, safety became an even greater concern with the oddly bent pipes sticking out still at head height. It also made an excellent climbing structure, something that may be great for playgrounds but not twelve-foot-tall art installations installed between a middle and elementary school. Safety was still a major concern for the design, and something that will take a lot more work to solve.
After this stage, the entire studio sat down together to discuss what to do next. At this point in the year the semester was about half over, and it was time to come to a consensus on what the final design was going to be. After about two days of discussion, Vertici was set aside for another group's project. Theirs, nicknamed "The Molar," had more of the design aesthetics that the studio was looking for. It also had a more conceivable form, and a stronger moiré pattern. However, the ideas from Vertici were not completely thrown out. The other design did not have a viable structure, so it was decided to try to blend Vertici's pipes into their form made of contours. There was plenty of unused interstitial space between the outer and inner shell that the pipes could occupy, which would interrupt the moiré at various points and create different effects at each vantage point. From here, it was time to figure out how to make this installation function. The biggest challenge from the beginning was structure; how to get the shape to stand up without interrupting the moiré effect. The original studio-wide design used a contour pattern to create the moiré effect, but the gap in between the thin metal ribs proved to be difficult. Many different structural ideas were tried, including vertical slotted ribs and sliced square pipes, but ultimately the horizontal ribs proved to be too difficult of a structural challenge to be conceived by our limited budget. The structure also posed another climbing hazard; the sides essentially becoming giant ladders perfect for small kids to climb, and eventually hurt themselves on.
The next solution was to replace the horizontal ribs with a perforated surface, recalling other early design options like Vertici. This proved to be easier to support, but the irregular form still challenged the structural side of it. Another question that was brought up was what kind of perforation to use, and whether we could still afford a custom perforated pattern. This felt crucial to the design, for standard perforations were not creating the effect we wanted in the design. It also helped solve the climbing problem, because we could control the size of perforations that were closer to the ground. Eventually we utilized the perforations to fade the form into the sky, and give it a sense of weightlessness and air, recalling the vertical proportions of the rest of Columbus.

One issue we discovered with the skin was that it could not have surfaces that bent in two directions. Steel resisted being bent in one direction, making it nearly impossible to bend a sheet in two separate directions across a form. Our original form had many of these double curved surfaces that led to the form being simplified drastically. A solution was to take vertical lines across the surface, and add variation by rotating those lines around a specific access. This allowed the internal surface to bend in a different direction than the outer, but both surfaces did not bend in the vertical direction. In other words, a straight line could be traced at any point along the surface from top to bottom. This also gave the interior and exterior surface a more logical formula to follow while still being intricate.
The biggest challenge was still conceiving the structure. An early idea was to use steel L angles cut at various lengths to create an interstitial frame that supported the skin. This created an x-y-z grid in between the two skins, and allowed flexibility for connecting the skin to the internal structure. There were two major problems with this structure. One was it interrupted the moiré effect in many locations, reducing the impact of having the double perforated skin. The next was how the skin actually attached to the L brackets, it was difficult to pinpoint exactly where that occurred and how to attach the skin to the flat metal piece without buckling the outer surface.

Another issue was the construction process; each individual angle would have to be cut at a specific length then placed in the structure in its exact location. In essence it was a very large jigsaw puzzle with a lot of very specific parts and no reference point to start.

After more design charrettes and collaboration on the structure, another more flexible idea emerged that used pipes, bolts, and a slotted system to allow the structure to adjust to fit the skin perfectly. The issue with this was it was too flexible, by allowing each joint to rotate in every direction, it did allow for fine-tuned adjustments but it also made it nearly impossible to locate what the exact final location was. Again, there was no reference point to base every joint on.
Plan View of Structure Concept
Drawn by Natalie Broton
The final structure came after a few more interstitial iterations. It involved laser cutting nearly every single piece, creating a vertical rib system supporting horizontal pipes that connected to the skin with U-brackets. There were also custom cut horizontal pieces in between the ribs as well to help resist lateral forces such as strong winds. This structure appeared to function the best and was decided to be developed further. The one issue with this, however, was constructability. Again, there were hundreds of individual pieces and no reference point to determine which piece went where, and some of the pieces of metal were more than 8 feet long. The vertical ribs were made of 1/8-inch steel plate, which is very heavy. An 8-foot piece would be too heavy for one or two people to handle, and this installation needed to be assembled by hand.

