Weed Cohort Panelized Housing

John Michael E Theofanides
California Polytechnic State University, San Luis Obispo
San Luis Obispo, California

This study analyzed how students took on primary design and contractor roles with real projects. It is focused on the feasibility of getting students heavily involved with projects that are meant to be built for real clients. This study will review a specific project that multiple Cal Poly interdisciplinary teams undertook that heavily emphasized panelization strategies and working-class family affordability. First the paper introduces the initial goals the clients set out for the project. Next, it gives an overall background of the design process using integrated project delivery. It studies the interactions between students and the client in a short window of time. The study attempts to capture what the project scope was and how far a university could theoretically reach in partnering with private organizations to other communities. That real challenge arises when that reach is hindered by the timeline restriction of the quarter system. When working with this real client, the overall scope of the senior project changed significantly over time. Finally, this study gives an overall view on how the panelized housing was meant to be constructed and whether the team succeeded in doing what it originally set out to do.

Key Words: Interdisciplinary Teams, Student Client Interaction, Project Feasibility, Panelization Strategies, Integrated Project Delivery

Introduction

In Fall quarter 2017, various Cal Poly students were presented with a unique opportunity to get involved beyond the standard classroom curriculum. Students from the Architecture, Construction Management and Architectural Engineering departments were asked to help in the design process for a small housing division that was to be built in Weed, California. For students majoring in construction management, this opportunity fulfilled the CM 415 (Integrated Project Delivery) class requirement. For students majoring in architecture, it would be credit towards their studio class. As for students majoring in architectural engineering, designing the small housing division in Weeds counted as their senior project. The project client was Great Northern Services (GNS). The company is a non-profit organization that runs a food bank and other community services to help meet needs in the local Siskiyou County community.

In September 2014, a massive fire, called the Boles fire, destroyed and damaged close to a third of all of Weed’s buildings including a portion of the lumber mill owned by Roseburg Forest Products Inc. Roseburg also happens to be a primary source of employment in the area. Due to the size of the fire and total number of structures destroyed, the city was not able to receive relief funding from the Federal Emergency Management Agency (FEMA). This meant homeowners in the area would have to rely upon their own insurance and help from the local community to
find new housing and to replace essential belonging. It was a local tragedy and many people from all over the county rallied to assist the citizens of Weed. I personally chose to join this project because the city of Weed is so close to my home. I remember how significantly it affected all of us in Siskiyou county when the fire hit. The community of Weed has never fully recovered despite the help that it did receive. Many families still remain without permanent housing.

GNS decided to step in and help in the regrowth process for the city of Weed. Their goal was to develop housing options for families that worked typical blue-collar jobs. It would allow for these families to permanently settle down. Since GNS is a non-profit and does not have high levels of funding power, they could not afford to capitalize the whole housing development all at once. GNS decided to use students in the design process for the development. This would save them thousands in design fees that they would have paid a licensed architect. GNS asked Cal Poly to help design their housing unit. If everything was to go according to plan, once the design was complete GNS could start construction as early as spring or summer of 2017. This study will analyze the original goals that GNS and Cal Poly instructors had envisioned for the project and how they changed over time. In addition, it analyzes how this affected students’ abilities to respond to the changing goals.

Process

As mentioned previously, during the summer of 2017 various students from different majors were asked to take part in the Weed Cohort. The cohort was the joining of these interdisciplinary teams all with one goal in mind; to assist in the design of a small residential subdivision for a city in need. Around 40 students decided to take part in this cohort. After a week of team building exercises in late September and a quick trip up to Weed to get pictures of the site we were working on, the project was underway. There were a few constraints on the project that each team had to work around. The target consumer for this project was working class families with children. The site was strategically chosen to be close to both elementary and high schools. This was to allow middle to lower class families that were affected by the fires to settle down for the long term, which aligns with GNS’s long term vision for the city of Weed. Our teams were asked to design a 3-bedroom house that was approximately 1,500 square feet and with a budget around 140,000 dollars. Soon into the design process it was suggested to GNS that they heavily emphasize prefabricated panels for all exterior walls. It was envisioned early on that Cal Poly could provide labor and potentially materials to assist GNS in meeting their tight budget. The plan was to build one house at a time and once it was sold, then construction on the next could begin. This was based on funding shortages, as GNS did not have sufficient amounts to fund the whole project at once.

