Stone and Steel: Adventures in Detailing

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Design-build within the studio is an opportunity for students to gain felt experience with built materials. While many students can boast experience with basic wood framing, either through Habitat for Humanity, summer jobs, or at home, most do not handle more complex materials such as stone or steel. As architects, we typically approach detailing as a concept learned over time, and through experience. For most architects, however, this occurs through the production of built work – it is the place where we learn the most from our mistakes, and the place where learning takes a great deal longer to absorb. Vittorio Gregotti expands this idea, where "…each architectural work annexes particular alignments that are open to experimental risks; in one sense each constructs not only a language but also a specific technique…. Each project must confront the difficulty of giving unique architectural unity to cultures that differ not only technically but also in their specific objectives and modes of representation."[1] Within the scope of architectural education, how far can we expect a student to go with their knowledge of details? Is it important, and should it be?

This paper will explore the strategies, methodologies, and results of a graduate level studio using design-build as a launch platform for an understanding of detailing. The studio was a year-long venture, moving from full scale fabrication studies that culminated in a gallery installation in the fall and progressed into the development of more traditional individual projects in the spring. In the fall, students grappled with stone and steel - the challenges created by their material properties as well as the tools needed. The studio also involved the interaction and relationship with AIA Wichita as well as donated stone and input from US Stone, creating a grounded foundation with practice from which to experiment.

WHY DETAILING?

Detailing in architecture is cumbersome in architectural education. Often seeing little actual construction prior to graduation, it is difficult to persuade students of the importance of tolerance, building layers, and the aesthetic value found in understanding the struggle between construction and design idea. Design-build education offers ways to address this issue but often misses the mark on detailing. Edward Ford highlights the difficulty of defining the detail: "Any comprehensive definition … would easily prove useless to the practitioner and satisfy only the pedantic theoretician."[2] He goes on to say that while the detail is impossible to define, the activity of detailing is about "varying the distance." This definition is still challenging, because it describes the way in which the architect changes the scale at which they work to conceive of what to do at specific moments relative to the whole.

In essence, detailing is at the core of what elevates architecture over construction. It is the evidence of an architects' thought process at a moment in the design where reality and drawing fuse. It is where the idiosyncrasies of the site are illuminated, grounding the work to a place. Without exposure to the failure of one's own drawings in the face of construction, passion about the subject can only reach so far to grab the imagination of a typical student. And yet, this kind of learning is problematic if pushed entirely into the professional field – if you learn through your mistakes, you are invariably building problems into the details of a building that may or may not be caught before the drawings leave the office, and the relevance of detailing as a part of the art of architecture is lost. Vittorio Gregotti's article on "The Exercise of Detailing" reinforces this loss: "…[it is] false to think that culture of industry or building… could solve the problem of detailing; this might be convenient or economic to the architect, but lead to the unprecedented downfall of architecture."[3] The problem of detailing lies, in part, on understanding that the detail, from its representation to its actualization, is the architecture.[4]

Historically, the shift away from dealing with built materials as part of the architect's education goes back at least as far as the Beaux Arts where, "The tectonics of the buildings only emerged in the detailed watercolor plans, elevations, and sections."[5] Marco Frascari emphasizes this in his discussion of the *analytique*: "The drawings carried few if any details and dimensions. The designer could be almost entirely dependent on his craftsmen."[6] Along with the formation of the AIA in 1859, the architect was siloed away from the contractor, the construction process, and tangible realities of real materials.[7] The AIA contract reinforces this, making the architect responsible for the drawings (lines) and specification (words). This eroded foundation degrades the value we place on understanding construction in part because of the elevation of the drawing as the locale for design. The drawing itself is not the culprit – it is in the way in which we delineate our roles and in the ways in which the architect assumes accuracy in a fundamentally unpredictable and flawed reality. Robin Evans captures this conundrum and its potential: "...[it is] the locale for subterfuges and evasions that one way or another get round the enormous weight of convention that has always been architecture's greatest security and at the same time its greatest liability."[8] These subterfuges and evasions can be seen most basically in the way we draw tolerance into a drawing – it is literally within the space of the line. Our ability to work around these conventions is, like our experience with construction, a learned skill fundamental to the education of the architect.

