Development and Implementation of an Industry Accelerated Construction Management Capstone Course

David L. Batie[1], Danny Morton[2]

Abstract- Construction capstone courses are developed to assist graduating students in understanding the realities of working in industry. Learning objectives are prepared to create activities that fully employ the knowledge gained and new technologies are introduced to ensure students maintain currency with the construction industry. This paper investigates historical Capstone courses and details development and implementation of a revised Capstone course structure that includes explanatory documentation on the use of two industry project management software platforms. Working with the McGraw-Hill Construction Project Network (MHC) and Information Handling Services (IHS), students are introduced to a variety of project documents that allows for enhanced analysis of selected assignment components. Outcome assessment results are discussed in conjunction with anticipated future course plans.

Keywords: Capstone Course; Innovative Teaching Methods; Industry Products Integration

INTRODUCTION

The East Carolina University Construction Management Capstone course emphasizes preparing graduating students for the realities of the construction industry. Courses are organized as a measuring tool for students and faculty when evaluating the knowledge gained in prerequisite classes of plan reading, safety, quality, estimating, and scheduling. In order to maintain industry currency, as well as utilize new technologies not standard in the construction field, the Department of Construction Management has expanded its capstone course to encapsulate improved industry software.

Working in conjunction with the McGraw-Hill Construction Project Network (MHC) and Information Handling Services (IHS), students are authorized to manipulate current construction projects during the semester and analyze pertinent specifications and drawing documentation utilizing various codes and standards requirements.

In order to develop the most vibrant capstone environment, the authors investigated a number of Capstone case studies. Based on these findings and Industry Advisory Board input, a new capstone class was developed. This case study supplies background on the new Capstone class structure, and explanatory documentation on the MHC and IHS platforms. In addition, an analysis of the student competencies as they relate to 1) building components and codes, 2) quantity take-offs and estimating, and 3) the ability to acquire needed documentation are undertaken. Exit interviews and class observations are used for analysis.

---

[1] East Carolina University, Rawl 326, Greenville, NC 27858, batied@ecu.edu

[2] East Carolina University, Rawl 330, Greenville, NC 27858, mortond@ecu.edu

CAPSTONE CASE STUDIES

Capstone classes have been the standard in construction management and engineering programs for over thirty years. Within ACCE and ABET guidelines, the capstone class has become an important component in determining accumulated progress knowledge. Prior to revising our capstone course, a review of the literature provided valuable documentation on viable components.

Catalano (2) noted the significance of student awareness in ethics and environmental issues in the industry. Mills and Beliveau (8) concluded that a capstone course should involve integrating upper and lower division undergraduates into senior level teams to develop critical thinking, leadership, and communication skills. Elzarka, Suckarieh, and Uwakweh (3) redefined their existing construction capstone course to understand new business processes, to understand concepts of research and innovation to improve a business, to put together a construction services proposal, and understand how to use information technology in managing construction. Kramer (7) discussed how an international capstone course would broaden a student's academic, personal, and professional views of the world's construction experience. Padmanabhan and Katti (9) changed the capstone course from using artificial projects constructed for the course to local real-life projects where students became engaged in service-learning projects. Jenkins et al (5) developed a capstone-design integration course where previous class design projects are taken to the field with students design-build teams. Butkus and Kelley (1) integrated professional practice real-world issues and activities to an engineering design capstone class. Hanna and Sullivan (4) discussed the establishment of a civil engineering capstone class where academic knowledge is applied to a practical problem. Jones and Mezo (6) believe team-teaching of a capstone course should be employed to enhance the learning objectives of the course. Sawhney, A., Mund, A. & Koczenasz, J. (10) employed internet-based computing technologies as a mechanism to bring real-life construction activities to the classroom.

BACKGROUND

Over the course of the past two academic years, the East Carolina University Construction Management program re-created its Capstone course to enhance the learning opportunities for graduating senior students. Students need exposure to the realties of company organization, project selection, bidding, estimating, scheduling, and Quality Assurance / Safety program development. In discussions with the Department's Industry Advisory Council, employers expressed the need for a more rigorous class to insure graduating seniors were prepared to be productive on entry.

