

# **Capstone Course in Construction Management**

**Joseph J. Cecere , Ph.D., CPC  
Pennsylvania State University/  
Harrisburg**

## **ABSTRACT**

Capstone courses offered in most construction engineering programs are designed to pull together much of what the student has already learned in previous courses. This will enable the student to gain an appreciation of how the different aspects of a construction project come together. The course is not an in depth study of any one function or technical aspect, but rather a synergistic overview of the project process.

Penn State Harrisburg's Structural Design & Construction Engineering Technology (SDCET) capstone course is separated into two sections so students can focus in either structural design or construction management. The sections stress their specialized area while still integrating elements of the other area. The four credit-hour course begins in the last seven and one-half weeks of the fall semester for one credit, and continues in the spring for three credits. The fall syllabus for the construction management option includes teams of students each forming a firm, dealing with organizational structures and personnel responsibilities, a marketing plan, company portfolio and potential client interview. The course continues in the spring with pre-qualifications, financial statements, RFP for CM services, project planning, bid packages and bidding, scheduling (bid and construction), value engineering, safety policy, and other CM services. Industry presentations and involvement provide the course with real world experiences. The course also integrates written and oral communications throughout to stress the importance of these skills for a successful manager.

## **INTRODUCTION**

The goal of a construction related curriculum is to prepare graduates to be as marketable and useful to future employers as practical. To meet this goal, students are required to take courses in business, English, oral and written communications, computers, math and science, as well as core courses in structural design and construction management. Hopefully all of these courses lead to a well-rounded individual who contributes to the construction industry. Most curricula have a senior "capstone" course which ties together much of what the student has learned in previous courses, while emphasizing the more important topics and skills.

To a large extent, there is a great deal of latitude given to the design of a capstone course. The content of the course may be influenced by the geographic area the university services, the aspect of construction that is the program's focus (industrial, commercial, or residential), the program's philosophy, the faculty's experience, and the perception of industry's needs. Course content may change with time, and courses may differ from program to program, but the basic goal is the same, to prepare the student for a career in construction, while satisfying industries' needs.

This paper describes the (SDCET) – construction option capstone course in order to provide an overview of its approach and experiences in delivering this course. By sharing this information, it is hoped that it will foster cooperation with construction programs to exchanging ideas thereby improving the construction educational process.

## **CAPSTONE COURSE - PHILOSOPHY**

Senior Project- Construction (CET 458) is the capstone course in the SDCET program at Penn State Harrisburg. The course is taken in the senior year. This capstone course is a yearlong course, starting the last 7-½ weeks in the fall semester for one credit and then continuing in the spring for three credits. The syllabus integrates most of the student's previous course work into a construction project so they can obtain a perspective of the entire construction management process.

In addition to the individual topics covered by the course, there are two important issues that are injected throughout the course; oral & written communications and teamwork. Communications are emphasized through written proposals, report writing, oral assignments, and facilitated classroom discussions throughout the course. The importance of teamwork is repeatedly conveyed to the students through their assignments and reinforced, hopefully, by the various components of the assignments.

The course is presented in a dual format with a one period lecture-discussion class and a two-double period projects-labs class. The project is a real commercial building project that is either under construction or just completed. The owner, architect, and contractors donate the drawings and documents, as well as provide information about various aspects of the project that assists the students with their assignments.

The course outline begins with an overview of an established, successful construction firm that provides construction management services as one of its services. The firm is expanding into a geographic location in which they are currently working and feel there is potential for more work. Therefore, they decide that they should have a physical presence there. The course then follows the branch location from its formation, marketing plan development, seeking clients, responding to RFP, performing construction management services, administering a project, and even bidding on a package.

The lectures contain subjects to which the students have been previously exposed in other courses, as well as subjects that benefit their company and help them succeed. Industry presentations provide the course with real world experiences that give the teams with valuable insight and ideas.

Topics that are covered include:

1. Construction Management
2. Main Company Perceptive
3. Branch Office Organizational Structure
4. Personnel Responsibility
5. Strategic Marketing Plan
6. Company Portfolio
7. Potential Client Contact & Interview
8. Pre-qualification Process/Statement
9. Financial Statement
10. RFP for CM services
11. Project Planning Process
12. Bid Packages Evaluation & Proposal
13. Single Bid Package Document
14. Scheduling (Bid and Construction)
15. Value Engineering (Design)
16. Competitive Bid (single package)
17. Safety Program
18. Project Administration
19. Resolution
20. Project Closeout

The following paragraphs briefly discuss the topics of the senior project.

## **ASSIGNMENTS**

The students are directed to form a three-person team that will become their construction firm for the entire senior project. The selection of team members is discussed since the teams and not individuals will be given assignments that will be submitted and graded. This procedure reinforces the importance of teamwork and how successful companies work together to accomplish their mission.