THE RELEVANCE OF DESIGN-BUILD IN ARCHITECTURAL EDUCATION

As counterpoint to the dilemma inherent in drawing and its disengagement with materials in the educational process, there is a lineage of interest in experimentation with materials and their incorporation into the building design from Frank Lloyd Wright's Taliesen West to Auburn's Rural Studio. The rise of design-build educational models in the past 20 years has been well documented and their popularity amongst students is great.[9] While there is a spectrum of approaches, for the purposes of this paper I would like to focus on the two poles of this pedagogical approach and some of the inherent issues that come with them. On one end the studio is geared entirely to the research and understanding of one or more materials' properties and potential. Toshiko Mori's seminar and exhibition *Immaterial/Ultramaterial* at Harvard in 2000 is a well-published example[10] of this type of materials research. Rem Koolhaas' 2012-13 "harvard-amo" studios that led to the exhibition and publication *Elements of Architecture* is another well-published example[11] of this model. These have produced exciting artifacts for practitioners to discover primarily in published literature, but there is a challenge in translating the results of that experimentation into actual built form. It does not have the immediacy of interpretation and applicability to current work or manufacturing, and the value in this research is primarily in sparking discussion and debate.

On the other side of the spectrum is the design-build studio as service-learning project engaged in the fabrication of built work typically within the space of an academic year. Auburn University's Rural Studio, founded by Samuel Mockbee and D.K. Ruth, is the classic example: working in Hale County, Alabama since 1993, the studio has completed more than 200 projects since its inception. There are two undergraduate studios and a master's program that participate in this studio experience.[12] Dan Rockhill's Studio 804, based out of the University of Kansas is another successful example of this model, completing over 21 buildings, primarily houses, each typically within the space of a year-long graduate studio.[13] Design Build Bluff, based out of the University of Utah and founded by Hank Louis, has also seen over 20 projects completed, and like Studio 804, it is a year-long graduate studio. Design Build Bluff typically works with the Navajo Nation and the studio, like Rural Studio, is located in the region in which they work.[14] The goals of these studios are quite high (producing a house from design through construction in a year) and the architecture is often seen as something beyond the reach of the clientele of these projects. Collaboration and project management are typically the most complex skills students must confront. The completed work can be seen as a highly elevated version of Habitat for Humanity, where the interaction with the client and developing the students' sensitivity to the design issues specific to that client is of primary importance. Ideally these projects are a wonderful addition to the urban fabric, they spread design education to a population that may be less exposed to design, and they deliver a quality product to the client. However, the projects can also be fraught with pedagogical, chronological and occasionally ethical issues, where the focus drifts more into an exposure to the vagaries of practice and the pressures of quality completion than the performance and refinement of specific details.

STONE + STEEL

The Stone + Steel studio is a graduate studio started in 2018 at Kansas State University. The goal of this studio was to find a middle ground pedagogically between pure materials research and pure service-learning that could capitalize on material and fabrication exploration while still challenging students to translate that learning into building-sized drawn projects by the end of a year-long studio. The hope was to gain from both approaches – by scaling back the production to prototyping, this would allow the students to focus on detail development and material/fabrication research without the redundancy inherent in the production of fabricating an entire building or the pressure of completing a building within a semester or year. Interfacing with the manufacturer US Stone and AIA Wichita would bring a level of realism to the students that could not be replicated in our fabrication facilities but could be brought to bear on the students' projects as they moved beyond initial prototyping into the spring semester.

The graduate studio was originally taught in the fall 2019 - spring 2020 semesters. The studios at Kansas State University have an accompanying support course each semester, and together these 4 courses describe a larger research arc for the students over the year. The fall semester for the Stone + Steel studio was geared towards fabrication research culminating in a gallery installation approximating three-quarters of the way through the semester. From there the students transitioned into overall masterplan development for the rest of the semester and then into a more traditional model of studio for the spring semester.