Following the research of a variety of capstone class development and enhancement case studies, the process of changing the course began in a committee composed of the authors, who have extensive Project Management experience in residential, commercial, and industrial construction. This high level of management experience and knowledge of a wide range of building types allowed for a comprehensive vision in developing course learning objectives and outcomes. The list of objectives (See Table 1) and activities and tasks (See Table 2) were deemed relevant for student's knowledge of the capstone activity. Before implementation, the authors met with selected Industry Advisory Board members to explain the process and to insure its industry appropriateness. To assure uniformity, the authors employed the identical presentation and assignment documents in all sections.

Table 1

Learning Objectives

To recognize and describe the Construction Management Organization

To describe the Role of the Construction Manager

To explain the Construction Management Process and have students recognize and translate the complexity of the process.

To provide students the opportunity to review, analyze, and discuss a Construction Project in a holistic process, and understand how the various management parts fit together in the process.

To recognize the importance of cost-effective Resource utilization.

To acquaint the student with the Project Control concept, and how this concept is employed in managing construction project. Recognize how to control the use of resources for a project. To illustrate and apply practices for the student to Progress a Job.

To illustrate to students the procedures for changes during construction, and demonstrate the procedures needed to manage Change.

To describe to students the various documentation items associated with a Construction Project, and how to employ procedures for recording documentation.

To recognize the importance of Soft Sciences, such as attitude, ethics, communication, motivation, and leadership when managing people on a Construction Project.

Table 2

Activities & Tasks

1. Project Segment #1

Students create a 1) Team company with formal organizational charts, company personal resumes, and provide a formal presentation detailing the team's attributes in the context of an Owner's Team Selection procedure and 2) a course schedule where students assign durations for each project segment, including anticipated addenda.

2. Project Segment #2

Teams will analyze the Contract Documents to 1) create a Contract Review document, 2) assemble General Contractor Submittal and Inspection spreadsheets, 3) produce a 60-90 Construction Project Schedule and a Logistics/Layout Plan, and 4) provide a formal presentation supporting their decisions made for the above noted requirement documents.

3. Project Segment #3

Teams will analyze the Contract Documents to 1) create a Project Estimate for the project, 2) create a full Project Schedule for the project, 3) create and provide required submittal samples and

transmittals for the project, 4) prepare required Purchase Orders for the project, 5) provide a sub-contract for a specified system of work, and 6) provide a formal presentation supporting their decisions made for the above noted requirement documents.

4. Project Segment #4

Teams will 1) analyze the Quality Assurance (QA) Manual and provided QA checklists and create a Quality Plan for the Project, 2) analyze needs and compose a Company Safety Plan, 3) provide a Term Project Analysis Report, and 4) provide a formal presentation supporting their decisions made for the above noted requirement documents.

Other Assignments

1. Teams will locate and choose a local construction project to visit weekly to formulate the following documents: 1) Project Summary, 2) Daily (Weekly) Reports, 3) Project Analysis, and 4) Photo Summary of Activities of the project.

2. Students will research and analyze legal issues concerning the construction process and specific construction contracts.

3. Teams provide Minutes of Weekly Meetings denoting progress, problems and action plans.

4. Teams provide Team Personnel Evaluation Reports every two weeks.

During the Summer 2006, initial contact took place with McGraw-Hill Construction Project Network (MHC) and Information Handling Services (IHS) to determine the use of their platforms in conjunction with the Capstone course.

MHC is a project management program for the construction industry that establishes new construction standards by connecting Owners, Designers, and Contractors in an electronic environment. This environment provides workflow solutions that assist firms in performing their work. MHC demonstrated how their product could be beneficial to our student's education, as well as there potential influence with future employers to use the product. MHC has become an active advocate for their program use. Mr. Norbert Young, McGraw-Hill Construction President, supported the program by providing the product for student use to educate them in industry's use of the program. (See Fig. 1) Working with MHC, we employed a usage report to monitor the amount of time, number of projects, and students accessing the platform to eliminate any form of potential impropriety. In the agreement with MHC, students have cost free internet access to the MHC webpage 24/7/365. The only departmental cost was a minimal instructor's fee. Students are able to access selected project contract, construction documents and other documentation during the bidding process. MHC also provides the Dodge View Plan Room so students can view construction drawings and prepare quantity take-offs of the project (See Fig. 2). The program also includes Sweets® for product data submittals.

