Architecture as Mediator of Environment: A Core Environmental Design Studio

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The façade, or enclosure, is the primary signifier of architecture as a whole. In Rem Koolhaas's "Elements of Architecture" the introduction to the chapter on facades states that as "a metonym for architecture … the façade is the element most invested with political and cultural meaning." [1] Throughout history of architecture the façade has taken on and reflected the cultural and political concerns of the day. Through each period, the architect has displayed an attraction and obsession with the façade as the location of innovation in architecture. Rather than see this as relinquishing of the agency of the architect, can we reimagine the role of the skin as both mediator of its environment and active produce of it? In this essay I will be demonstrating how these questions and issues are pedagogically addressed within a coordinated undergraduate core studio.

Students were asked to design three small buildings on a single site. Each project asked the students to consider a single environmental actor as its primary focus of the design. The projects leveraged architectural responses to lighting, acoustic, and thermal issues. While each building leveraged a single environmental force students soon realized that many of these systems overlapped and are codependent. The semester starts with the design of an Architecture of Light: a free standing gallery. The second project was an Architecture of Sound: a performance space that must function as a closed performance space in the winter and an open performance space in the summer. The final project was an Architecture of Heat: a spa and boat house that utilized thermal experience and natural ventilation. In this essay I will be discussing how each of these projects related to each other, what tools the students used, and where there might be opportunities for further developing this pedagogy.

ARCHITECTURE AS MEDIATOR OF ENVIRONMENT // ENVIRONMENT AS MEDIATOR OF ARCHITECTURE

In Rem Koolhaas's 2014 Elements of Architecture, the façade is defined as the primary signifier of architecture. The book's introduction to facades states that as "a metonym for architecture … the façade is the element most invested with political and cultural meaning." [2] Thus, arguing that throughout the history of architecture, the façade or enclosure has taken on and reflected the cultural and political concerns of the day from nationalism during the renaissance, internationalism during the '20s, and '30s and environmentalism in our current architectural context. Through each of these periods, the architect has displayed a fascination and maybe the obsession with the façade or enclosure as the location of innovation in architecture. As more and more of the interior space of buildings is codified and regulated through code and compliance, the architect continues to retreat to the skin of the building. Rather than see this as relinquishing of the agency of the architect, can we reimagine the role of the enclosure in producing innovative space? How can the enclosure of the building influence our experience of the space both within and outside of the building? How can the skin of the building become both mediator of its environment and active producer of said environment? In this essay, I will be discussing how these projects are related to each other, what tools were used by the students, and where there are opportunities for further developing this pedagogy.

In "Five Points for a New Architecture," Le Corbusier declares that the architecture of the future will consist of 5 discrete and discernable elements: piloti, roof garden, free plan, ribbon window, and free façade. [3] While each of these elements is still present today, none is more influential in the practice of architecture than the free façade. Corbusier describes the free façade as such: "By projecting the floor beyond the supporting pillars, like a balcony all-round the building, the whole façade is extended beyond the supporting construction. It thereby loses its supportive quality, and the windows may be extended to any length at will, without any direct relationship to the interior division."[4] This understanding of building construction still remains today. The free façade, as an innovation, does not exist on its own and is only made possible by its clear relationship to the structure of the building. The invention of reinforced concrete and steel allowed the skin of the building to be separated from the role of supporting the building to take on issues light, ventilation, aesthetics, atmosphere, composition, and surface. How then shall we conceptualize the building enclosure in our contemporary context, which is understandably focused on energy?

The enclosure of the building shares many similarities with the skin of the human body. Our skin is the primary organ that interacts with our environment through conduction, convection, radiation, and evaporation. Not dissimilar, the enclosure of a building must also act as a mediator between the environment and body to provide shelter. As such, the skin of the building is the space of intense systematic overlap, having to negotiate temperature, light, circulation, structure, aperture, and ventilation. What programmatic, spatial, and aesthetic opportunities are made apparent by the environmental functions that the skin of the building must take on?

