Interdisciplinary Studio Pavilion [ISP] 2019

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Abstract:
The Wine History Project of San Luis Obispo is an organization aimed to preserve the wine making history of the Central Cost of California and educate those who are unaware of the rich viticulture history throughout the region. This interdisciplinary pavilion project required design exploration, form development, and constructability review execution to generate a design for a mobile wine-artifact pavilion that will be exhibited throughout the SLO county and beyond. Designing the mobile pavilion required coordination with both architects and architectural engineers to aid in the creation and design a pavilion that was not only visually appealing and functional, but also met the constructability requirements of the client.

Key Words: Pavilion, Exhibition, Artifact, Wine, WHP

Background

The narrative of the WHP is a broad narrative of the viticulture environment: agriculture, land use, crop selection, the economic vitality of the county, and the relationships among the people who form the history of San Luis Obispo County. The purpose of the ISP 2019 project is to design a pavilion that will enable the public to experience a connection to that narrative. This studio will be an immersion in tectonic architecture. Tectonic architecture is defined as "the science or art of construction, both in relation to use and artistic design."

Process

The Interdisciplinary Studio Pavilion 2019 was structured as a competition between interdisciplinary teams of students to design a suitable pavilion for the Wine History Project of San Luis Obispo (the "WHP"). Its curricula emphasized aesthetics; fabrication methods and techniques; ease of assembly, reassembly and transportability; and function.

Students were organized into eight interdisciplinary teams of architecture, architectural engineering and construction management students. Teams were tasked to produce conceptual designs, schematic

designs, digital models, physical mock-ups, detailed drawings, structural calculations, detailed cost estimates and materials lists, description of fabrication techniques and methodologies, fabrication labor estimates, interconnection details, and assembly and disassembly manuals. At completion of the course, students presented their work, including scaled mockup models. WHP representatives selected the design (or designs) of one or more teams. This design (or designs) will survive to the build phase of the project. The build phase is outside of the scope of this senior project.

The ISP goals and objectives are listed in Table 1.

Table 1

ISP Goals and Objectives

Goal	Description of Goal	Description of Objectives
1	Incorporate WHP values into the design, demonstrated by achieving the listed objectives.	a) establish a set of 3 to 5 value propositions through interviews with the WHP; b) gain WHP approval of these proposed value propositions; and c) demonstrate how the design addresses each value proposition.
2	Achieve an integrated design through interdisciplinary teaming, demonstrated by achieving the listed objectives.	a) establish team protocols for interdisciplinary participation; b) measure the team's adherence to those protocols; c) establish a list of design elements that required interdisciplinary participation in their design; and d) explain the interdisciplinary characteristics of each of those design elements.
3	Connect the user to the design and the design to the site, demonstrated by achieving the listed objectives.	a) establish a suitable scale that enables users to connect with the pavilion through the exhibits mounted therein; b) express the defining narrative that connects the pavilion to the site; and c) explain the specific features of the pavilion that advance that narrative
4	Facilitate the user experience, demonstrated by achieving the listed objectives.	a) identify one or more elements of the user experience, and b) demonstrate how the pavilion facilitates those experiences.
5	Incorporate tectonic portability into the design, demonstrated by achieving the listed objectives:	

Deliverables

The inspiration for the final design of this pavilion stemmed from the biomimicry of an earwig wing; a structure that was lightweight, strong, and inherently compact. This enabled us to pursue a design that not only spoke to these qualities, but also was feasible to engineer and construct if selected by the client. The final design that we presented to the WHP representatives was named Flow; a name reference to the hyperbolic paraboloid roof profile that was achieved. Flow embodied the traits of an earwig wing with its lightweight aluminum framing that is broken down into twelve pieces for a compact, strong and easily transportable structure.

Design Description

The structure itself has a footprint of 400 SF and slopes from one end to the other 6 feet to 12 feet tall. Constructed out of all aluminum HSS members, the pavilion utilizes a truss lateral force restraining system to combat the wind loads associated with the polycarbonate covered roof. These trusses are located the 6-foot low corners of the structure and serve also as a gravity member with a 4x4" HSS post in the very corner of the system. On the 12-foot-high corners there are also 4x4" posts with 2x4" accent members sloping up from the ground to match the aesthetic of the roof. In total, the entire pavilion is comprised of twelve modules that are designed to be assembled and disassembled with relative ease and be light enough to be moved from location to location with minimum effort.

During the design phase and after speaking with the Wine History Project about what they value in the pavilion, our group determined that it would be necessary to implement features that allowed for customization and modulation of display space. After several designs were tried, it was decided that we would implement a channel-like track on the roof joists that carried free-hanging panels that would double both as partitions to modulate circulation as well as provide a surface to mount display posters. This proved to be a great opportunity to not only provide a unique means of changing the flow of people through the pavilion, but it also provided customer value by granting space for the WHP to display artifacts.

Electronic Deliverables

Arguably the most important deliverable as the Construction Manager on the ISP project were the shop drawings and details that are to be utilized for the fabrication of the project. These drawings would require careful coordination with the Architectural Engineering of the group to ensure both connection strength and accuracy to the structural model developed and analyzed during the design phase. It was also vitally important to deliver accurate details on the fabrication requirements of the structure to enable the smoothest and clear-cut set of directions for the next ISP studio to construct the pavilion.