The methodology within the studio was iterative beginning with an abstract first exercise that then folded into a series of small team fabrications building to the final work for the installation. Stone and steel were the subjects of this research as limestone is native to Kansas and both stone and steel are typical vernacular

Figure 1. Examples of the fall semester initial iterations (above) and process photos of the students working in the fabrication lab (below). Image credit: Timothy Struemph, Nicholas Horvath, Genevieve Baudoin, and Olivia Ashbrook.

materials of the region. Of all metals, mild steel was the easiest material to work with in our shop, and we could also acquire donated limestone from US Stone. The juxtaposition of an easily worked material like mild steel with the more fragile and cumbersome limestone offered a counterpoint around which to develop an understanding of detailing. Prior to the students' entry into the shop, they dove into precedent research, looking specifically at grout-less stone and metal façade systems as well as lateral technologies, from agrarian to vernacular to aviation. The purpose of a broader approach to precedent study was to illustrate that there are clear patterns in the ways in which stone and metal are attached to a building, but that metal in particular has undergone quite a lot of innovation from the utility of a crop irrigator to the structural rigidity of a plane wing or corn silo. In this manner, the precedents were approached similarly to a language immersion course, where patterns, innovations, and connections could imprint on the students as a foundation for their detail design development.

The first foray into the shop began with an overall introduction to our shop and its capabilities. Every shop is different, with its own limitations and specialized equipment, and every student comes with their own background and skill set. The first exercise was meant as an equalizer: the students were each given a 1'x2' piece of 18-gauge steel and a block of 1'x1'x3.5" limestone and were told to use about 15 different tools in the shop to aid and abet their process. They were required to lift the limestone off the ground in some way (not as a whole block, but in parts) and to transform the sheet steel so that it could stand on edge. The students could use additional flat bar, angle, tube etc. to flush out their ideas, and there was no pressure to produce either an outstanding art object or compelling design that would propel them forward after that initial study. (Figure 1) The students did, however, quickly learn the limitations of both the materials and tools, especially as it might relate to sequencing and tolerance. In particular, the limestone allowed very few tools with which to shape it – a tile saw and some hand drills and chisels. The students were limited to not only the size of the tile saw blade and bed, but also the angles and precision of their cuts. An 1/8" slot was an easy connection to make, as were a number of different sized holes – it was more challenging if they were drilling blind from two sides or sawing on the long face (also blind) to make their material thinner. Many of them learned that while sawing a slot in limestone is easy, drilling a hole through that afterwards will simply break the stone!

With the sheet steel, there were two large learning curves for students. The first, like the limestone, was in sequencing their moves. For instance, if a student used the electro-magnetic bender to make two bends, it would be virtually impossible to produce a third bend. Or, if a student used the plasma cutter on a piece of steel, they could not then shear the steel or bend it. The second learning curve was in attempting to weld 18-gauge sheets: as beginning MIG welders, they typically burn right through or warp the metal. The students learn to use thicker steel, how to seat a rod for a perpendicular weld, or how to tack to prevent warping, as examples. The exercise was equalizing because there is always something a student learns to be pretty good at in the shop regardless of their initial skill level. Also, the addition of limestone as a required material was typically more