After meeting with Projectone, a local custom fabricator, a solution emerged. Their work typically consists of large art installation and they specialize in using machines to create intricate yet easy to assemble art pieces. Their solution to our problem was to break the section into easily manageable modules, turning large bulky ribs into smaller, cube-like shapes. These modules could then be bolted together on site, making the assembly process easier and the margin of human error less. The last challenge to be solved was to come up with a way to keep track of each individual piece as they come from the laser cutter, because again we were faced with the jigsaw puzzle problem. Another one of my studio mates created an elaborate but understandable naming convention, giving a name for each individual piece and telling where that piece is related to other structural pieces. The final step was to create a logical way of naming each piece of the skin, and then to make cut sheets to send off to the fabricators for each individual piece. A blueprint for bending the horizontal pipes was also needed, simplifying the complex spline down into a series of arcs that a CNC pipe bender can read then recreate the individual sections. At the end of this semester, we had a final project that was ready to be sent to the fabricators to check for feasibility and begin prototyping.
Final Structure Exploded Detail
Drawn by Joe Koslow
Full Structure Exploded Axon
Drawn by Joe Koslow
MY CONTRIBUTION

This was a collaborative studio project, and required everyone's participation in the creation of the form and the solving of the structural issues. I used my adaptable skills to help others develop ideas where I could, often consulting with other students both on the form and the structure. However, my main creation in this studio were the various models needed for the final exhibition. I was given the opportunity to design the model base for a 1” =1'-0” model as well as create a larger context model to help explain the project.

The model base was something different than what is normally done in architecture. My professor wanted something more conceptual instead of an accurate representation of the site, not to mention the physical site at this scale would be well over 6 feet long. I analyzed the surrounding site context, and reduced it to the most basic forms and scale in relation to the site. An important feature was the flat façade of Central Middle School. The architect used a unique window pattern that added variation to the brick expanse, and created a dynamic backdrop for this installation. I included the full height of the wall to scale, but cut it down to make the final piece more manageable. The next noteworthy site element was the large sidewalk that wrapped around the site and terminated further north at the school, this I represented with a separate piece with a small gap between it and the rest of the model. For practical reasons, I created a smaller separate piece for the final model to rest on. This could easily be removed and carried separate from the bulky model base, providing stability to the model and making both easier to carry. My final design choice was to create a unique leg piece to support the base. Due to the unconventional form of our design, I did not want to create simple legs that did not represent our design in any way. Instead, I used eight steel conduit legs to support the base, and terminated the pipes at top and bottom with 3D printed pieces. The pieces mimicked the Saarinen pedestal table design, tapering the same way the top and bottom of the support does. This references Columbus's rich architectural design heritage and provides a more elegant and stable connection to both the floor and base. The last design solution references the complexity of the installation through the positioning of the legs. They begin and end in a logical, straight fashion but in the middle they cross to another random point, adding complexity to the base and creating a moiré effect among the legs. The crossing is balanced so every piece is supported equally and the center of gravity still remains in the center, making the structure stable.

The other project that I worked on was creating a context model to show the design references around the site. This was created by first 3D printing the architecturally significant buildings around the site and then creating simple white rectilinear shapes to represent the rest of the buildings. The base was milled out of a single piece of birch plywood, providing contrast to the stark white buildings and creating intricate detail to show site features like the site outlines and streets. Milling the base also allowed for the library and First Christian to be set into the base, showing their true elevation change. Just like the original design, this context model also used advanced manufacturing to create a more complex and accurate representation of Columbus.
Our project was presented to the rest of the college through an exhibition in the College of Architecture and Planning (CAP) first floor gallery. Here we curated an exhibit that showed the main points of our design through models, drawings, and an animation a student put together. Other CAP students walked through the gallery and asked us questions about the design process and Exhibit Columbus in General. The exhibit will be up for a week and will be taken down after graduation. At this time, a summer Graduate studio will take over the project and finish it up to be ready for the program in the fall.
FINAL THOUGHTS

This was by far one of the more challenging assignments I have completed in my education, but by far the most rewarding. Design-build projects are a completely different challenge than creating a conceptual project. With unbuilt projects, there is little concern for assembly process or financing; this is usually something figured out later in the process. But with a design-build project everything must be considered when designing, otherwise it will become increasingly difficult further on in the process.

Working in a collaborative group of thirteen was also challenging at times, especially when we were all trying to design together. Design is something that is incredibly conceptual; if one person is unable to draw what they are thinking accurately or describe it in a way others can understand, it can become very frustrating. This also was a project that required significant time outside of class; communication among thirteen students was also difficult at times. Our solution was to break into separate teams, but all the work still relied on what other teams were doing. There is a saying in the architectural profession that it is impossible to design in a vacuum; this project only emphasized that aspect of this field even more.

Despite all the difficulties of real-world problems and collaboration, this was still an incredibly satisfying experience. The complex and unique form challenged my design skills in a way that they are hardly challenged. Working with actual materials and site specifications brought to light real world issues of budget and material capabilities. Most of my education focused only on one of these issues that I may face in my career ahead, but working with a project that had these issues to be solved simultaneously made me feel more prepared to face similar challenges in my upcoming professional career. I was very glad to have participated in a challenging project, and I am proud to say that I helped create an installation for Exhibit Columbus.
References:


