A "REAL WORLD" APPROACH TO CONSTRUCTION ENGINEERING TECHNOLOGY EDUCATION: PHASE II - SENIOR CAPSTONE EXPERIENCE

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INTRODUCTION

What happens when successful professional construction design/build activities are integrated into an established four-year construction engineering technology and construction management program? Hopefully, the result will be a highly skilled and educated construction professional prepared to respond to the ever-changing fast-paced world of construction. These desired results can be accomplished by creating an academic program that simulates a "real-world" construction environment within an academic setting. In essence, throw away the traditional "lecture and release" approach to higher education and create an experiential, real world "learn by doing" approach to construction education.

This particular construction education concept was initiated several years ago by a group of construction faculty from Pittsburg State University with a variety of professional backgrounds in construction, architecture, engineering, and construction management with a goal to develop a new academic approach to construction education. The approach is relatively simple. Instructors would no longer focus on traditional lecturing, classroom activities, grading and assignments. Instead, they would focus on leading, guiding and mentoring groups of students in design, operations, methodology and management in a simulated construction company environment. This process would require students at each level, first year through graduate, to become part of a multi-faceted, multi-functional construction design/manager/construct organization inside a university environment. Faculty would become company officers, CEO's, senior project managers, department managers, etc. First year students would assume introductory roles (plan reviewers, as-built and shop drawing developers, quantity takeoff surveyors, etc.). Each year a student would move up to a different more advanced role. Field engineers, material testers and estimators at the second year level. Senior estimators, project engineers, superintendents at the...
third year level. Project managers, contract managers, etc. at the senior/graduate year. Project teams would be developed from a cross section of the various levels of students. As the semester/year progressed, special workshops, training sessions would be required for the various jobs and responsibilities (legal issues, ethics, safety, CAD, design concepts, etc.). Students needing to attend traditional courses like English, History and Math would in essence be attending a meeting for that period of time each day. The students would be required to be "at work" in some sense a minimum of 8-9 hours each day.

The faculty involved in this project recognized that it would be difficult to incorporate this model into a traditional academic environment in one quantum leap. They initially started with a freshman-level construction graphics course to assess potential pitfalls, identify successes and failures, and determine student attitudes and interests relative to this construction education approach. The results of this two-year pilot study were positive and provided the incentive to move to the senior end of the educational experience. The next step was the development and assessment of a five-year pilot study to assess the incorporation of this model into the construction senior-level capstone course.

The primary concerns of the faculty for this second phase included: 1) how well senior students would function in an environment where they were evaluated subjectively and objectively, 2) how well the senior students would adapt and accept a simulated "real-world" educational environment after the near completion of four years in a traditional academic environment, and 3) how much involvement and interaction from the faculty team would be necessary to lead, mentor and manage the students through this experience.

OBJECTIVES

The primary objectives of the second phase of this project were:

- to determine the reactions, attitudes and concerns of the participating students regarding a radically different approach to higher education both from a course and an entire degree perspective.

- to assess the overall professional aptitudes and attitudes of the participating senior students relative to accepted quality standards in a construction project environment.

- to assess the ability of a senior student to adapt to a flexible simulated-company educational environment versus a traditional structured educational environment.

- to evaluate the successes and failures identified throughout the second phase.

- to measure the reactions, attitudes and concerns of the participating faculty and associated administrators (chair of the department and construction program coordinator).

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The need for radical change in higher education is well documented by numerous studies and literature. In *The Quality Professor-Implementing TQM in the Classroom*, Robert Cornesky modifies Demings 7th and 11th point for quality improvement as follows: "Adopt and institute leadership. Your aim should be to help students do a better job." and "Eliminate the traditional, standardized grading system from the classroom. Eliminate management by objectives and numbers. Substitute leadership, making sure that what the students learn, they learn well." Cornesky goes on to say that in order to change student attitudes, behavior and work quality, educational systems need to be changed. These systems being teaching style, organization of materials, assignments and evaluation methods.

Dr. Richard Felder, a recognized authority on effective teaching, suggests that traditional teaching styles do not often match with preferred learning styles. In fact, his studies comparing engineering students learning style preference and engineering and engineering technology faculty learning style preference, show that preferences vary considerably between the various groups. Dr. Felder’s studies show that undergraduate engineering students prefer a learning style with an emphasis on sensing, visual, deductive and sequential teaching, with no distinct preference between active and reflective teaching methods. In contrast, engineering faculty, in general, prefer intuitive, visual, inductive, reflective and sequential learning styles. Engineering technology faculty tend to prefer sensing, visual, deductive and sequential methods, with no distinct preference between active and reflective methods. Dr. Felder’s studies and philosophies support the objectives of this project to assess student perceptions and learning styles vs delivery methods.

With the construction industry demands on graduates of construction programs constantly increasing, it is important that students in the program receive "real-world" experiences early and often in their academic career. The importance of integrating real-world professional construction experience, team work/team building, construction company operations and interactive communication guided the objectives for the second phase of this project.

**DESCRIPTION**

In order to implement this pilot study, the faculty changed the name of the capstone course to Construction Senior Projects, and rewrote the description to reflect the proposed methodology.

A pseudo-construction company called "PSU Construction" was developed along with a company policy and procedure manual. The faculty were set up as the principal partners in the company with each faculty responsible for a specific aspect of the company operation (engineering, equipment, estimating, project management, safety). A brief history of the company was developed outlining specific projects and accomplishments. In essence, the faculty developed an entire company structure to accommodate this pilot study. This was done with input from a number of construction companies and with some realization that changes and modifications would be necessary as the company evolved. Through this process, the faculty realized rather quickly the challenge that they would face of playing two roles, one role as a
company executive and another as an educator. Another major challenge, that began to surface immediately, was finding the necessary time to adequately, and professionally service this single course in light of other academic demands.

To control access to the Senior Projects course, the PSU faculty were responsible for enrolling the students into the course. The faculty agreed that no student would be enrolled in the course until they had an acceptable letter of application, a resume and had received favorable reviews from an interview. With this in mind, the process began with the first advertisement distributed to all construction program seniors inviting them to submit a letter of application and a resume to the company by a specific deadline (the semester prior to the course being offered) in order to be considered for employment with PSU Construction. The faculty, as company executives, reviewed all the letters of applications and resumes and responded to all applicants relative to PSU Construction’s interest in scheduling a follow-up interview. For applications and resumes that were considered to be of a good quality, the applicant received a letter scheduling an interview with 3 to 4 of the company partners. For the applicants that submitted inadequate or inappropriate resumes, a letter was sent thanking them for their application but expressing PSU Construction’s present lack of need for an individual with their abilities. This first shocked a number of students who were not invited for an interview and they quickly asked what they were supposed to do. The faculty then assumed their roles as faculty and offered advice and mentoring on writing a quality letter of application and a resume. The students then were given a second chance to submit and be accepted. If their second attempt was not successful, they were asked to pursue an alternative process called the Senior Projects Thesis.

During the initial semesters, the faculty worked extremely hard to mentor students on the proper methods of submitting letters and resumes as well as the proper methods of interviewing. Faculty set up mock interview sessions for students to experience good and bad methods of interviewing. These were videotaped for student review. The faculty conducted the interviews and then led a discussion session relative to interviewing. Ultimately, each student underwent interviews with at least three of the faculty. Sometimes the faculty conducted the interviews individually and sometimes the interviews were held by several PSU faculty at once. This provided a variety of approaches to the interviewing process. Over time the faculty developed a very good set of questions typical of construction company interviewers.

Once students were "hired" and accepted into the course, they began an orientation and training session. The orientation session consisted of a company history, company policies and procedures, company paperwork and a review of projects (past and present). The training segments included special seminars on various topics presented by either faculty or construction professionals. The typical seminars included topics covering leadership, planning and scheduling, estimating, design process, safety, team building, contract documents and cost control.

Once the orientation process was completed, the students, based on their resume and their interviews, were assigned positions and projects. The project teams then met with the project coordinator (one of the faculty) to review the project. The project review included determining

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the requirements to establish a project manual containing information on the owner, designer and all associated parties, a project scope statement, a budget, a milestone schedule and the desired contract documents. The project team then met with representatives of the project owner to determine owner needs and to basically review the entire proposed project with the owner. In most cases, the owner represented local community groups or private groups associated with the University (City of Pittsburg, Parks & Recreation, Boy Scouts, local church groups, etc.). The owner’s were instructed of possible limitations and requirements associated with PSU Construction and the impact of using students on a project. Typical issues covered during these meetings included liability issues, insurance, design limitations and liability, time constraints, labor and equipment restrictions, etc. These meetings served as a basis for negotiating the basic terms of a contractual agreement. After the initial meetings each group was required to submit a thorough project scope statement, a preliminary design, a preliminary budget and a preliminary schedule and a contract to the company for final approval. Once approval was received, the project team was given the okay to proceed with the project. If the project was a design/build project, the team had to substantially complete a set of working/detail drawings with design approval prior to initiation of any on-site construction activities. If the project was a construction management project, the team had to submit a detailed plan for construction and management of the project. Once the construction phase began, the team members were responsible for all project management, all site management and all field engineering for the project. Their labor source could be subcontracted labor from actual area subcontractors, or they could use underclassmen as labor through a special lab credit unit (LCU) program required by all four Construction Methods courses. This provided the seniors a real-world experience in the management of skilled and in many cases unskilled labor.

As the projects progressed, each team was required to submit interim progress reports, schedules, budget reports, change orders, labor reports, variance reports, etc. They were required to interact routinely with the owner or the owner’s representative. Each team met weekly as a group and with at least one member of the faculty. They were required to make a formal presentation at midterm, at an advisory board meeting and a final presentation at the end of the semester. Throughout the project, all communications were logged and recorded (phone, fax, meetings, etc.). At the end of the semester, each group submitted a complete project manual, and each team member was required to submit an individual accomplishment book for evaluation. The faculty had established various policies and procedures throughout the pilot study reflecting design review, site inspections, progress meetings, etc. that each group was required to follow. The summation of progress, customer feedback, interim reports, presentations and final review resulted in a project team and individual grade. The faculty, as a group, determined both individual and project grades after an exhaustive evaluation of the project documentation and project success.

PROJECTS

The following represents some of the various projects completed by PSU Construction over the last five years.

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Leffler Park Shelter House. A design/build shelter house project for the City of Pittsburg as part of a park renovation. (60' diameter structure).

KEY Construction Field Office Trailer. A design/build project for KEY Construction to remodel an existing mobile trailer into a temporary field office with a storage area, conference room and an office.

Gazebo Project. A design/build gazebo project for a local retired businessman as a part of an overall landscaping project.

Bridge Project. A design/build covered bridge project for a local retired businessman as a part of an overall landscaping project.

Fence Project. A design/build wood fence project for a local retired businessman as a part of an overall landscaping project.

Boy Scouts Site Improvement Project. A design/build project for the local Boy Scouts on a piece of property requiring landscaping and a new septic/drainfield.

Boy Scouts Plagen's Shelter House. A design/build 32' x 32'shelter house project for the local Boy Scouts camp site for meetings and summer camp.

City of Pittsburg Low-Income Housing Project. A joint venture design/build housing project with the City of Pittsburg to develop low to moderate cost housing in an underdeveloped section of Pittsburg.

Methodist Church Playhouse Project. A joint venture build/manage project with a local architect to construct a multi-story playhouse for a local church pre-school.

Four Oaks Golf Course Bathroom. A design/build bathroom project for the City of Pittsburg golf course.

Kiwanis Park Bathroom. A design/build bathroom project with the City of Pittsburg and the local Kiwanis group to improve a local "pocket" park.

PILOT STUDY RESULTS

The initial results of this five-year senior capstone/PSU Construction pilot study are generally positive. Each key constituent (faculty, students, owners, supporting industries) has provided feedback relative to positive components and areas of concern.

**Faculty Feedback**

Positive Aspects

1. Extremely beneficial to the students. Simulates real-world construction in an
academic setting. Duplicates many of the everyday construction activities and interactions.

2. Enjoyable for the faculty to be involved with projects and to see project successes.

3. Ties together a number of courses and provides a student with a real-world experience prior to graduation.

4. Stress importance of professionalism, communication, safety, quality and planning in the construction industry.

Areas of Concern

1. Very time consuming. It is imperative that faculty be given additional support or release time to properly address the course demands.

2. Documentation for the company needs to be standardized to improve communications and consistency.

3. Credit hours offered for the course needs to be increased.

4. Student issues. - Not all students take the course seriously. Time conflict of students in their senior year and conflicts with job interviews.

Student Feedback

Positive Aspects

1. Good experience. Simulates real construction projects but on a smaller scale.

2. Stress importance of communications and planning.

3. Helps develop teamwork.

4. Extremely rewarding when the owner is satisfied.

Areas of Concern

1. Clear definition of expectations from faculty.

2. Limited credit hours compared to time commitment.

3. Lack of availability of skilled labor on building projects.

4. Lack of time available by faculty.

Owner Feedback

Positive Aspects
1. Satisfaction of working with the students.
2. Activity provides a real service to the community.
3. Positive community/university interaction.
4. Development of leadership skills in the students.

Areas of Concern

1. 100% completion of each project in a timely manner.
2. Commitment and involvement of students varies from one student to the next.
3. Quality control.
4. Level of communication. Lacking on some projects.

**Industry Feedback**

Positive Aspects

1. Great simulation of actual projects but on a manageable level.
2. Good for the students to learn about leadership and communication skills on an actual project.
3. Positive application of formal education.
4. Good measure of students abilities prior to graduation.

Areas of Concern

1. Liability exposure for the students, faculty and university.
2. Safety issues and concerns with inexperienced labor.
3. Maintenance of quality during all phases of construction.
4. Amount of time faculty commit to this one course.

**CONCLUSIONS**

After a review of feedback and completed projects from this five-year study the following conclusions can be made.

1. The simulated process is an extremely valuable educational tool for construction education.
2. The time commitment for all involved is a major issue.

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3. Students in general prefer this model versus a strictly academic classroom setting for construction education. Students also feel like they learn a lot about soft skills (communication, leadership, people skills, planning, documentation) through this process.

4. The process continues to improve and evolve much like an actual construction company. Nothing is the same each semester.

5. The faculty must continue to play a major role in mentoring and leading students.

6. Faculty and university administrators like the associated publicity and program recognition.

GENERAL COMMENTS

As a result of the five-year study, the PSU Construction Engineering Technology and Construction Management program has decided to continue the process as a major part of their construction education. Improvements based on constituent feedback are being implemented.

All seniors will be required to take the American Institute of Constructors (AIC) certification exam as part of the capstone course. All underclass students will be strongly encouraged to participate in co-op/internships prior to acceptance into PSU Construction. A new set of policies and procedures are being drafted to reflect necessary changes. The faculty are considering forming PSU Construction into an LLC and maintaining company insurance. A full-time para-professional constructor has been requested as an addition to the staff.

REFERENCES


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BIOGRAPHICAL INFORMATION


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