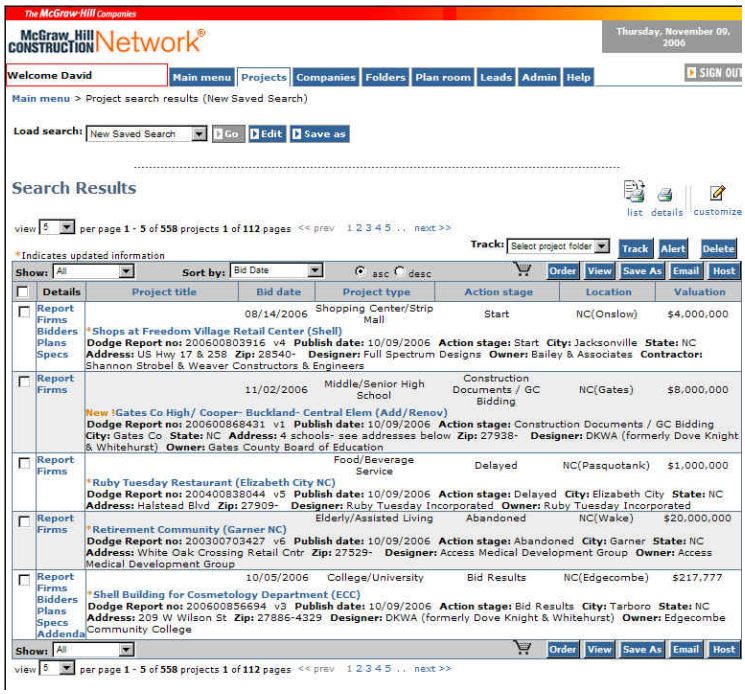

Figure 1: McGraw-Hill Construction Network Platform

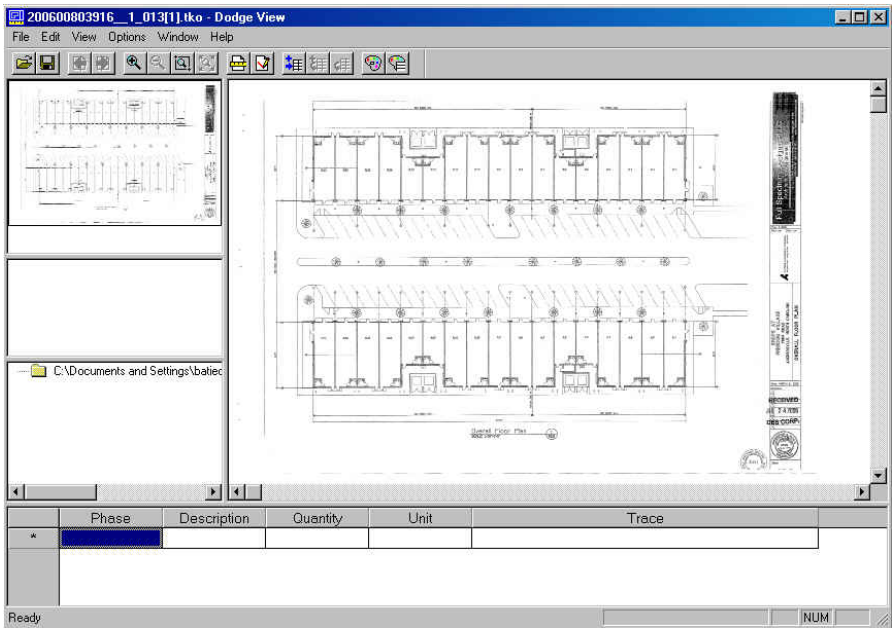

Figure 2: MHS Dodge View Plan Room

The authors determined that access to specification and drawings codes and standards was essential for student learning of industry statutes. Research of computer-based systems showed that Information Handling Services (IHS) could provide our students with needed documentation on construction standards and codes. In negotiations with IHS, the department was

able to secure the International Building Code (IBC) Reference Standards Collection and the additional UL Fire Resistant Standard. This package provides unlimited access to the IHS Specs and Standards Index, and allows students and faculty to review the needed specifications. (See Fig. 3) Cost for the program was paid by our Professional Advisory Council. All CMGT students have access to this program, and the program is used in six undergraduate classes, as well as the Capstone class.