Periodic check-ins with GNS were done throughout the quarter to help give teams direction and vision on their designs. At the end of the quarter, representatives came to San Luis Obispo to do a final review of our designs and pick one that would be taken forward to the next steps of construction. During the design phase, the construction management majors’ main tasks revolved around giving the student architects vision about maintaining the proper budget constraints of the project through proper material selection and design strategies. Panelization was a large portion of what the construction managers took into consideration during the integrated delivery process. IPD has been a recently introduced delivery method in the construction industry. It involves all parties in the design of the building to collaborate on a project before it has even begun. Contractors, engineers, and architects all help the owner put their thoughts to paper through this collaborative process. The integrated project delivery method gives the owner the design they want and makes the construction process more efficient and as easy as possible. In our case, the construction managers gave insight to the other team members in order to keep the building within reason of what could realistically be done. Referring to constraints due to panelization as well as the overall resources GNS had at its disposal to build it. This was because the original goal of the project was to develop precise panelization
plans that were to be constructed at Cal Poly and shipped to the site. The goal of this was to cover all labor costs that GNS would of otherwise had to pay for by hiring a local contractor. The panels, in theory, could quickly all be laid out and stood up in one day once shipped to Weed.

Further in the project, we encountered many problems with these prefabrication goals, even though it was our main reason for doing the project in in the first place. Due to our limited budget to maintain an affordable house, there was not a lot of room to work with for our design teams to do much outside of the box in regards to materials or strategies that would make the panelization process faster and cheaper. Initially, our teams considered many options such as cast in place concrete walls or SIP’s. Structurally Insulated Panels are innovative and efficient panels that include both interior and exterior sheathing each enclosing an insulated core. They reduce labor costs for framing and insulation, by eliminating steps in the construction process. This, like many other ideas, was shut down due to budget concerns. So, although we tried to design the most efficient panelized homes we could not and our panel designs ended up consisting of typical lumber framing.

Originally, the goal was to allow Cal Poly and other organizations to contribute as much as they could. This would save GNS a lot of money with the tight budget they had. Cal Poly’s residential construction class (CM 214) was scheduled to assemble the wall panels in their normal course curriculum, in which the class typically builds a tiny home. After panels were constructed, it was planned out that students of the College of the Siskiyous would assemble our prefabricated panels on site. This would be done under the supervision of Yreka’s Workforce Development interim director Mark Klever. The College of the Siskiyous is a local community college located in Weed, which serves about 2,500 students. The school originally planned to create a construction trades program. This project was to be the kick starter for the program allowing for hands-on learning. If these students were to assemble the panels, and potentially other parts of the house, significant cuts could be made on labor costs in GNS’s favor. Another potential contributor to the GNS housing project was to Roseburg lumber. They expressed interested in donating all lumber materials to the cause. Currently residing in Weed, is a large lumber mill owner by Roseburg that already employs a large number of people in the area. The donation was dependent upon having a solidified and approved design that included an accurate lumber order. The combination of these things had the potential to save GNS almost all framing material and labor costs.

With fall quarter coming to an end, it was time for GNS to pick a winning design. Rod Merys and Bonnie Kubowitz, our main contacts at GNS and directors of the organization, came down to Cal Poly in December of 2017 to see each team and to give their final review of their project design. The competition saw one winning design picked at the end of the day. However, when GNS moved forward with this design, only the floor plan was really kept. Other team’s design ideas were pulled into the final plan to suit what GNS desired. This solidified the principles of integration that set forth the project in the first place.