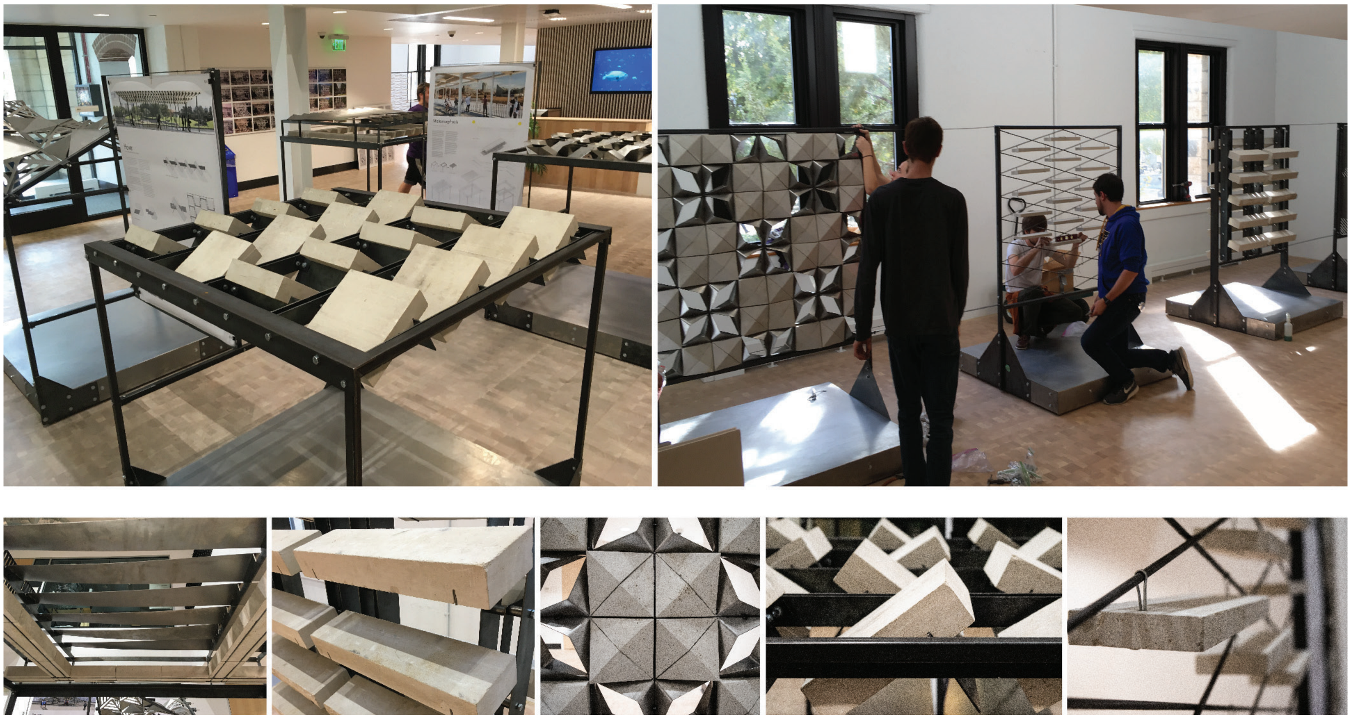

Figure 2. The final gallery installation, shown here re-installed at Kansas State University. Students: Olivia Ashbrook, Megan Burke, Landon Cook, Mitchell Culbertson, Giuliana Fustagno, Nicholas Horvath, Andrew Mallinson, JD Meyers, Alycia Pappan, Dylan Schoenfeldt, Kristen Seideman, Jared Shelton, Reed Strawn, Timothy Struemph, Andrew Wood, and Andrew Zielke. Image credit: Genevieve Baudoin and Nicholas Horvath.

alien to the students, and everyone struggled with inventing ways of connecting the stone to steel.

Familiarization with the tools and materials without the pressure of design completion was invaluable to the students. The weight of the stone and the sharpness and oiliness of the steel is immediate in the shop and took the students fully out of their comfort zone as their work clothes attested to. However, their sketched ideas were quickly modified as their understanding grew. Any studio's interaction with materials could be limited to this kind of play before launching into a studio project. For me, it was important to push the students' level of engagement with the materials beyond that initial interaction because the students needed to engage in the back and forth of design, then build, then change the design, then build again. Their designs could be directly informed by the lessons learned in the first fabrication study and the next series of iterations could work towards refinement and sophistication in the design rather than either a misunderstanding of the tools or materials' capabilities or a weak design that could only focus on the materials without a larger program developed for its use.

As the exercises progressed, more programmatic requirements were added into the design criteria, and by the fourth fabrication, the students were prototyping screen and canopy systems that would be built and installed for the final gallery installation. Given that the students would not be able to replicate the precision of a manufacturer specializing in stone or metal systems, the prototypes developed had to embrace programs with more inherent flexibility, like screens and canopies, without the obligations of the building envelope. This would also translate to a real building where it would be unlikely that an architect would manufacture the façade, but that architect could develop and even manufacture details that would be incorporated into the design. The students were also able to visit the manufacturing facility of US Stone to see how limestone is transformed from the quarry into the blocks needed for an individual design as well as a mock-up of US Stone's grout-less grid-system supported cladding system (requiring a steel support structure). Despite reading and reviewing this type of cladding system during their precedent research, it was a useful revelation for the students to see in person that this kind of system relied on grooves and gravity support, similar to many of their final prototypes.