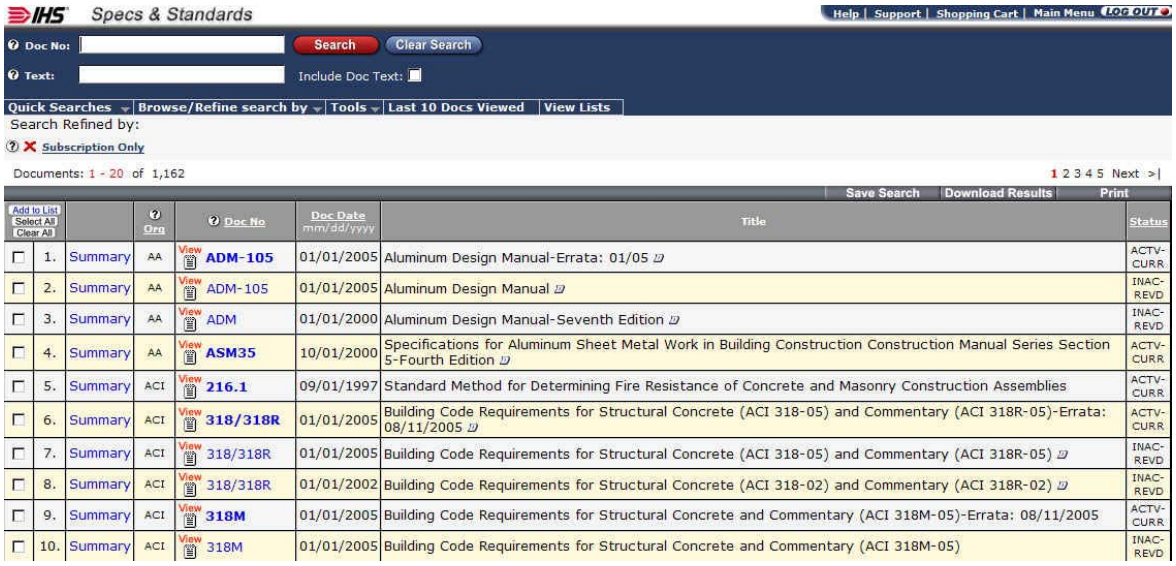

Figure 3: IHS Interface Webpage

COURSE DELIVERY TECHNIQUE

During the first year, Capstone students were introduced to the McGraw Hill Construction Network, Dodge Reports, and IHS, specifications and standards web based platform. The authors selected the "Gates County Social Services Building, Gatesville, NC "project for its completeness of documents, physical size (<10,000 Gross Square Feet) and complexity of the contract documents. These conditions allowed teams of four students to successfully complete the assignments required for the course. Later classes have used similar sized building types. Subsequent Capstone course students are introduced to these platforms in their prerequisite Construction Quality Control class.

Expedition© (web-based) software is used by team members and faculty as a Contract Management and Communication tool. Since students are introduced to this software in a prerequisite class, they are expected to have full knowledge and ability to manipulate its functions. All documents and Request for Information (RFI) clarification requests from teams are created using the Expedition© platform. As with MHC and IHS, Expedition© is available 24/7/365 to students.

The Capstone class is interactive with the Instructors serving as facilitators. They provide assistance with content understanding, as well as expectations for success. During the first class period of each project segment, Instructors review the content of tasks associated with the segment and advise teams of potential addenda that could change their Scope of Work. At that time, teams are advised to consider time allowances and appropriately plan and schedule for their potential change. Discussions are conducted with teams and individual team members to provide additional assistance with the various processes associated with a particular project segment.

Students use the MHC and IHS platforms throughout the semester to develop the different Project Segments. Due to the nature of the activities associated with the project segments, students access the contract documents to develop assigned processes and systems associated with the selected MHC project. Just as Project Managers and Superintendents are required to maintain jobsite plans and specifications for operational functions during the building process, Capstone students have 24 hour access to the plans and specifications. This accessibility increases the team's efficiency in segment development.

The MHC platform contains live projects currently being bid in the University's geographic area, so students are capable of viewing and analyzing MHC platform projects in a similar vein as construction companies track projects and evaluate for bidding. To enhance this experience, instructors assign an additional live project for the teams to evaluate in order to make a bid determination. Having the information (plans, specifications, and project reports) available on-line increases team effectiveness, time management, while providing students with working knowledge of a process industry uses to maintain, expand, and manage their business operations.

