AEI Student Design Competition: Value Engineering & Design Build

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The Architectural Engineering Institute puts on a yearly student design competition that features interdisciplinary teams from colleges across the country. The project for the competition was the Jack H. Miller Center for Musical and Performing Arts on the Hope College campus in Holland Michigan. The main challenges in the problem statement address acoustics, using mass timber, and add alternative roof top space. Through a collaborative process, our team created a proposal that addressed the challenges and why we were the best fit for the job. I worked with a fellow construction management student, Shannon Wheeler, to produce our portion of the work. We created a multi-level estimate, schedule, site logistics plan, and other project management plans. We achieved this through our knowledge in the construction curriculum as well as being assisted from faculty and industry members. Overall, I learned that effective communication was a big key to success and that we had created a strong proposal by the date it was due.

Key Words: Construction Management, Collaboration, Competition, Architectural, Engineering, Design

Introduction

The competition is put on through the Architectural Engineering Institute (AEI) and features a design heavy competition style. The teams are allowed to select which design categories they want to participate in, such as structural, architectural, mechanical and electrical. They also feature a construction management portion that is required regardless of which design sections are chosen. Therefore, our team consisted of two architectural engineers who contributed to structural design and three architects who contributed to acoustics and alternative pricing features. The team also featured two construction managers to handle the basics of estimating, scheduling, safety, quality and much more. The competing teams are given specific information and tasks by AEI and are then challenged with completing those tasks effectively and accurately. There is a 3-month period of work that takes place for the teams to finish these tasks and challenges. Once the deadline arrives they are to turn in their final proposal to AEI and wait to hear if they were selected for finals. If selected, the teams would go to Washington D.C. to present on their findings and compete for placement. The goal of my participation was to incorporate value engineering methods, as well as use my design-build knowledge from the Reno ASC student competition in delivering this project.

How It Came Together

I had originally been looking to complete my senior project in a different manner but I was original introduced to the competition by fellow construction management major Shannon Wheeler. She was initially an architectural engineering student who transferred into construction management and was asked to participate in the competition by some of her architectural engineering friends. The team was headed by the two architectural engineering students where they then recruited the other team members through the engineering and design community on the Cal Poly campus. Once the team formed, we find out what our deliverables were and when we needed to complete them by. This is where Shannon and I both decided on the areas of focus for the competition and how we would apply our own unique senior project approaches to the competition. I of course chose to focus on value engineering and design-build and Shannon chose to focus on achieving LEED Gold and sustainability. We then got our senior project proposals signed off by Phil Barlow, who is our project SME and SPD.

The Process

Once our team formed, we established a work and meeting schedule detailing when things needed to be done and when we would meet. We ended up with a weekly meeting that allowed us to bounce ideas off each other and make sure we were on the same page. Occasionally, these meetings turned into longer work days that allowed us to work together and ask questions in real time. Considering that Shannon and I were not involved in the design, we were able to complete a good portion of our work on our own time. This was important in the process of completing our deliverables because we could meet more frequently by using the construction management lab. We needed to use a multitude of software such as Bluebeam, Microsoft Project, D4 Cost Estimator and more, that only the lab computers had.

Shannon and I had also turned to the guidance of professors and industry members for assistance during the course of the competition. We asked Greg Starzyk a lot of questions because we were enrolled in his CM450 course, which touches heavily on the use of software and an integrated project delivery method. We were able to take ideas from our class and apply them to the work that we were doing, which is described further in the section below. When it comes to industry member support, my dad has been in the industry his whole life and has been a great resource for us during the course of the competition as well. He mostly was able to help us determine the feasibility of the design and logistical decisions, helping to keep us on a forward moving path. He also helped us by answering questions we had on a variety of concerns with the estimate, schedule, and site logistics.

My Areas of Focus

The first area of focus for me during this competition was implanting as many value engineering initiatives as possible. The primary way I had addressed the issue was to use Cross Laminated Timber (CLT) panels and mass timber to construct the superstructure of the building. The use of CLT panels and mass timber in place of structural steel and cast-in-place concrete created a more sustainable building system as well as helping to cut down on the time and costs of construction. This approach takes advantage of prefabrication strategies, which is a huge thing to consider

when constructing in the cold Michigan climate. This approach also focuses adding value to the entire building, rather than having a few smaller value engineering options. Had there been more information and time allotted, I would like to have addressed more individual value engineering concerns.

The second area of focus was using my knowledge of the design-build delivery method and applying it to the competition project. As a result, the delivery method of the project was design-build, with our company having in-house design and construction professionals. The use of design-build not only allows for more collaboration between the project team, but also allows for shorter durations to get on-site and therefore complete the project. This is again something to consider as an advantage when working in the Michigan climate. Lastly, the design-build delivery method allows for an easier ability in recreating the project, allowing for us to have established a project basis for future projects if this were done in real life.