In the end, there were eight 4' x 4' finished prototypes developed by the student teams of two. The prototypes had to be designed to be seen on both sides and perform in some way (screening for privacy, shading, etc.). The students were also challenged to consider Kenneth Frampton's notion of the tectonic in which it "…revealed ligaments of the construction and in the way in which the syntactical form of the structure explicitly resists the action of gravity."[15] This carried the theme of the initial exercise through to their final fabrications. (Figures 2 and 3) The actual installation required the students to consider the weight and prefabrication needed to fully assemble the gallery installation

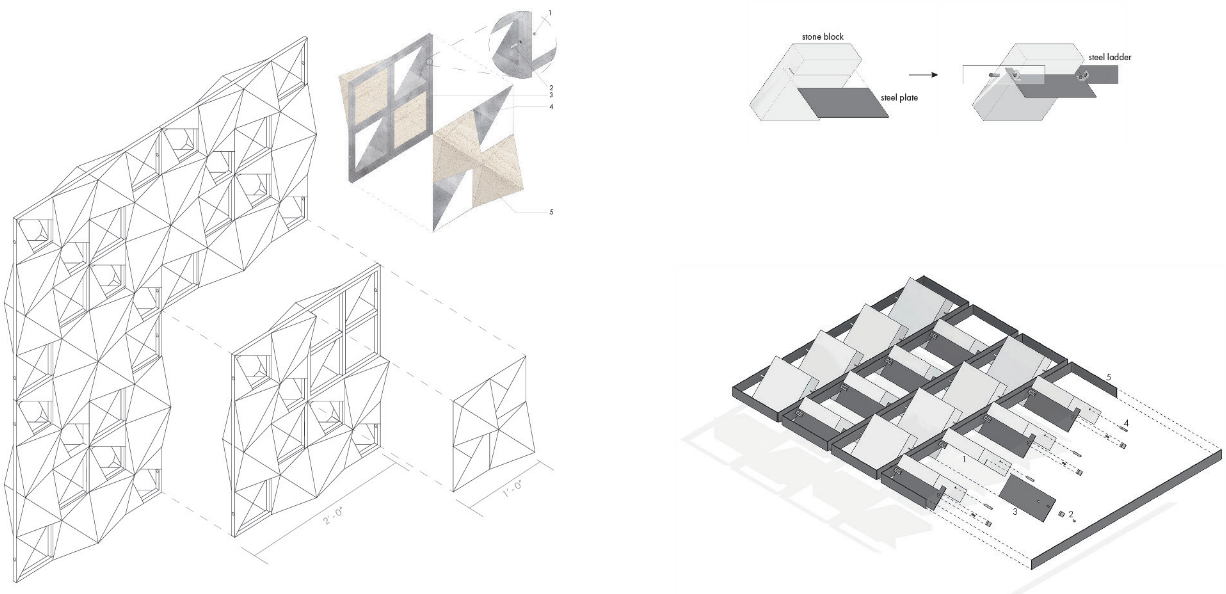

Figure 3. Example exploded axonometrics to show assembly from the fall semester. Students: Dylan Schoenfeldt + Giuliana Fustagno (right) and Olivia Ashbrook + Andrew Wood (left).

over two hours away from the shop. The installation process had to be completed within a few hours, and it could not rely on fixing the finished work to the floors or walls for support. This added criteria forced the students to design as a group and allowed them to engage in the realities of producing a built object, where collaboration and delegation were necessary to see the whole exhibit complete.

FROM R+D TO STUDIO APPLICATION

After the installation was complete, the students transitioned to developing master plans for three sites in Wichita and more detailed buildings designs within those sites. The relationship with AIA Wichita came more clearly into focus after this transition, where the students reviewed with at least 16 architects three times over the course of the project. Through both their knowledge of the sites and experience in the field, the architects participating brought a consistent level of realism back into the students' projects. This re-grounded the students' ideas from fabrication research and the idealized world of studio into applying that knowledge to the city.

