Interdisciplinary Studio Pavilion [ISP] 2019

Alex Beaubien
California Polytechnic State University
San Luis Obispo, CA

The Interdisciplinary Studio Pavilion 2019 was designed for students within architecture, architectural engineering, and construction management to be placed into eight interdisciplinary teams and design a pavilion that reflected the narrative 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. Deliverables for each team's structure focused on these curricula that required numerous design refinements and construction feasibility studies. This required each team member to contribute their respective knowledge about architecture, structural engineering, and construction to create a pavilion that fulfilled WHP’s goals. Final deliverables for the project included a fabrication plan, operating manual, and full scale model. Effective communication, construction feasibility studies, design software, and mock-up experimentation led our team to create a “succulent” inspired design that ultimately fulfilled WHP's requirements.

Key Words: Interdisciplinary, Pavilion, architecture, architectural engineering construction management

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:	a) establish joinery of elements that enable easy knockdown and reassembly of the pavilion; b) specify durable connections that with withstand numerous knockdown/reassembly cycles; c) assure that all hardware is weather-resistant, (the use of

non-corrosive metals and/or compatible metals is encouraged); and
d) amalgamate all connections into the architectural aesthetic.

Deliverables

Fabrication Plan

A detailed fabrication plan was developed for my team's uniquely designed, "succulent" inspired pavilion. This plan includes information that future students would need in order to fabricate the structure. In creating the fabrication plan, special considerations were made that the structure would be built using Cal Poly's College of Architecture and Environmental Design (CEAD) resources alone. The fabrication plan specifically includes material lists, processing activities and activity sequences, required connectors, fasteners and fabricating equipment, material handling and storage plans, safety and security plans, material costs/quantities and fabrication hours, and other details inferred by the materials and systems based on our team's design.

Operating Manual

Alongside the fabrication plan, an operating manual was created for my team's pavilion. This manual included information that explains how to properly assemble, transport, and handle the structure. Cal Poly's CAED resources were also considered in creating the operating manual. Specifically, the manual includes assembly drawings and connection details, transportation guidelines, assembly and disassembly instructions, maintenance and operating instructions, spare parts lists, and other reasonably necessary details based on our team's design.

Full Scale Model

A full scale model of our team's pavilion was created as a final test of design, engineering, and constructability. The model represented a section of the pavilion that utilized all materials, fabrication methods, and operating procedures that would be used to build the entire structure in the future. To build the model, we used materials provided by local vendors and resources provided by Cal Poly's CAED support shop.

Lessons Learned

Like all of the pavilions designed and created in the ISP studio, my team's pavilion was unique in its own way. Any unique structure requires different thought processes that push design phases to construction phases. To create the pavilion, affective use of communication, construction feasibility studies, design software, and mock-up experimentation were imperative for my team's success.

Communication

Throughout the ISP studio, communication was key in order to keep up with design changes and how they affected the construction process. My team went through numerous design iterations, which consequently changed construction and engineering elements. It was imperative that these changes were extensively analyzed to keep our design feasible for building. This required all parties to communicate effectively each day. However, this was not always the case.

Ineffective communication required re-work, resulting in long hours of continuous design analysis and debate. This occurred most with the approach of deadlines. My team's architects would use ample time, usually down to the last day before submission, to refine their designs and ideas about our structure. This gave me little time to do any constructability analysis on any recent model, resulting in numerous clashes of ideas about aesthetics and size on our charrette deliverables. This forced re-work that could've been avoided.

Construction Feasibility

Construction feasibility played a huge part in the creation of this project. Each design iteration called for extensive research about how the structure could be built. Being the "Construction Manager" on the project, it was my responsibility to determine whether the architect's designs could be built and assembled by university students.

Different than all teams, use of wood as the main material for construction proved beneficial in analyzing my pavilion's constructability. My past experience with wood construction allowed for quick analyzations of how a design could be cut and built. Wood also proved beneficial due to manageable sizes and weights provided by local vendors.

The greatest challenge with using wood was determining the type of connections needed to join each member. To mitigate this challenge, communication with my team's structural engineer was key. Working together, we found that two key elements were needed: the locations at which all members connected and the amount of stress within these connections. My role was finding the former.

In order to find appropriate angles and lengths needed to locate each connection, scaled construction details had to be drawn. This required the use of a design software. Having some experience with Autodesk's AutoCAD 2016, I was able to teach myself how to draw scaled construction details that matched the architectural design that was desired.

Design Software

Adoption of Autodesk's design software, AutoCAD 2016, was an extremely helpful tool on this project. Use of this software allowed me to create scaled drawings of each structural member inspired by the architect's design. For my structure, scaled drawings were made for each wood member, including actual lengths and thicknesses.

Early on, I discovered that many wood members would need to be different sizes than imagined by the architects. This was important when considering the actual size of the structure. Having this in mind, I was able to create a reasonable sized model that would represent the pavilion.