### **Name, Motto, and Logo**

The teams are instructed to create their firms. They create a company name that may reflect the type of services they perform, represent an individual or group, or just have a name that will be catchy and dynamic. The company's name will be used throughout the entire course when sending correspondence and representing the team. Along with the name, the teams must determine the type of organization they will operate under that may be a partnership, corporation, or company. All of the firms are located in the same city, but the teams are directed to establish their home office and branch office addresses and telephone numbers. The teams also are required to create a company motto and logo that will be incorporated throughout course. Creativity is encouraged in developing these items.

### **Branch Office's Organizational Structure**

In establishing a branch office, an organizational structure as well as the roles and responsibilities of the personnel needs to be developed. Because there are various types of organizations, it is important for the team to understand the activities that are associated with operating the office and the difference between managing a project and operating a branch office. A discussion of the basic office functions that includes managing the office, legal matters, bonds and insurances, contract administration, estimating, safety, marketing, human resources, home office linkage, procurement, financial accounting, field supervision, and the project process. The team determines the type of management approach, the organizational structure, and the different responsibilities assigned to the limited personnel at the branch office. The organizational chart shows the individual's name, title, chain of command, responsibilities, and linkage to a specific person and their title at the home office.

### **Personnel Responsibility**

The team discussed the various individual backgrounds and how they interrelate in order to appreciate the operations of the office. Fictitious individual resumes are created that demonstrate the person's experience which will support their new role and responsibilities within this branch office. These resumes will also be used for future team assignments so the team must be careful to generate appropriate experiences for potential clients who will be seeking their services. However, the team is not aware of the upcoming specific projects, so the personnel must have a broad group background. Appearance and standard format are expected for these professional resumes.

### **Strategic Marketing Plan**

The students discussed what would make the newly formed office successful, as well as the goals and objectives to accomplish this. The team develops their mission statement and the company objectives. There is a discussion on the types of marketing activities that can be developed to accomplish their goals. A critical component to their plans is establishing themselves in the geographic area. The team's plan considers a variety of activities that can be spread over the year, as well as the cost involved to complete the individual activities. These activities can include signs, ads, printed materials, mailings, membership, apparel, workshops, personal contacts, and community involvement. An itemized marketing budget is also submitted along with the plan to the home office.

Once the plan is approved, the teams submit updated reports every four weeks that represent quarterly reports. The updated report explains the activities that were performed during this period, the results of the activities, any variations to the plan, and their actual cost expenditures. The reports also must relate to the approved marketing plan as well as the office's objectives. The last report submitted is a summary report of the year.

### **Company Portfolio**

The company portfolio will be the major tool for the teams to explain their firm to a variety of individuals. This document represents the entire company and provides an overview of their organization. The teams discuss the items that should be included in this document that includes previous projects, volume of work, company history, services, and safety, in addition to others. The presentation of this document is also discussed so teams develop a high quality professional document. Recently, some teams have gone high tech by also putting their portfolio on a CD and generating a web page along with a printed document. It is recommended that the teams keep their firms simple, but to be creative too. They are warned that whatever they include in this document will have a ripple effect on future assignments. The teams who decide to be large, multi-service firms with numerous branch offices will cause additional work for the team in future assignments.

### **Potential Client Contact & Interview**

The team develops an information packet that includes their portfolio and a business letter that is sent to an architectural firm. The team requests the opportunity to have a meeting with the architect, and is successful in scheduling a meeting. The teams discuss the interview process and the various items associated with the meeting. The attire and manner of the participants is a part of the process. The interview reinforces that all of the team members must be familiar with their documents, as well as being prepared for the questions a client may ask. A thank you letter is sent after their meeting and they need to keep in contact with the architect.

### **Pre-Qualification Statement**

The teams are then invited to submit a pre-qualification statement for a potential client. The teams will complete the AIA standard document creating data from information they stated in previous activities including the company's portfolio and their client's interview. The team will also investigate existing banks, trade firms and other resources that they will utilize in completing the statement so the information is accurate to the area.

### **Financial Statement**

The principals of a financial statement are covered so teams understand the information they will need to complete this report. Teams develop bank statements, list their assets and liabilities, provide information on contracts in progress, and evaluate their property and equipment worth has part of the financial statement. Again, the team needs to review the previous information that they generated has it relates to this report.

### **RFP for CM Services**

The teams are informed that they are qualified to respond to a "Request for Proposal" for CM services for a specific project. The team's discussion includes items required in the proposal such as previous projects, the services they will perform, key project personnel, preliminary schedule and the proposed CM bid cost. The RFP is for an actual project that a CM firm recently completed and agreed to allow the class to use for the senior project. The CM also will speak to the teams throughout the course about different aspects of the project, as well as provide actual data. This assignment also includes an interview with the owner. The team makes a 15-minute presentation and answers questions from a panel. All of the team members must be familiar with the proposal.