Also included as a part of the fabrication plans but that was included in the final poster was the truss detail of the full-scale mockup that I built. This construction detail illustrated the angles and lengths that each member must be cut in order to assemble each modular truss section. This however not only served the purpose of guiding the future fabricators of the structure, but it also informed the client as to what the general size and magnitude of these pieces would in turn be. Having the construction detail completed before the fabrication of the mockup was invaluable as it gave our team a means to double check our member angles and lengths before final welding of the full-scale model.

Piggybacking on the fabrication plans, the assembly manual was created in order to properly instruct the next ISP group on how to assemble the structure once built. With this manual I was also able to depict the transportability of the entire pavilion, further allowing for clarity on the intent of the fabrication components. This manual was made possible with the illustrations generated for the fourth charette deadline in which our group's final poster was set. The architects were able to model the structural components in 3D on Rhino and used them to illustrate the setup and teardown of the pavilion.

Pavilion Mock-Up

In order to properly portray the true design intent to the Wine History Project board members, a full-scale mockup was required to be built that depicted the "most important" connection/section of the structure. The corner truss section was elected to be constructed because it not only illustrated the lateral restraining system of the pavilion, but it also showed the ease of connection that the gravity system shared with the roof. It was important that I built a model that would accurately represent the final product, which I believe that I accomplished at the final exhibition. This deliverable, though not a deliverable for the CM students, was vital in being able to explain to the client (visually), what they should expect when the full-scale structure is fabricated.

From beginning to end we developed four iterations of the structure which built upon feedback received by the clients-each refined with display space, usability, portability, and circulation kept in mind. In the end, as the Construction Management major of the group, I produced schematic drawings and detailed fabrication/assembly plans for the Spring 2020 students to use to construct the pavilion.

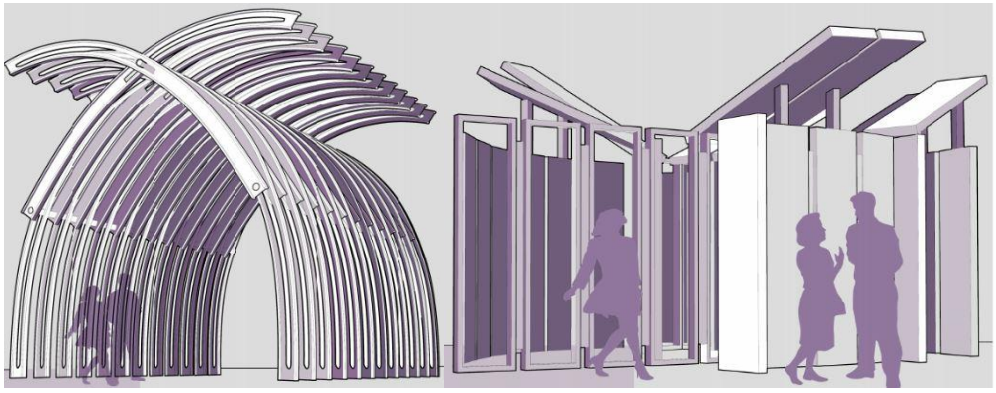

Figure 1: Two of the three initial design iterations which had great influence on the final pavilion design.

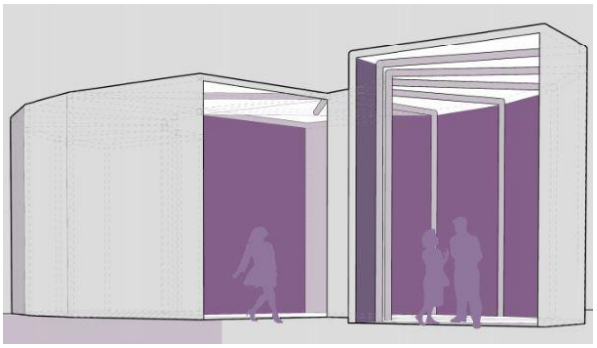

Figure 2: Aluminum-framed inspiration which opened our group to the idea of using the lightweight yet strong material.