Following the selection of a winning design at the end of Fall quarter 2017, a team was formed to carry the project on to the next steps. This team was made up of four construction management students and one architect: Ainsley Henderson, Brock Armstrong, Ryan O’Neill, myself and Jackie Budidharma respectively. The formation of this team was to fulfill our senior project by carrying the Weed Cohort to the final stages of its completion. During Winter quarter 2018 the team was given the responsibility to further refine the designs and construction process of the house. The team had weekly meetings with the clients which further perfected the design that GNS wanted. Jackie was the architect on the project and made the appropriate changes to the plans. The rest of the team was in charge of making models, plans, and estimates to complete our panelization plan. We analyzed all of our options on logistics and constructability, soon after discovering the many obstacles that laid ahead of us. We soon realized that completing our original goals would be tough to accomplish. This is where our original project intent fell apart.
As far as panelization strategies, we came upon some realizations that were crucial to the decisions we made throughout the process. The interdisciplinary teams in the fall helped contribute to our discovery. At first, we restricted our panel design to 8 ft increments in length and height. This was because weight and transportation were a significant consideration in how the panels would be moved from the Simpson Strong-Tie laboratory on Cal Poly’s campus eight hours north. Initially, we thought they would be carried by hand by students without any rigging equipment, then stored in a shipping container of sorts. With time, we decided to use larger panels that extended the whole wall’s height. This reduced total stud count needed to be used and addressed connection issues. This led to a discontinuity in the exterior wall panels being only 8ft tall. This causes connection issue that would have to be resolved with extra hardware, brackets, and bracing. Adding the additional height to our panelized walls would solve this problem. This potentially could have been solved using trusses instead of rafters in the roof. However, we ended up designing the panels to span the complete wall lengths. This would reduce the overall amount of panels and wasted material for the project. Although this would simplify panelization, there were other aspects that would have to reconsidered in response. With this change though many lumber members were longer than sizes that Roseburg Products created in standard framing members. This meant, we had to change to laminated wood beams, which were more expensive (refer to conclusion of paper for diagrams).

Not only did our panelization plan continually change like addressed above, but many other plans changed that were originally relied upon to complete our original project proposal. One problem in this project was trying to do so much within the small window of time we had and many other expected factors that heightened the dilemma we soon found ourselves in. For starters, it was originally envisioned that the Cal Poly residential construction classes (CM 214) would build the panels during their lab time during the winter and spring quarters of 2018. Theoretically, if there are four teams per class, for two classes per quarter that build for two weeks a quarter, we calculated that 64 panels could be built in this time. This depended upon each team building at a rate of 2 panels per week. This was of course if we were to use standard size framing members, which we decided against. Our team developed thorough panel plans and estimates to be able to accurately supervise the construction of these panels the following quarters. Soon, after collaboration with Professor Stacy Kolegraff, it was discovered that the panels could realistically not be built in her class. The class typically only spends a week of the ten-week quarter framing walls for tiny homes in the Simpson Strong-Tie laboratory. With roughly 20 different panels needing assembly, it would take too much time away from the class curriculum. No longer able to proceed with our original goal, it was soon decided around week 2 of Winter Quarter that the 4 construction managers on the team would build the panels ourselves. However, it was not that simple.

At this point in the project, although a final design had been chosen, GNS representatives were continually changing some details in the plans during our weekly meetings with them. Jackie would change her floor plans to respond to their requests; this did not come without consequence. It forced our team to continually change our panelization plans back and forth for weeks. We soon came to realize that we were quickly running out of time to actually start building. Once a floor plan was finally finalized, we still had to wait on approval by a local engineer, Morgan Eastlick and city stamping of the plans. This in turn thwarted our pursuit to begin panel construction as soon as possible. As aforementioned, Roseburg lumber also previously expressed an interest in donating most, if not all, lumber for the project. Unfortunately for us, Roseburg had been burned before when they had donated to projects that never ended up getting built. Because of these past interactions they would not completely commit until building plans were approved and stamped. We were in a catch waiting for approval to start building and time was winding down.

