Presentation of Construction Management Topics in a Competitive Bid Module

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Abstract

Engineering Project Management is a senior level class taught once a year in the Ohio Northern University (ONU) Bachelor of Science in Civil Engineering (BSCE) degree. Topics include organizational structures, project delivery systems, engineering economics, critical path method analysis, team dynamics within project management, and responsibilities of the engineering manager within various project phases. This year we have added a two-week module to present Construction Management Topics. The module was organized and presented with the help of construction engineers from Environmental Pipeliners, and Kokosing Construction Company that are alumni of the Civil Engineering Program at ONU. The module consists of six lectures covering the following topics: Team, Documents and Project Organization; Plan Reading and Quantity Take-off; Productioning; Material and Subcontractor Procurement; Scheduling; and Project Wrap-up. The class is divided into two bidding teams, which are divided into four work groups. The lecture material is built around each team preparing a competitive bid for an actual Ohio Department of Transportation (ODOT) Project. The teams are given ODOT plans, specifications, standard drawings, material and subcontractor quotes, and addendums. An actual sealed bid opening is held on the last day of the module.

Introduction

CE 414 is an engineering project management course taken by all senior civil engineering students at ONU. The course topics were developed two years ago and organized around the text written by Oberlender. Additionally, this course provides the students with their only formal experience in engineering economics. In 2001 an additional educational objective was formalized as follows:

“To introduce the students to the concepts of civil engineering construction project management, project procurement, contract documentation, and construction estimating.”

The associated course outcome was stated as follows:

“After successfully completing this course, the student should be able to prepare a construction bid using quantity take-off analysis, production estimating techniques, specifications, and subcontractor procurement information.”

The Ohio Contractor’s Association (OCA) is a strong supporter of technical education programs at the universities throughout Ohio. The state organization and the local chapters conduct several programs each year specifically focusing on educational outreach to the college students. The Toledo Chapter OCA conducts a “contractor for a day” program in which students spend a
day with various contractors exploring the intricacies, complexities, and magnitude of ongoing heavy highway and building projects in the region. The state OCA organization conducts a yearly student construction estimating competition for teams of college students from throughout the state. OCA also provides scholarship funding from both the state and local chapter level to support students who are pursuing a technical education and are interested in a career in the construction industry. Two OCA member companies, Kokosing Construction Company, and Environmental Pipeliners (EP), and their ONU alumni engineers have been especially strong supporters of the ONU civil engineering program.

Construction Module Design

I wanted to design an approximate two-week module to accomplish the course education objective and outcome for construction management. I contacted Lori Burgett-Jackson of EP to ask for her input on the overall concept and specific topics. I also asked her to pursue the idea of having experienced construction engineers help us conduct a laboratory experience that would require the students to immediately implement and integrate the chosen discreet lecture topics to complete a heavy highway bid. Oberlender\(^1\) stresses the concept of deciding who does what when for how much and the unavoidable interlocking relationship among scope, budget, and schedule. I believed that the construction module concept would give us the opportunity to present all of this information to the students in a real-world experience. Within a week Lori had procured all of the needed engineers from Kokosing and EP to lead lectures in each topic area.

The lecture topics chosen for the two-week module are described as follows:

1. Team/Project Organization. In this lecture the class was divided into two bidding teams. We distributed all of the information that the student teams would need for the entire module including the following items: a set of Ohio Department of Transportation (ODOT) plans from a recently bid heavy highway construction project, ODOT standard roadway and bridge drawings, ODOT specification books, contract general and special conditions, and supplier quotes. We had brought an overwhelming physical volume of paper and information to present to the teams on purpose. We wanted them to get an immediate impression of the magnitude of the information that they would have to quickly synthesize over the next two weeks to successfully complete the bid project.

Doug Zimmerman was the presenter for this topic, and he delivered the first project addendum to the students setting the location, date and time for the sealed bid opening. The need for each of the items of information was discussed. Additionally, Doug discussed the following topics: documentation of all calculations, possible organization of the companies into subteams to accomplish the work (organizational breakdown structure (OBS)), and delineation and organization of all the work to be completed (work breakdown structure (WBS)). I assigned an initial student leader for each team to help get the organizational work underway quickly. I made it clear to the companies that it was up to them to decide on their organizational structure and project leadership throughout the module. At the completion of his presentation, Doug told the students he would return in two weeks for the sealed bid opening.
2. Plan Reading. Larry Winkleman presented the second topic covering the organization of the ODOT plans in detail. The lecture explained the fundamentals of plan reading to the students by showing them where basic information that they would need to prepare their bids occurs throughout the ODOT plans and contract documents. The students were also shown a set of plans from a project that Larry had recently bid. He explained to them how he initially conceptualizes the construction project, color codes proposed construction phases, and then proposes to his bidding team how the project might be built and how they should bid the project. The concept that they had to acquire a detailed understanding of how they would build the project (WBS/OBS during construction) before they could bid it was a key issue for the students to learn.

Larry worked through a quantity take-off example with the students during the lecture and stressed the importance of these calculations in preparing the bid. Also, he stressed the need for documentation and organization in preparing their work.