In this studio, we asked students to reexamine the relationship between enclosure and environment through a series of small buildings on a single site. Each building interrogated a single environmental factor, but students found that many of these systems overlap and are codependent. The semester started with the design of an Architecture of Light: A free-standing gallery which includes a cafe and various auxiliary functions. The second project was an Architecture of Sound, the design of a performance space that must function in two modes: a closed performance space in the winter, and an open performance space in the summer. Using acoustics as their primary driver of design, students considered material and cladding as well as spatial organization. The third and final project was an Architecture of Heat. This project asked the students to design a spa and boathouse that utilized heat as the primary driver of design. In each of these projects, the enclosure's influence on the space of the building extends well beyond its physical boundary, demonstrating an innovative attitude towards light, temperature, energy, and material.

The enclosure of the building has always been a point of contention and debate for the more intractable issues of architecture: from Loos's declaration, that ornament should be banned to the postmodern view of the façade as a signifier, to the technocratic facades of the more recent environmental movements. By the end of the semester, students were able to place their design ideas within the pantheon of architectural solutions for the enclosure while understanding the façade as an integrated system having to tackle performative, aesthetic, and cultural issues all at once.

PEDAGOGICAL CONTEXT OF STUDIO

This studio, as a pedagogical tool, is an opportunity to critically engage the content of core technology, history, and representation courses through their application in a design-focused environment. As such, it is the intellectual space where students can test first-principals, stretch their understanding of those principal's application, and invent new architectural responses to technological, historical, and representational precedents learned through the core architectural education sequence. A student's experience in technology courses, for example, is gained through concrete interaction with precedent or codified architectural responses to environmental needs and typically is evaluated through objective measures. At best, critical engagement with the topic is often delayed to upper-level studios, and at worse, the content delivered in these courses is avoided in lieu of a focus on formal explorations. This studio sought to integrate environmental concerns and their first principals into the core studio design sequence.

Of importance to this desire to integrate environmental concerns into the core studio, is the understanding of design education as experienced-based learning, and an understanding of design education's relationship to the Kolb's Learning Cycle. Kolb's learning style argues that all learning takes place through a cyclical form consisting of Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. [5] This pedagogical model leans on the work of past scholars such as American Pragmatist William James and John Dewey. [6] John Dewey's writing on experience and art as well as experience and education had a notable impact on craft and making base educations like what occurred at Black Mountain College. [7]

Each of the steps in the Kolb Learning Cycle can be mapped onto an architectural education, with some of them even overlapping. Concrete Experience, in which a student has a new experience or encounters a new bit of knowledge, may happen in the core technology course with the delivery of codified and typological responses to environmental concerns. That knowledge is then processed through the Reflective Observation step. This is often achieved through exams and projects with objective outcomes allowing the student to reflect on and test what they have learned. Students then take these reflections to studio where Abstract Conceptualization can occur. This abstraction asks the students to distill what they have learned and produce generative responses to the new knowledge they have gained. Following this abstraction, students participate in Active Experimentation by using their new ideas, generated through abstract conceptualization and testing them through architectural design. At this point, the cycle repeats, with the students again having a concrete experience through the production of their designs.

To demonstrate this process, let's look at daylighting, a topic taught in the core technology course. In order to consider issues of daylighting, the students would learn about solar angles in their core technology course. They may also discuss the history of this technique, developed by the Fred Keck in the 1930s, or the modern history of solar homes. The student would be tasked with homework, projects, and exams, which may ask the students to use DIVA, Climate Consultant, or hand calculation. These assignments would represent the Reflective Observation step and would act to demonstrate the validity of the knowledge they have learned and their ability to leverage it objectively. The students then bring this knowledge to studio where they are asked to think more critically about all the various aspects of architecture through the lens of light, sound, and thermal issues in the formal and performative design of architecture.

This studio is the final semester of the four undergraduate course studios resulting in a BSAS degree. At this point in the student's education, they've taken three design studios and are in the process of taking the final core architectural technology course as such students have a base knowledge of orthographic projection, spatial design, passive environmental strategies, as well as a background in history and theory. At the same time, the students are taking Architectural Systems 2, which focuses on lighting, both natural and electric sound, acoustics, and thermal issues related to HVAC systems. During these two courses, students learned how to use Diva, Climate Consultant, Post Occupancy Devices, Autodesk CFD, and thermal cameras to explore and evaluate the principles of light, acoustic, and thermal experience.