### **Project Planning Process**

The project continues with each team being "selected" as the Construction Management firm for the upcoming project. The evaluations relate to the construction method, the resources available (including equipment,

materials, money, space and technology), the document requirements, and other factors that will be considered in developing the construction plan. The team's plan also formulates the CM activities that will affect the project.

### **Bid Packages Evaluation & Proposal**

There is a team discussion on the role the CM performs in the design and bidding process. The team evaluates the project documents, the construction process and other factors to determine the appropriate number of bid packages as well the content for each of the packages. This is presented to the owner along with a rationale for the recommendations and the sequences of the bid letting.

### **Single Bid Package**

From the list of bid packages, each team is required to produce a single bid package document that is sent to a potential bidder. This process will include the instructions to the bidders, the scope of work, the general and technical specifications, and necessary bidding documents all necessary to bid on the package. The teams will receive calls from bidders with questions or clarification of the document that they need to response.

### **Scheduling (Bid and Construction)**

A preliminary computerized CPM schedule is developed that will be used to create the pre construction schedule and assist the team in the bid package process. The team expands the schedule to a construction schedule once the bid packages have been awarded. This schedule will be reviewed by the various prime contractors and other parties to insure all parties "buy-in" to the timeline for the project activities. This schedule will be one of the two key driving forces, the other being cost, to the project and its success. The team discusses the importance of monitoring and updating the schedule to keep it on track.

### **Value Engineering**

Because owners change their minds, other materials become available, or someone feels that there may be a better process, the value engineering process is discussed. The team receives a memo from the owner requesting the team to perform value engineering on a specific item. The team will define the item and its use, analyze the value of the item, review possible alternate options, and submit its review and recommendation. The team becomes aware of what the word "value" means and that the least expensive option may not be best one for the client.

### **Competitive Bid (single package)**

The teams are invited to prime contractor and competitively bid on a specific bid package. The package is one that the owner (instructor) puts together which requires the team to submit a bid that includes a lump sum, a cost breakdown of quantities, direct and indirect cost, makeup and profit, a safety program, a performance bond, and a bid package construction schedule that fits into the overall construction that is part of the bid documents.

### **Safety Program**

Safety is discussed not so much in terms of codes and requirements, but in terms of awareness, information, and prevention. The team will create an effective safety program that they will manage during the construction process. The advantages and disadvantages of incentive programs (safety awards, bonuses), available training, and record keeping used by contractors and owners alike for requirements and reducing job related accidents are discussed.

### **Project Administration**

New construction management personnel are surprised to find out how much paperwork there is on a job. In addition to the up front plans that need to be developed (QC plan, safety plan, environmental plan, waste management plan and others), there is the ongoing reporting, letters, transmittals, meeting minutes, procurement records, revisions to specifications and drawings, change orders, estimate updates, accident reports, and others. Many students do not realize that paperwork (written communication) consumes a large part of the manager's workday. The project manager also needs to understand that "control" simply means looking at where you are, comparing that against where you want to be, and taking action (if necessary) to bring yourself back on track. Basically, in construction, you track progress and costs (incurred expenses). The team will generate a process that provides a guide to the project administration.

### **Project Closeout**

The teams see how much work is involved when the job nears completion. Discussions include final inspections and punch list generation, submittal of warranties and guarantees for workmanship and equipment, lien releases, and turn over of as-built drawings. The significance of turning over the care and control of facilities to the owner is also discussed. The team submits the final list of activities they need to accomplish to close out the project and required by the home office to complete their work on this project.

### **CONCLUSION**

The senior project course at Penn State Harrisburg presents a well-rounded picture of a construction management firm. Organizational philosophies, management styles, establishment an office, and securing a client to perform CM services are presented; pre-construction activities, bid package evaluations, planning & scheduling requirements and bidding on a package, organizing a safety program and performing value engineering are practiced and discussed. People skills such as communications and teamwork are emphasized. Throughout the entire course, a special emphasis is placed on effective oral and written communication.

The purpose for the course is to place construction management into a perspective so students see how the various subjects they have studied come into play. Industry has positive feedback on the structure and content of this course. A SDCET graduate is an immediate asset to his firm with this real life senior project course.

### References

Associated General Contractors documents, AGC Web Site, ([www.agc.org](http://www.agc.org))

Barrie, Donald S. and Paulson, Boyd, Professional Construction Management, McGraw Hill, New York, New York, 1992

Construction Estimating & Bidding- Theory, Principle, Process, Associated General Contractors, Alexandria, VA, 2000

Demkin, Joseph A., The Architect's Handbook of Professional Practice, John Wiley & Sons, New York, New York, 2002

Haltenhoff, C. Edwin, The CM Contracting System, Prentice Hall, Englewood Cliff, New Jersey, 2000

Hammer, Willie and Price, Dennis, Occupational Safety Management & Engineering, Prentice-Hall, Englewood Cliffs, New Jersey, 2001