The intention in the spring was to incorporate their details from the fall into their final projects, but the mode of translation from initial fabrication research varied amongst the students. For some, there was a direct translation and incorporation of their initial studies into their projects. One example of this was Timothy Struemph's final project. His initial fabrication research with his partner Mitchell Culbertson was focused on creating a stone louver system. Their fabrications grew radically more refined than their initial impulse by the way in which the stone attached to their steel support structure and confronting how to make the system dynamic from two sides (without a clear front and back). For many students including Tim and Mitch, the way in which their system could attach to a frame or the ground added another layer of complexity to their final design. Their finished fabrication, while still visibly a louver system, had become much more sophisticated in its connections from stone to steel and in the way the steel was made a visible part of the overall design. In the spring, Tim decided to turn this whole system sideways, preferring a vertical louver over the horizontal louver he and his partner had originally generated. He was also interested in integrating his system into the building envelope. From that point, the system continued to develop until he ultimately had to change materials to better accommodate the needs of the façade he had developed. While the façade ended up extremely far from where he started, the process was iterative, each decision cycling through the development of the design. (Figure 4)

For others in the studio, the translation of their fabrication research was not direct, involving more a translation of learning about detailing into their final projects. For example, Nicholas Horvath and Reed Strawn resisted working with the stone in the process of their research. The largest single struggle they confronted was tolerance using the materials of the studio. They had excellent ideas on paper that struggled to come to fruition in the lab. Their tool expertise and the limitations of the lab itself continued to thwart them throughout the fall semester. For the final installation they chose to create an all-metal system largely because of the challenges they ran into with the stone. Even with this decision, their design, because it consisted primarily of welded sheet metal, could not be suspended in the way in

Figure 4. Final fabrication details of Timothy Struemph + Mitchell Culbertson in fall 2018 (right) compared with the final detailed axonometric of Timothy Struemph in spring 2019. Image credit: Genevieve Baudoin and Timothy Struemph.

which they had originally anticipated using drilled holes to allow “hidden” rods to support the load. The tolerances were so unanticipated that the final product was forced to be supported with much thinner rod. In the end, the final prototype had to be braced from underneath to prevent sagging. While the end product is eye-catching and still performed in many of the ways in which they had anticipated, both students learned as much from the failure of their system as they did from its successes. In the spring, Nick’s project took this learning very much to heart. (Figure 5) He returned to details in stone, but the weight of the stone drove him to skin the building and develop a complex layering system, clearly learning from precedents such as Renzo Piano’s Nasher Sculpture Center. He recognized that his efforts to compress the work of his system into a single layer made the construction difficult from an adjustment standpoint, and it was difficult to embed and tune the performance of the design. His detailing process in the spring still grappled with ways in which the materials would hide and reveal their support structure, and his ability to read into the process of another architect’s approach to detailing was greatly abetted by his failures in the fall semester.

CONCLUSIONS

Looking back at the results of this studio, the students had a steep learning curve in the fall semester attempting to fabricate 128 sq ft of canopy and screen system using heavy materials that needed to be easily broken down, driven to site, installed, and broken down again and re-installed in yet another location. The translation process into their spring projects was varied amongst the students, in part because of the decisions some teams made in the fall semester to achieve the deadlines set in place to build the final installation. Having an end-product was a useful motivational tool for the students and it gave them clear practical requirements. Because some groups were less strategic in their research, they stopped design development in order to complete fabrication and invariably their final work felt unresolved or they curtailed the development of stone into their schemes. This led to a combination of direct and indirect translation of the results from the fall into the spring. Both processes had merits, but I would have liked to have seen a more continuous level of development over the year.

This middle ground approach to integrating design-build (or what I am calling fabrication research) into architectural education is more productive for the students’ learning when it supports detailing as a critical practice within architecture. While purer materials research or service-learning oriented design-build also incorporate fabrication, the emphasis on detailing and tectonics is necessarily subordinate to the other goals of these studios. But fabrication research that supports failure and the integration of that learning into the studio rather than in the office allows students the opportunity to play with what is possible without the pressures of ensuring the longevity of their designs.