THE SITE

The first exercise for the semester was to master plan. The students were asked to propose landscape based changes to the site along with the three proposed buildings that would organize the movement of people, water, animals, plants, etc. [Fig. 1] For each project in the semester, students were tasked to use one of their primary environmental factors to organize the site. For example, students used diva and made physical models that allowed them to understand how their design decisions on the site might be effect by the daylighting concerns. It was not required of a student to use computer simulation or physical simulations, but physical models were encouraged. Students were provided with a gnomon dial, a sundial that allowed them to understand the equivalent sun angle of their desk lamp. Each student was able to use the lamp on the desk to approximate the sun. These physical models allowed for a rapid examination of the solar effects of their design decisions.

As the site was going to be reevaluated for each project, the qualities of the site changed based on the design decisions of the students. For the second project, an architecture of sound, students went to the site with their acoustic recording devices and used it to and analyze and then draw a map of all the areas of acoustic intensity. They then took these measurements in to account for the next iteration on their site master plan. For the final project, an architecture of heat, students looked at their site one final time, using wind patterns across the site to affect the position of their final building. In the end, these 1:50 contour models were iterated on four times over the course of the semester with students, cutting into them, rearranging them, as we layered additional environmental factors on top of them.

ARCHITECTURE OF LIGHT

Light is a powerful signifier in architecture. One only needs to look at the work of Peter Zumthor, Corbusier, or Renzo Piano to see how architects use light to produce various atmospheric experiences, signify sacredness, give direction or suggest warmth. Even the color of light has specific connotations. For example, warm light measuring 3000K is suggestive of home, hearth, and the first fires. While white light measuring 6000K