Deliverables

The deliverables for the project featured a lot of the same things that we learn and complete throughout the course of the Cal Poly construction management curriculum. The deliverables that were needed for the competition are listed as follows:

- Estimate
    - Level 1, 2 and 3
    - Life Cycle Costs
- Schedule
- Site Logistics
- Lean Construction
- Project Management
    - Delivery Methodology
    - Jurisdictional Requirements, Constructability
    - Quality, Safety, Risk

We were able to complete the estimate using a different pricing method for each level. For example, our level 1 estimate took historical data from similar recent projects and found an average price and price per square foot. Level 2 was completed using the D4 cost estimating software that we had just learned in CM450. This estimate took data from a similar project in both size and definition and gave a breakdown of what each of the 16 MasterFormat divisions would cost. Lastly, our level 3 estimate was completed using a Uniformat Level II spreadsheet that break down into over 20 different cost categories. In each of these categories, we went into much more depth as to what was going to be used in construction. This was then compared with the D4 level 2 estimate, where both total project costs ended up fairly close.

For the schedule, we were able to use a template schedule that is used for the Reno design-build team where we applied it to this specific project. We accomplished this through the use of Microsoft Project and by asking my dad when we had conflicts with our line items. We were also able to utilize Bluebeam in creating our site logistics plan. This was done by marking up an overhead image of the site and displaying where items would be placed, such as material laydown, the office trailer and more.

When it comes to lean construction and the many project management deliverables, Shannon and I were able to combine our knowledge from what we had learned in previous classes. For example, we have learned a lot over the years on quality, safety, and risk so we have an ample supply of knowledge in those areas. For things that we didn't know, we were able to research online for solutions as well as asking my dad for help. For example, we are not familiar with the jurisdictional requirements of Holland, Michigan, so we had to look those up online. If we had questions as to what was being detailed, we could either continue to look into it or ask my dad or others for assistance in determining the meaning.

Lessons Learned

There were many things that I learned throughout the AEI competition, but the main takeaway for me is how effectively discuss and collaborate on topics between multiple disciplines. It's hard to be able to relate your ideas to others when they themselves have their own ideas on the same subject from a different point of view. This was the case, for example, when trying to discuss budget concerns with the other architects and designers on the team. They had some great design ideas, arguably good enough to get us to the finals in D.C., but the budget was very slim for this project. It forced us to be able to communicate our points to each other and then come to a compromise/ agreed upon decision. I think issue between construction managers and designers/engineers is always an issue, but it is even more so at this point in our careers considering we have yet to fully grasp the entirety of our respective industries.

One other main lesson that I learned during the competition was the importance of time management. The competition itself was not very time pressing, but I had to complete the work for it at the same time as competing in the Reno competition and taking a full 16 units. With a plate as full as it was, it forced me to schedule my work accordingly for each of those categories. This skill is something that is of high importance and value in our industry and I hope I can continue my good practices as I enter into it full time.

Appendix – Itemized Cost Proposal & Site Logistics

Project:	**Jack H. Miller Center for Musical Arts**		
Owner:	**Hope College**	67,200	Gross Building Area (SF)
Location:	**Holland, MI**	137,500	Site Area (SF)
Estimate No.:	**1**		
Estimator:	**Sotto Voce**		
Date:	**2/4/2019**		

PRELIMINARY ESTIMATE	**MARK-UP**	**TOTAL**	**$/GSF**	**COMMENTS**
GUARANTEED MAXIMUM PRICE COMPONENTS				
A10 - FOUNDATIONS		$ 2,198,623	$ 32.72	
B10 - SUPERSTRUCTURE		$ 5,540,515	$ 82.45	
B20 - EXTERIOR ENCLOSURE		$ 537,143	$ 7.99	
B30 - ROOFING		$ 1,044,639	$ 15.55	
C10 - INTERIOR CONSTRUCTION		$ 2,135,726	$ 31.78	
C20 - STAIRS		$ 332,640	$ 4.95	
C30 - INTERIOR FINISHES		$ 595,143	$ 8.86	
D10 - CONVEYING		$ 166,460	$ 2.48	
D20 - PLUMBING		$ 934,720	$ 13.91	
D30 - HVAC		$ 1,946,784	$ 28.97	
D40 - FIRE PROTECTION		$ 526,655	$ 7.84	
D50 - ELECTRICAL		$ 2,643,832	$ 39.34	
E10 - EQUIPMENT		$ 27,000	$ 0.40	
E20 - FURNISHINGS		$ 260,300	$ 3.87	
F10 - SPECIAL CONSTRUCTION		$ 234,355	$ 3.49	
F20 - SELECTIVE DEMOLITION		$ 105,000	$ 1.56	
G20 - SITEWORK		$ 2,036,525	$ 30.31	
G70 - OFFSITE WORK		$ -	$ -	
FIXED PRICE COMPONENT				
Z10 - GENERAL REQUIREMENTS		$ 1,506,526	$ 22.42	
SUBTOTAL		$ 22,772,585	$ 338.88	
SUBCONTRACTOR BONDS	2%	$ 341,589	$ 5.08	
GENERAL CONDITIONS		$ 2,798,048.00	$ 41.64	
GENERAL INSURANCE	2%	$ 388,683	$ 5.78	
CONTINGENCY	6%	$ 1,578,054.32	$ 23.48	
DESIGN FEES	3%	$ 836,368.79	$ 12.45	
OVERHEAD & PROFIT	3%	$ 861,459.85	$ 12.82	
TOTAL		**$ 29,576,788**	$ 440.13	
ROOF TOP SPACE		$ 1,925,380	$ 28.65