Each team is responsible for the management of their team, team members, and segment content. Students are strongly encouraged to begin a plan at the start of the term that utilizes the individual member expertise, and assign a project coordinator to manage the work flow, and develop means and methods for controlling documentation and communication.

Teams may request meetings with the Instructors to discuss team progress as well as team personnel problems. In this role, the Instructor serves as both Project Supervisor and Mediator to assist teams with focusing on the task at hand and resolving problems or disputes. This provides teams with a methodology to develop a forward moving path to complete project segments and meet course obligations and requirements.

The inclusion of the MHC and IHS platforms was essential for the project development of the class. The ease of access and uniformity of information was essential in process development and understanding by the students. The ability to obtain standards referenced in the Contract Specifications provided students with a superior understanding of the processes associated with the specifications and how they impact other project processes developed during the semester.

POST-SEMESTER CLASS ANALYSIS

At the completion of the terms, the authors interviewed students to ascertain the effectiveness of the new class structure and the MHC and IHS software components employed. Additional opinions and comments were obtained from the University required Student Opinion of Instruction Survey (SOIS) and graduating seniors exit interviews [CMGT 4664, 11].

Student comments regarding class overall effectiveness and the segmented class structure included the following:

- "The class is beneficial and the structure of the class gives a better concept of the overall construction process."
- "Offers a great opportunity to use knowledge gained in the curriculum and to apply and expand on that knowledge."
- "Enjoy the freedom of the class and team project management."

- "Like the "segments" of the class and required oral and document presentation as it provides input for improvement in the next segment."

- "Provides awareness of teamwork and team communications and the importance of time management."

- "Reinforces the need to understand the contract documents and to develop administrative controls for the project.'

- "Prefer the class to meet 5 days a week (50 minutes per class) versus the present 3 days a week (50 minutes per class)."

Student comments in regard to the class being beneficial in terms of developing a project and managing project resources and time included the following:

- "Beneficial in application of knowledge gained from the curriculum and allows teams members to build on and expand their knowledge."

- "Enjoy forming a company and the freedom to develop the project utilizing skills of team members."

- "Gives a sense of confidence and accomplishment in our abilities as we enter the construction industry.'

- "Ties everything together and enhances the understanding of construction processes and process control.'

- "Reinforces the need for effective communication and documentation of projects.'

The comments from the students were favorable and reinforced the overall course objectives as defined by the authors. Of major importance to the authors was the students feeling of "ownership" of both the class and assigned semester project. At the beginning of the semester the students were informed that class time and team resource management to meet segment due dates and professional presentations of segment material was the sole team responsibility. It is evident from the comments and work generated by the teams, that each team viewed the project as "their" project and the team was accountable and responsible for project delivery as specified. Student comments recommending additional hours per week in class was pleasantly surprising, particularly since no additional credit hours for those contact hours was requested or recommended by the students.

The students provided a great range of opinions regarding the use of the MHC and IHS programs. They ranged from ease of program use and liked the ability to access from off campus to having great difficulty using the program. Most of the comments expressed the need to introduce the programs earlier in the program curriculum in order to remove the substantial learning curve. Enhanced instruction of use with examples needed to be included. In some instances the students wanted to use hard copies of plans and specifications. They stated the constant need to zoom in and out using the MHC Plan room caused them discomfort and made reading difficult. Students also requested that they be allowed to convert the plans used in the MHC platform from PDF to CAD files.

IMPROVEMENTS OF MHC AND IHS PLATFORMS AND CAPSTONE CLASS

The restructuring of the Capstone class and inclusion of the MHC network and the IHS platform for the past year have enhanced course effectiveness and expanded the knowledge and understanding of participating students.