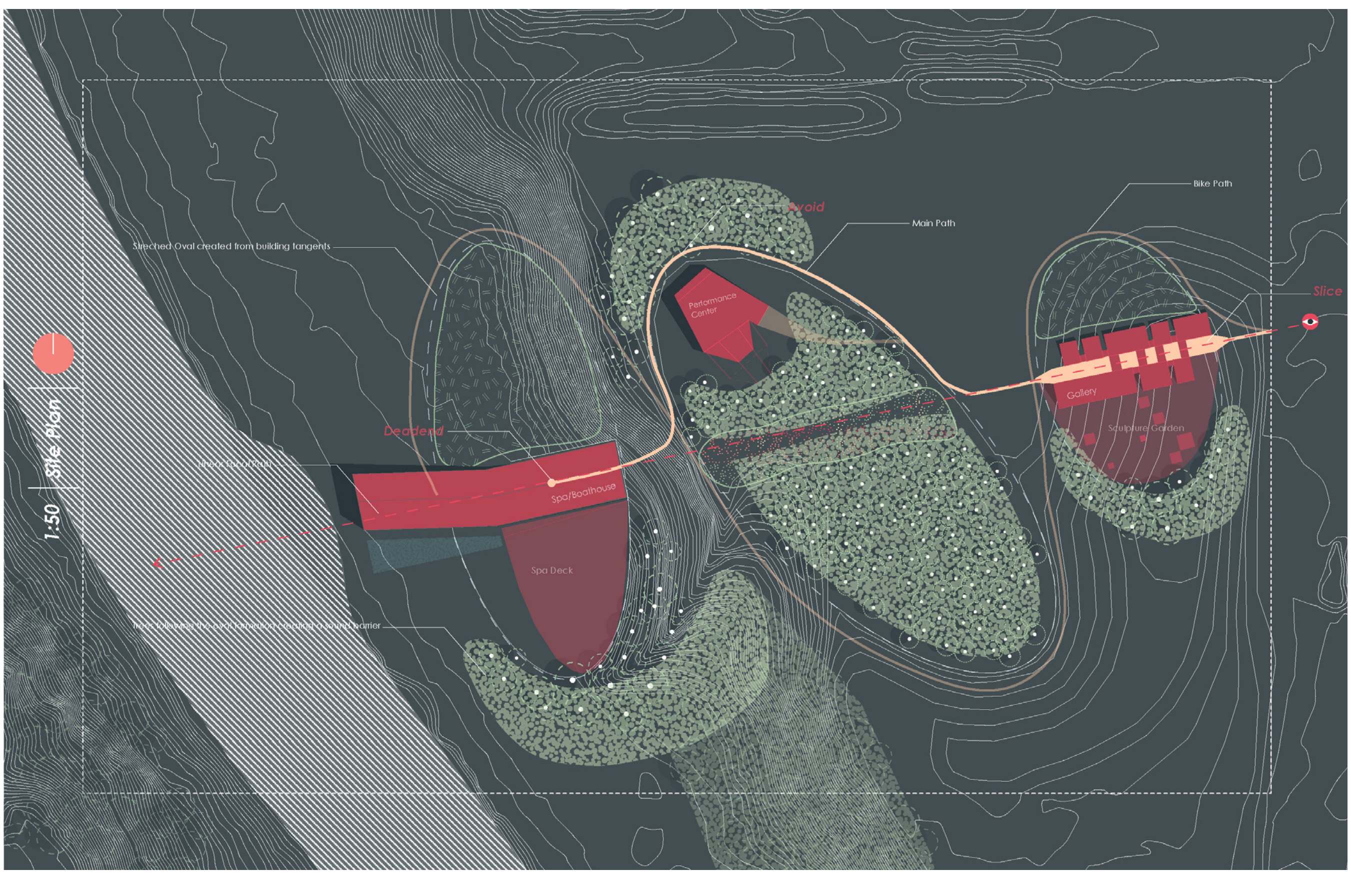

Figure 1 Master Plan: Marle Barnes, Amanda DoBas, Alexis Meyer

suggests a hospital, office, or a cold space. In each of these cases, light is considered an element of design that actively shapes space as much if not more than the surfaces of architecture. In this way, an Architecture of Light is as much about the form of the building as it is about the performance of that building. Considering the quantity and quality of light, duration, orientation, form, and performance, students designed a single story 8000 sqft gallery and café that uses natural daylight as a design element.

For this project, students use a combination of digital computer simulation and physical modeling to explore various aspects of lighting as related to the form of their buildings. Students were asked to build a large quarter-inch to a foot model, which would allow for renderings to be produced using phones or a small camera. [Fig. 2] Normally complex and difficult for students to accurately simulate within the computer, lighting effects such as specular reflection and translucency of material, could be easily simulated and documented through a physical model. Photoshop is the primary tool used in editing these images, but given the precision of the physical model as a rendering tool, the only entourage needed to be added to the images for scale. Students were able to immediately evaluate their projects based on their workability to achieve a given lighting goal. Whether that goal was a sequence of spaces containing a gradient of lighting condition or abrupt adjacencies of different light qualities, students were able to immediately test this with their gnomon dial and their desk lamp. These tools allowed students to rapidly-produce a series of iterative renderings with that physical model. This allows students to produce an immediate feedback loop between their design and their performance, providing a direct relationship between formal moves and performance as the model acts as an open system allow the students to adjust to light and material input through the adjustment of the lamp and editing of the physical model.

Projects were also evaluated based on compositional and architectural terms — student's ability to design a sequence of experiences leveraging architectural tectonic moves to create various lighting experiences. Lighting devices taken from their technology courses were incorporated into their designs and allowed the students to evaluate specific elements of their buildings through objective means within their technology courses. This project focused on light was the easiest for students to engage because light, unlike sound or heat, is visible and representable given current architectural tools and techniques. Students would come to find that when the architectural or environmental factor is not easily representable such as sound or ventilation or other thermal issues that they needed to create additional visual cues to allow for a critical exploration of those environmental factors.

ARCHITECTURE OF SOUND

SOUND, outside of performance spaces, in architecture often lacks the focus that it deserves. As Michael Kimmelman notes in the New York Times, "We talk about how cities and buildings look. We call places landmarks or eyesores. But we rarely talk about how architecture sounds, aside from when a building or room is noisy." [8] SOUND can enrich our spatial experience in productive and detrimental ways. Yet it doesn't operate in isolation; spatial configurations also have a dramatic influence on the acoustic landscape of space. In other words, the form and its performance are inextricably linked. Additionally, program, user density, material, wall assembly, surface texture, and many other criteria influence the acoustic performance of any space. A well-designed room can diffuse, focus, amplify, or deaden any sound. Could we imagine and Architecture of SOUND in which a visual experience of a space is as important to the aural experience of that space? As architects, it is our job to leverage all the environmental forces on our buildings as designers and to see them as opportunities. While acoustic paneling, for example, can solve many acoustic problems, without careful consideration, it acts as merely performative wallpaper, lacking any productive spatial consequence. For this project, the wall or enclosure was asked to take on physical properties and sectional thickness to engage both geometry and material.