Using AutoCAD to draw our final mock-up model also proved to be very affective. The drawing's scaled accuracy provided ease of reference for dimensions in the construction of our mock-up model. All members were cut to size as modeled in the drawing and ultimately fit together as we hoped. This tangible result gave me confidence that my other developed construction drawings accurately modeled the full pavilion. Without the creation of a scaled drawing, our approach to building the mock-up model may have taken much longer. Our team was the first group to finish building our mock-up.

Mock-Up Experimentation

Construction experimentation was an extremely valuable experience on this project. Creating a full sized mock-up model tested my knowledge about construction management. Beginning with procurement, extensive research was conducted to find material estimates and quantities for my model. This required me to perform a unique quantity take-off based on a mock-up I had previously drawn. These quantities included materials such as wood 2x4's and metal shelving brackets. Once the take-off was complete, I was required to contact potential vendors for access to material prices. It was very important that my estimate adhered to a pre-set budget, requiring the use of value engineering. In order to meet the budget, my team decided to create our own metal shelving brackets instead of ordering them.

Creating the mock-up section with CAED support shop resources also represented how the entire structure would actually be built by future students. Having some construction knowledge about fabrication equipment allowed my team to build our model sufficiently. However, using the experienced, professional advice of the CAED shop's employees was the main reason for my team's success. For example, when we were tasked to fabricate our own metal shelving brackets, the shop manager provided us with not only the fabrication equipment, but also examples of how to design the bracket so it could be made feasibly and quickly.

The finished mock-up model allowed for the discovery of assembly and transportability strategies. The single fin that we constructed shed light on the actual size of our pavilion and how many people were needed to handle it. To transport the model, it required at least three people. Considering that the full pavilion pieces would be larger, I assume it would require at least twice the amount of handlers for set up and support. Also, with more pieces such as foundation plates and roof aluminum sheets embedded on the entire future structure, set up time and assembly would increase drastically.

Alongside this experience, I discovered that our team's design on paper had a different aesthetic expectation than what was actually built. Any cuts that were intended to represent smooth, circular surfaces proved to be difficult to replicate as designed. For example, the use of jig saws required a very steady hand to cut unique, curved surfaces that were aesthetically acceptable. We were able to see these aesthetic deficiencies on our final model due to student error and inexperience.

Overall, the construction process for this model was difficult, but rewarding. Given the experience and resources provided to build our pavilion, it was acceptable to have small aesthetic deficiencies because building a perfect structure is nearly impossible. Ultimately, my team experienced success with minor hardships in fabricating our built model. Using these findings, it seems likely that constructing our entire pavilion using CAED shop resources alone is an obtainable goal.

Photos

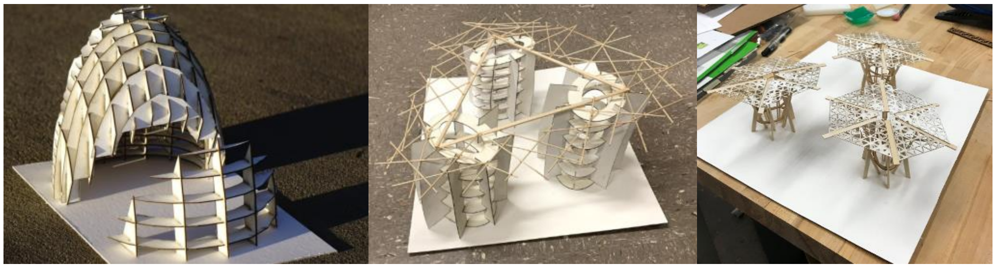

Figure 1: (Left to right) Initial design concept model, design development model, final design model