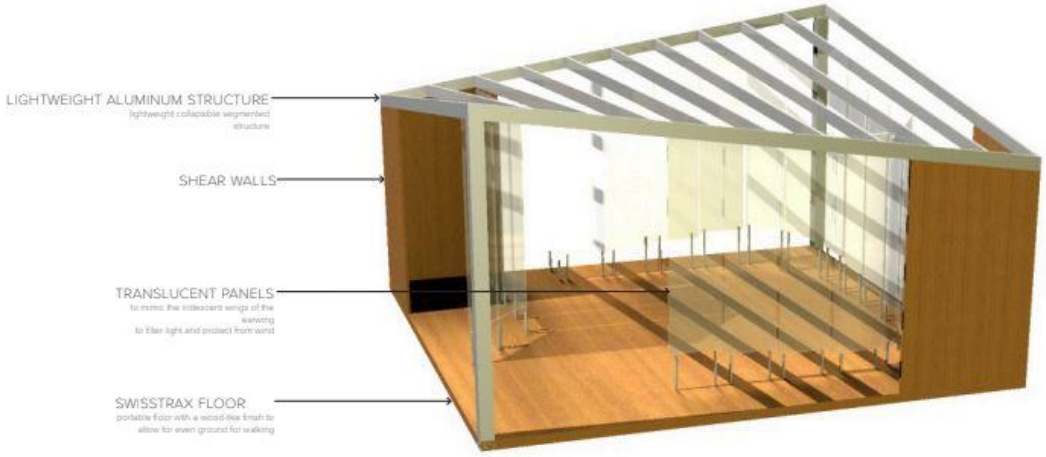

Figure 3: Pre-final design that included the sloping roof, shear walls, and a lightweight aluminum structure.

Figure 4: Final design with the dramatic sloping roof and use of movable hanging panels attached to the above structure.

Figure 5: Fabrication of the final exhibition mockup which includes the LFRS truss and roof framing above.

Lessons Learned

After completing the design portion of the WHP Pavilion project, it became apparent that constant collaboration was the driving force of the success of this project. Not only did each team member play a crucial role in meeting studio deadlines, but each individual brought their own unique set of skills to the table which proved to be invaluable. In order to be as successful as we were and have our design chosen as the pavilion to be built, we were faced with adversity that had to be evaluated and mitigated to stay on track with our progress.

Early on in the project I switched groups from the original group I was assigned to which proved to be a challenge to adapt and overcome to the change of team dynamic. When I migrated teams, I had to shift my focus from the original design development that I had been involved in and evaluate, analyze, and adjust my thinking to suit their design intent. I quickly learned that I had to quickly scrap my original deign ideas so as not to bring over ideas from the previous group; all in hope of aiding in the design of our own unique pavilion.

The biggest hurdle we faced was trying to incorporate the client's values into the design of the pavilion while paralleling the architect's mandated design criteria of biomimicry. Overcoming this feat meant that as a team, we had to work together and propose different design elements that would eventually satisfy both standards. The first three forms that were initially generated had their own set

of unique features that were in some way linked back to biomimicry. These three designs, though creative in their own regard, lacked cohesiveness that was relatable to our original design precedent. In order to realign our design intent and deliver a design that embodied all three forms, our group sat down and broke down each model into specific design aspects that made each one unique. In doing so, we were able to isolate the key components that added to the overall esthetic and functional appeal of the structure in order to deliver a more comprehensive finished project. In retrospect, this was truly the turning point for our team's success when communication, collaboration, and cooperation which ultimately led to our design selection.

Upon finalizing the design and preparing for the final client exhibition, it became evident that the fabrication of the scale mockup would entail more work than could be done in the allotted timeframe of a week. When it was all said and done, me and all of the other groups spend more time in the CAED shop trying to craft and accurate representation of our pavilion design. This led me to the realization that come time to fabricate the full-size pavilion in the Spring, adequate time to fabricate the structure needs to be considered so as to not sacrifice quality and craftsmanship.

One dynamic of the project that I truly struggled with was the reassurance that cost was of no object with regard to the final design. It was emphasized that regardless of the price, the Wine History Project could simply "get more donors and raise more money." This lofty way of thinking, in my honest opinion, was the wrong approach to take when guiding the studio along the design process. When it came time for the final reveal of everyone's designs, it became apparent that some designs had little to no regard for the cost of construction; with many pavilion designs topping $20,000 and above. I knew that by implementing value engineering into our design as it came to fruition, we were more poised to be considered for the final design to be built. Given the variables of design and potential additions to the pavilion in Spring 2020, I allowed for some contingency to exist within our cost-to-build estimate, which arrived at a total of $12,000. Not only do I believe that the constructability of our design stood out, but compared to other designs, our pavilion shined through with a relatively conservative price tag. Lesson learned: when someone says price is of no object, take it with a grain of salt.

A technical skill that I was able to sharpen by taking part in this project was my ability to tig weld aluminum. Previously I have worked with aluminum similar to the scope of the project, but never would I have thought that I would be required to do so much welding in such a short amount of time. Though it was challenging to complete, the fabrication of the truss and roof system for the mockup was a great opportunity to get better accustomed to working with aluminum and fabrication in general. Because of the inherently difficult discipline of welding that the project called for, many of the groups who were also utilizing aluminum in their projects approached me to help weld several components together. Not only was it nice to help other groups in need when it was crunch time, but I truly learned that nothing is more fulfilling than donating personal time and talent without expecting anything in return. This resonates with the construction industry (and throughout life) that using your talents to help others goes a long way.

This interdisciplinary project proved to be more challenging than I had originally anticipated, mainly in part to the degree of collaboration necessary to have a successful project. From the beginning, it quickly became apparent that the Wine History Project Pavilion Design had no better option than being interdisciplinary; as any other method of delivery would have proved to be lacking in certain building elements. Overall, I believe that myself as one of the Construction Managers on the project played a huge role in the success of my team and am proud of the progress we made and the feats we overcame along the way.