Figure 2 Model: Armand Gamboa, Lucas Anderson

Project two tasks the students with the design of a performance space that will host speakers and music-based events. Additionally, each design must be able to open to the exterior to provide additional seating in the summer months. This performance space will be naturally daylit from above except for the moment in which space opens to the outside. Students should avoid direct southern light from entering the space. Each of these spaces requires varying qualities of sound.

The performance space consists of several design / programmatic elements: the stage, reflector, diffusive geometry, racked seating, and absorptive rear wall. [Fig. 3] The reflector redirects sound back towards the front of the audience. This element should be made of hard, acoustically reflective material. The diffusive geometry of the volume prevents echo, creep, and flutter. This geometry should not be concave. Concave shapes focus sound and are considered an acoustical defect. The racked seating ensures clear eyesight for each of the audience members. Refer to the Architectural Graphic Standard, Nuefert's Architect's Data, or the Architects Studio Companion for more information on seating. The rear wall must be made of an absorptive material with geometry that encourages diffusion.

For this project, students were given typological responses to sound within architecture. Deliverables for this project focused on the assembly of typological elements, which were known responses to acoustic issues within architecture. The reason for this was only four weeks with the goal of this again being to challenge the students to think critically about architectural spaces of sound. In the end, this project had a clearer translation of the architectural respond to sound as the typological responses to sound are both geometric and material based. This gave the students an accessible entry point to manipulating sound without having to understand the first principals of sound. While the first project on light directly challenged the architecture students to think about the representation of light using physical models and minimal photoshopping, the second project on sound leveraged typological architectural responses and thus did not immediately engage architecture students in the representation of sound as a design exercise, in thinking about opportunities to further develop this pedagogy this is one area that could leverage more of the relationship between the documentation of post-occupancy tools or could start with the representation of sound.

ARCHITECTURE OF HEAT

Thermal issues in architecture are an ever-present and an under-utilized influence on our experience of buildings. The experience of various thermal sequences is often suppressed through the use of mechanical systems and the ubiquity of the 72-degree Fahrenheit space. The primary task for this project was to think of architecture as a sequence of thermal experiences, considering both the source of heat and the temperature. Heat delivered or removed through Conduction (physical contact) or Convection (moving air) or Radiation (the sun) have various experiential and formal consequences for architecture. As the human body experiences temperature through difference, cold relative to warmth, can architecture formally or spatially reflect this reality? [9] How does one transition from hot to cold? How does one transition from the exterior to the interior? Are these transitions abrupt with strange juxtapositions or gradual as a continuous gradient? How can these differences be manifested in the building's form and performance? From the Baths of Caracalla to the work of Peter Zumthor at Vals, it's easy to see how architects have used heat to produce various atmospheric experiences. As with each of the previous projects, the Architecture of Heat is as much about the form of the building as it is about the performance of that building. Project three tasks the students to design a boathouse and spa with various auxiliary spaces. Each of these spaces requires varying thermal qualities that are the result of its programmatic requirements, relationship to the exterior, and relationship to the sun.

The students successfully leveraged computational fluid dynamic (CFD) software as a design tool for this project. [Fig. 4,5] While the project on light leveraged the physical nature of light and the physical reality that it as a medium is visible, the same type of physical simulation of the flow of air or heat in a building presents many scalar issues. While salt bath models are a particularly productive way of modeling this physically, the rapidity of the studio environment required something