During the past year several areas of concerns surfaced:

- The assignment of usernames and passwords for our students utilizing the MHC network.
- Assuring that the MHC project assigned to the class would remain active during the entire semester
- Allow students to convert the MHC PDF drawing files to CAD files
- The need to expand the IHS platform to include additional industry standards identified by faculty

The majority of the concerns / issues had been resolved. To assist in the management of usernames and passwords for the MHC network, MHC suggested a faculty member be assigned the network administrator role to work in collaboration with MHC technical support. To assure projects assigned for the semester would remain live and available for the semester, a new procedure has been established with MHC in project selection prior to the start of a new semester. The ability to convert the MHC drawings from PDF to CAD is progressing; however the authors are continuing to work with MHC to ascertain a more effective process. The inclusion of additional standards in the IHS platform will be handled through negotiations with IHS based on faculty input for suggested standard needs and requirements.

The transition to MHC and IHS has been relatively seamless and well received by students and faculty utilizing the systems. The platforms have created a bridge between teaching trends and provide the tools needed for industry usage of current technology and information associated with the construction industry. The platforms allow the demonstration of the real world and real time industry applications of technology.

Finally, faculty and industry discussions have identified several courses, in addition to the Capstone and Quality Assurance classes, that would benefit from the integration of the MHC network and IHS platforms. They include program courses in Civil & Construction Materials, Architectural Plans and Analysis, Mechanical and Electrical Systems, Estimating, and Scheduling. MHC and IHS would provide instructors a variety of construction projects and contract documents to reinforce course content and structure as well as industry standards germane to each course. All courses will begin employing the platforms in upcoming semesters.

REFERENCES

1. Butkus, M. & Kelley, M. (2004) Approach for Integrating Professional Practice Issues into Undergraduate Environmental Engineering Design Projects. Journal of Professional Issues in Engineering Education and Practice. 130 (3): 166-172.

2. Catalano, G. (2004) Senior Capstone Design and Ethics: A Bridge to the Professional World. Science and Engineering Ethics. 10 (2): 409- 415.

3. Elzarka, H., Suckarieh, G., & Uwakweh, B. (2002) Redesigning the Senior Construction Management Capstone Courses at the University of Cincinnati. ASC Proceedings of the 38th Annual Conference, 25-32.

4. Hanna, A. & Sullivan, K. (2005) Bridging the Gap between Academics and Practice: A Capstone Design Experience. Journal of Professional Issues in Engineering Education and Practice. 131 (1): 59-62.

5. Jenkins, S., Pocock, J., Zuraski, P., Meade, R., Mitchell, Z. & Farrington, J. (2002) Capstone Course in an Integrated Engineering Curriculum. Journal of Professional Issues in Engineering Education and Practice. 128 (2): 75-82.

6. Jones, J. & Mezo, Mike. (2007) Team Teaching the Capstone Management Course: How and Why. ASC Proceedings of the 43rd Annual Conference.

7. Kramer, S. (2004) An Alternative Senior Capstone Class: Experiential Learning & European Construction. ASC Proceedings of the 40th Annual Conference.

8. Mills, T. & Beliveau, Y. (1999) Vertically Integrating a Capstone Experience: A Case Study for a New Strategy. Journal of Construction Education, 3 (3), 278-288.

9. Padmanabhan, G. & Katti, D. (2002) Using Community-Based projects in Civil Engineering Capstone Courses. Journal of Professional Issues in Engineering Education and Practice. 128 (1): 12-18.

10. Sawhney, A., Mund, A. & Koczenasz, J. (2001) Internet-Based Interactive Construction Management Learning System. Journal of Construction Education, 6 (3), 124-138.

11. CMGT 4664 (2006-2007) SOIS / Exit Interviews with CMGT 4664 Students, East Carolina University.

David L. Batie, PhD, NCARB, RA

David L. Batie is an Associate Professor of Construction Management at East Carolina University. Dr. Batie holds a Ph.D. in architecture from Texas A&M University and a Master of Architecture and BSAS in Architecture from the University of Nebraska-Lincoln. He is a licensed Architect having over twenty-five years of experience in design and construction, and has been recognized as an ECU Scholar-Teacher. His current research is directed at Sustainability issues in construction, Internet/Multimedia Learning Applications, and Design/Build Applications.

Danny Morton, MAED, RAB, CSI

Danny Morton is an Instructor of Construction Management at East Carolina University. Mr. Morton holds a BSBA and MAED from East Carolina University. He holds Registrar Accreditation Board ISO 9001 Lead Auditor certification and has over thirty years of experience in construction management. His current research is directed in Project Management, Quality Assurance and Human Resource Training in construction.