Figure 2: Final “Succulent Pavilion” design renderings

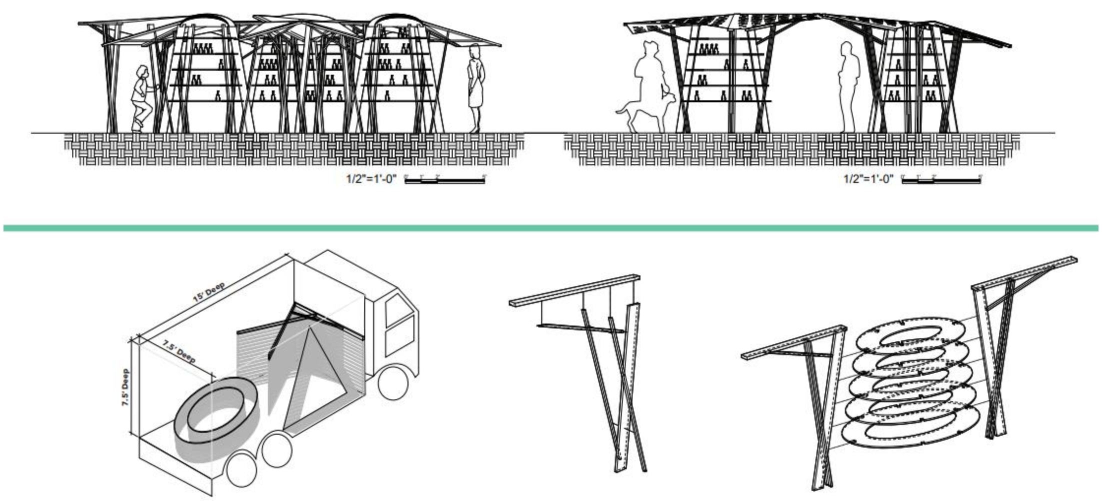

Figure 3: Assembly and transportation diagrams

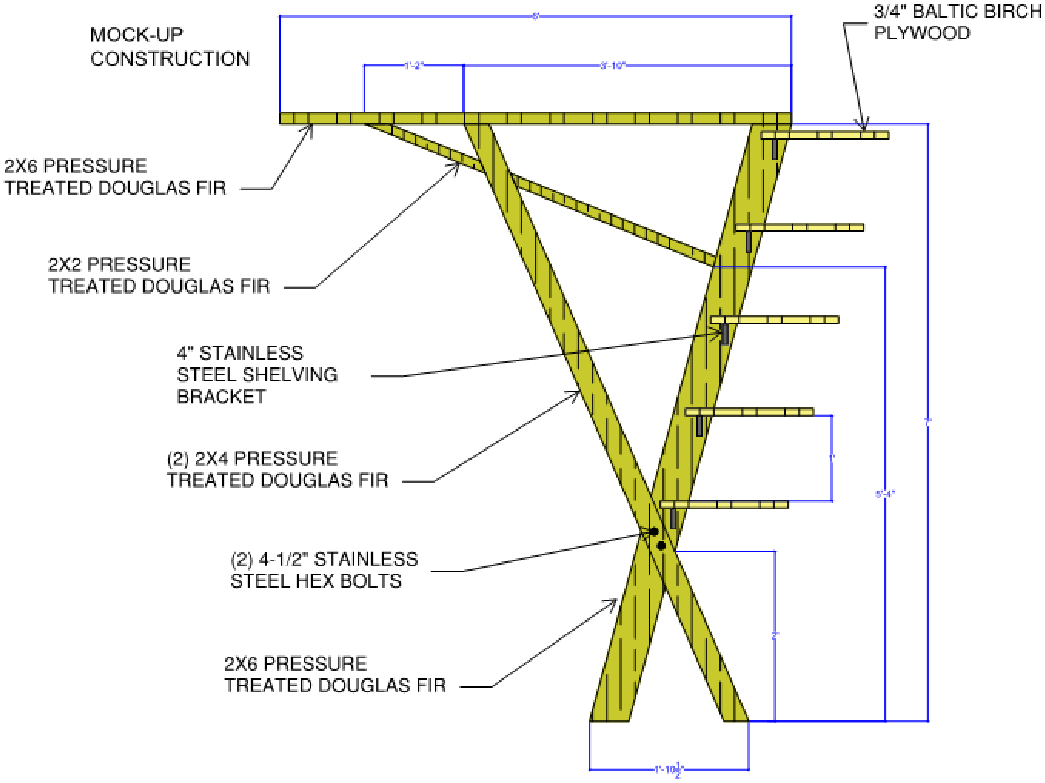

Figure 4: Construction drawing of our full scale model

Figure 5: Construction progress photo of teammate, Kaustab Das, in Cal Poly's CAED support shop

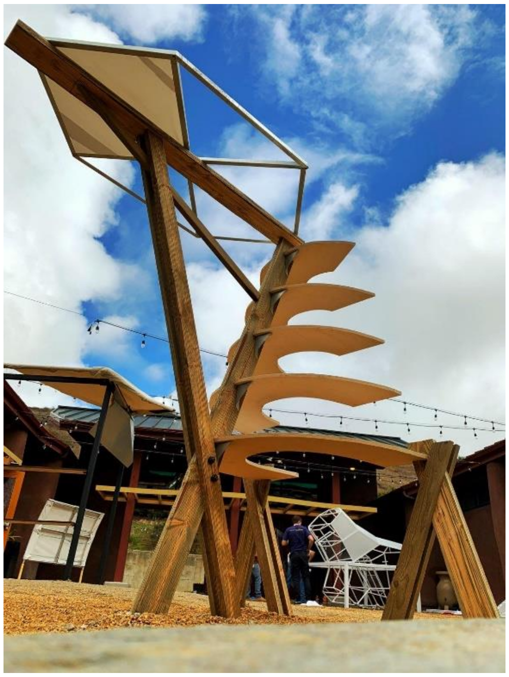

Figure 6: Completed full scale model displayed at the Pavilion Structure Open House