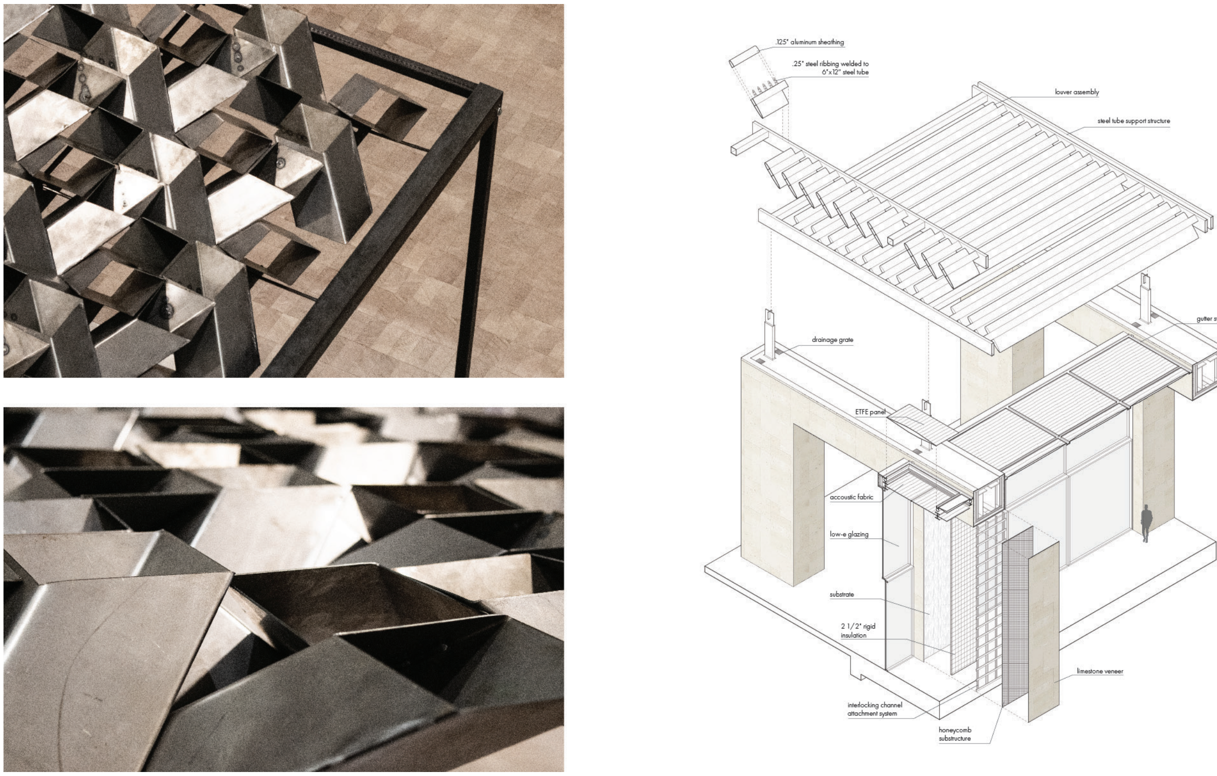

Figure 5. Final fabrication details of Nicholas Horvath + Reed Strawn in fall 2018 (right) compared with the final detailed axonometric of Nicholas Horvath in spring 2019. Image credit: Genevieve Baudoin and Nicholas Horvath.

For me, fabrication research is also a better fit within a 5-year M.Arch. program. In this setting, a students' education is already dramatically compressed from either a 4+2-year M.Arch. or a 1.5-year M.Arch. (following a B.Arch.). Finding the right place within a curriculum for hands-on materials research can often be at the sacrifice of time precious to the development of a design within studio, and it is best placed when the students gain enough expertise in understanding the materials relevant to architecture that there can be some lateral learning between the material experimentation and a design in studio. At Kansas State University, our 5th year is structured to enable a level of research in the final two graduate studios, allowing the flexibility to integrate fabrication.

The Stone + Steel studio is running for a second time during the 2019-20 academic year. The goals of the studio are similar, aided by the successes and failures from the previous year. The overall structure remains the same, and the students will be fabricating prototypes for a final gallery installation this semester. The students now have the ability to see what was done previously, and much of that learning has been quickly incorporated into the studio already. The students are all relying on incorporating stone into their fabrications, and overall simply learning from what has been done has been enough for the students to bypass many shop-related issues of the previous studio. The key change this year will be in the translation from fall to spring. The intention is to better set the stage this semester for more continuity from detail to overall design, but like the process of detailing, I may learn more by failing.

ENDNOTES

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