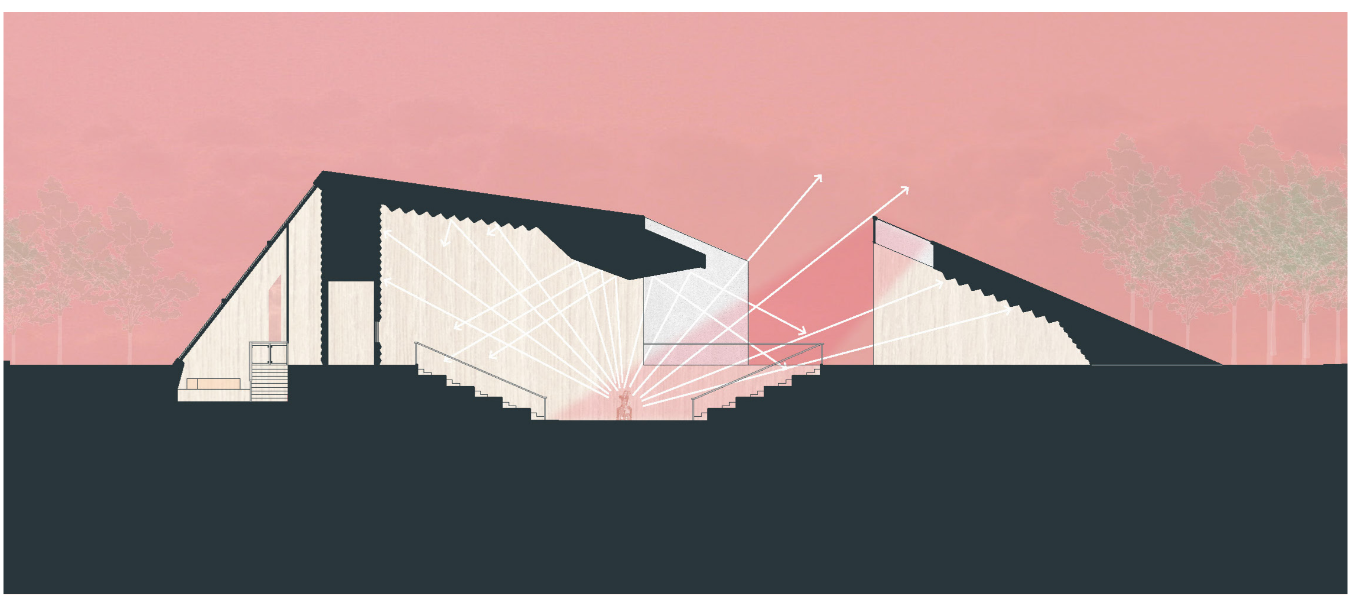

Figure 3 Section: Marles Barnes, Amanda Dobas, Alexis Meyer

Figure 4 Model: Marles Barnes, Amanda DoBas, Alexis Meyer

faster. CFD was taught to the students in their technology systems course and was leveraged as a design tool. Students quickly iterated through various forms, orientations, and programmatic adjacencies to determine the most productive or desirable atmospheric arrangements. Simulations allowed the students immediate and precise feedback on their design. Their integration to the design process from the very beginning of the project resulted in forms and arrangements that were both unfamiliar to the students and generative. The more productive projects engaged CFD in the iterative process while the less productive projects engage CFD as a check or a final representation tool. Projects that leverage these tools early and as part of the design process treat the first principles of environmental factors as actors in the design process.

CONCLUSION

In conclusion, the success of the studio lies in the exercises in which students were able to engage with physical processes through their models. It was discovered that whether it is a physical model or a computer simulation is less important than the interaction with that model producing a feedback loop between the student's architectural desires and the physical reality of the processes with which they are engaging. Pedagogically, Students learned through experience and engagement with these first principals to develop an intuitive sense as to how they might engage the design process of environmental architecture through a cyclical or iterative process. As Reyner Banham notes for architecture to succeed, environmental forces will need to be "naturally subsumed into the normal working methods of the architect." [10] Importantly, the integration of these tools into the design process at the level of the sketch or the study model meant that they were not treated as an a posteriori check on the desires of the student but as an active participant in the design process. Lastly, the enclosure or skin of the building as the point of emphasis of this studio ensured that the students, we're engaging with these forces at the moment with which they engage architecture. As was noted in the introduction, the facade or enclosure of architecture has often been a place of contention. It is often within the enclosure or the facade where a number of these performative aesthetic and cultural issues collide. By positioning the environmental factor early in the design process and by entangling it with what we might consider a study model or sketch and by removing the typological responses, students generated architectural responses that were more nuanced, generative, and inherently exploratory. Additionally, through a deep engagement in these first principles learned in the student's core technology courses within a studio environment allows them to push and pull on the function or role of these environmental factors in the design of architecture.