3. Productioning. Lori Jackson and Jeana Gillespie presented the lecture on productioning. This was one of the hardest concepts of the bidding module for the students to implement. Accuracy in productioning relies so heavily on the estimator being familiar with her/his people and equipment and with their capabilities on different types of projects. Additionally, most of the students have little generalized contextual experience to draw upon to even make reasonable average production predictions for people and equipment.

Lori discussed how crews were formed to accomplish various tasks on the project and how decisions were made for needed equipment. Although the students had very little background experience in this area, the lecture strongly reinforced the concept that the estimator has to have a clear understanding of how the project will be built down to the discreet task level (WBS), and the people and equipment needed to accomplish those tasks (OBS). Jeana also walked the students through an actual example of productioning crews and equipment for earth moving and embankment construction.

4. Material procurement. Vic Turner presented the fourth lecture in the series on material procurement and on general procedures for dealing with subcontracts in construction management. Vic reviewed some of the individual suppliers’ quotes that had been supplied to the student companies in the first session. He was able to point out discrepancies in the supplier’s quotes that were caused by the supplier’s misunderstanding of the project specifications and from calculation errors such as converting between English units (which the suppliers are used to working with) and metric units (which the unit price bid for the project required). Mr. Turner also discussed and showed examples of typical purchase orders and contract documents for suppliers and subcontractors that Kokosing uses in their construction projects. Additionally, he discussed the planning and scheduling that must be included in procurement of specialty items that require a long lead-time.
5. Scheduling. Dave Christensen led the fifth lecture on project scheduling. Earlier in the quarter, we had covered the topic of scheduling from a fundamental perspective. The students were aware of the different types of scheduling systems and various software packages that were available. Many of the students were already making use of Microsoft Project\textsuperscript{2} and Primavera Sure Trak\textsuperscript{3} in preparing schedules for their senior design project proposals. Dave, who is a very experienced construction project manager, discussed how he would take a project that his company had been awarded and set up a project schedule for construction. His presentation reinforced the theory that I had presented earlier in the quarter along with the pre bid scheduling that Larry Winkleman had presented earlier in the module. Additionally, Dave’s presentation took the students to a different level of conceptualizing the actual project that they were working on as multiple tasks occurring simultaneously.

Dave explained how he built the network analysis (critical path schedule) starting with the basic building blocks of the individual work tasks. He calculated durations looking at various crew, equipment, and production scenarios. He tried changing production to reduce time and looked at the resultant increases in resources and money. For me the presentation was the incarnation of Oberlender’s\textsuperscript{1} theory of the interlocking relationship between scope, budget and schedule.

6. Project wrap-up, safety, and risk. Dan Walker presented this final lecture in the module. He is a vice president with Kokosing and is responsible for safety on their construction projects. Dan discussed in detail the safety and training programs that all of their workers complete, and how important it is for all of their workers to comply with the company safety protocol at all time on the projects. They are a self–insured company and rely on their workers to be safe on the job to keep their risk rating and insurance costs low allowing them to bid more competitively.

**Construction Module Logistics**

The construction module was staged over a two-week period. The students had one or two days between each lecture presentation to work on bid development. Each lecturer was willing to answer questions that the students had on any aspect of the bid at the end of each lecture. Most questions focused on developing reasonable production estimates, and on setting overhead and profit factors. Multiple questions were also asked about construction methods for performing complicated tasks, and most of these were formulated to get more accurate estimates of production needs.

On the last day of class, Doug Zimmerman returned for the sealed bid opening. The two companies submitted sealed bids which included their bid tabulation, all supporting documentation, and signed contract documents and bid bond. The two companies’ bids were opened and read. Doug went through all of the major bid items and discussed the differences in the unit prices of the two bids with the students. After the bid, I prepared a bid tabulation of both companies’ bids along with the bid from the actual company that was awarded the project. This bid tabulation was emailed to all members of the class.
Conclusion

I was very pleased with the entire bid module and the outcome of the bids. The students had complained about their lack of experience in productioning throughout the process. However, in two weeks they had sufficiently progressed in their abilities to compile a reasonable bid that one of the bid teams was 6% under the actual bid, and the other was 8.5% over. These are very credible results on a complex heavy highway bid project.

There were several benefits to this approach to teaching these construction management topics. The students had a real-life heavy highway construction project bid experience within a realistic timetable similar to what may be expected of them when they start working after graduation. The students were exposed to professional engineers in the construction management field that perform this type of work on a daily basis. The engineers were able to stress the practicalities that have to be dealt with beyond the fundamental theories while reinforcing information that I had given the students earlier in the course. Also, all of the engineers brought real life experiences to the classroom to share with the students. Hearing the stories of real life experiences in application of the theories that they are learning builds context for the students that they can operate from in the future accelerating their process of developing individual expertise.

The students were able to meet and relate to several professionals who were alumni of the same degree that they are pursuing. Perhaps this helps the students to picture themselves ten years from now in a successful professional life. Also, it is important for us as an engineering academic program to continually maintain and strengthen our ties with the construction industry. The contractors need to be able to make input into our academic programs for they are one of our main constituents.

References


Biographical Information

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