Continually remaining hopeful that things could be approved by the end of winter quarter, we persisted in our efforts. Once we started spring quarter, our team came to accept the truth that in the time given to use in the quarter we could not wait any longer on approval and be able to finish the panels ourselves. So, with that we wrapped up the bulk of the project process. I think this is where it is hard for me to justify trying to utilize full time students for real
life projects. We invested a lot of time into a theoretical project that did not pan out in any way we intended for it to go. I think it would have been much more rewarding and our project would have felt more complete if we actually were able to build.

Alternatively, the panels could in theory be built next year through Cal Poly’s Service Learning (CM 420) class or sometime down the road. Either that or GNS would just have to cover the cost of building the walls on site. I think this is the most effective option for them. In our research of this method, our team concluded that panelization ultimately is not the most efficient way to build, especially when we are dealing with standard lumber. I think the whole idea of panelization in this project does not make a lot of sense feasibly. There are complications to shipping lumber down to San Luis Obispo, asking students, who do not have much experience, to assemble the panels by hand, then sending them back up to Weed. Realistically, this would not be worth the money saved by simply building onsite. On top of this, panelization uses extra material due to the need of extra studs for each panel connection. Additionally, GNS would have to cover cost for the transportation to San Luis Obispo and back to Weed. A drive that is over 1,000 miles round trip would not even offset the costs where panelization would realistically be worthwhile.

Diagrams

Initial Panel Proposal

2\textsuperscript{nd} Panel Proposal

Final Panel Proposal

Lessons Learned

Expectations can be a big weight on projects. Owners and designers can be disappointed in the outcome of a project. Sometimes, it simply does not pan out the way that you want it to. I think the main takeaway from this project is that you cannot expect too much, especially when it comes to work with school and the scheduling constraints that are set in place there. I think too much was expected going into this project. In my opinion, GNS
expected a lot from our designs for the small amount of money they were willing to spend. Following Fall quarter, when a final design was picked, our senior project team was first expecting to be supervising the CM 214 residential class in building the panels that would then be stored somewhere on campus. The curriculum established that the class would not give us the proper amount of time that would need to be allocated for the construction of dozens of panels. This is because the department must still teach the students the necessary curriculum and cannot change due to this one project. We expected to be building panels by early winter, and it turned out we would not be building them at all. I think the main concern is the time table one must deal with when relying upon students to play large roles for these real projects. The quarter system is 10 short weeks and you cannot get as much done in that time as you think you can. If any project is to succeed all parties must be able to fully invest in it. Unfortunately students have many other responsibilities and commitments that do not promote this. On top of that, there are concerns when it comes to availability, given the time allowed due to the structure of the school system. As seen with this project, we can only take the project so far even though we all would have loved to see it come to fruition. I learned that when dealing with any project that involves a public-school system, my expectations must be lowered. Although our panelization strategies did not work out, we still gave GNS a floor plan that suited their needs perfectly.

**Conclusion**

In regard to senior project success I would say overall the project was a success. This experience gave myself and the team a better understand what it means to interact with real clients and an interdisciplinary team. Things do not always go according to plan. It is a much different experience compared to regular construction management classes, where students focus on estimating and presenting a contract analysis of a project. I now have a more thorough understanding of how prefabrication works, including its benefits and drawbacks. It is an innovative construction practice that has been on the rise in the industry in the last few years. So it was to our benefit to enlighten ourselves on that process. Regarding the construction of the panels, I would not say that we, as a team, have failed. However, things did not happen as we originally proposed or hoped for, which was kind of disappointing.

For GNS I think their success is subjective. I would imagine that they could have already started the project months ago if they were willing to build to typical home building standards and pay the standard amount of money for the type of home they wanted. GNS did get a fully comprehensive floor plan out of this study. However, I wonder if it was it worth all the time each party put in. In conclusion, I think expectations were set too high for a budget that was as low as it was.

**Further Reading**

To further explore more material and other focuses that went into this study read the following papers:

- Resiliency vs Reality by Ainsley Henderson
- Material Choice and Pricing for Great Northern Services (Weed Cohort) by Ryan O’Neill
- Panelized Workforce Housing by Brock Armstrong