ENDNOTES

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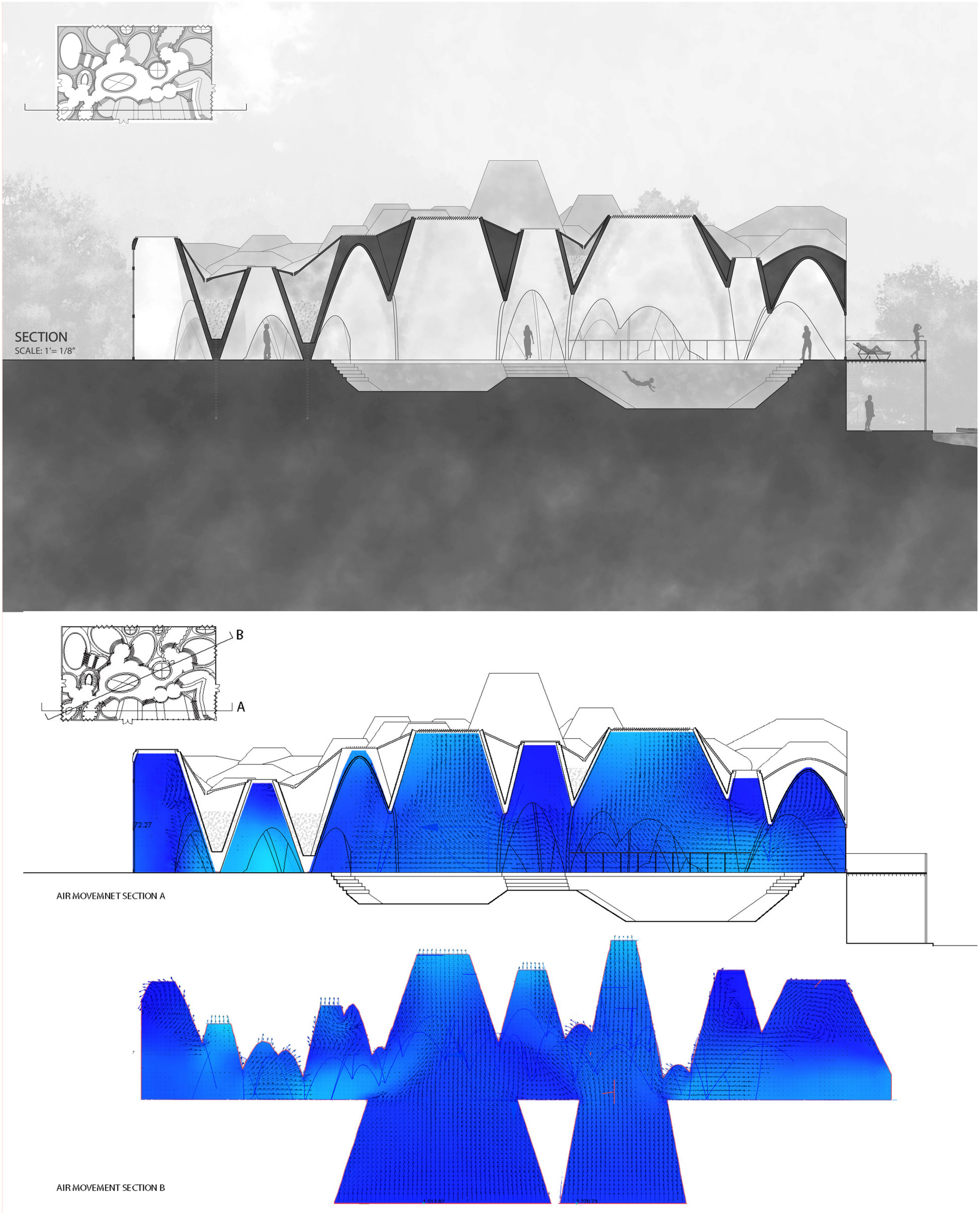

Figure 5 CFD Section: Cole Hunt, Shawn Malcolm