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Industry Participation in the Interdisciplinary Team Design Project Course of a Master of Architectural Engineering Program

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Abstract

This is a case study of extensive industry participation in the capstone design course of the Master of Architectural Engineering program at the University of Nebraska – Lincoln. This course, entitled Interdisciplinary Team Design Project, pairs teams of professional engineers and students to provide mentoring, assessment, and feedback, as the students work on interdisciplinary teams to design the building systems for a real-world project. For the spring 2010 semester, over 33 industry professionals participated in the course, each contributing approximately 40 to 50 hours of mentoring and assessment. This paper describes the course format and industry involvement, which provides students with invaluable, hands-on learning experiences.

Introduction

Though many professionals working in the engineering industry are often required to apply theoretical knowledge to real-world situations, the mechanisms to prepare engineering students for industry life vary greatly among institutions. One model to help prepare architectural engineering (AE) students for this application of knowledge has been developed at the University of Nebraska – Lincoln (UNL). This model integrates industry partnership and mentoring into the Interdisciplinary Team Design Project capstone design course of the Master of Architectural Engineering (MAE) program. Though persons from industry have been involved with the instruction of this course since 2003 (the first UNL MAE graduates), major revisions to the course were made in 2009 to formalize the industry interaction and increase its effectiveness. This revised course format was continued during the spring 2010 semester and will be described in this paper.

Course and Project Description

The Interdisciplinary Team Design Project is a four-credit, semester-long capstone course taken by all UNL architectural engineering students in their final year of the ABET-accredited MAE program. This program is part of the Charles W. Durham School of Architectural Engineering and Construction housed in the Peter Kiewit Institute in Omaha, NE. Students complete a four-year Bachelor of Science degree in Architectural Engineering, followed by the one-year MAE during which they focus on one of the following technical areas: (1) structural systems; (2) lighting and electrical systems; or (3) mechanical and acoustical systems. This capstone course builds upon previous discipline-specific design courses, and requires the integration of these disciplines. It is typically taken in the last semester, and is intended to provide students with a

real-world building design experience, in addition to mentoring, assessment, and feedback on their work from professional engineers.

Course Description

At the beginning of the course, the students are split into interdisciplinary teams and remain in these teams for the duration of the course. The members of each team work together to complete the following steps of the building design process for a real-world project, with some overlap between phases:

1. Architectural Design (1 – 2 weeks)
2. Schematic Design (4 weeks)
3. Design Development (7 weeks)
4. Construction Documents (5 weeks)

The building systems designed by each team include structural, electrical, lighting, mechanical, and acoustical. During each phase of the building design, the students must complete baseline requirements for the project, which are specific to each building system. For example, during the schematic design phase, the structural students must complete discipline-specific work including gravity and lateral load resisting system comparisons and selection. The student teams are also assessed on their incorporation of the following areas of broader scope into the project: building system analysis, building efficiency, sustainable strategies, budget strategies, and interdisciplinary coordination. Throughout the course, each team submits meeting minutes and timesheets documenting the time each person spends on the project.

Project Description

For each semester the course is offered, a different real-world project is designed by the students. For the spring 2010 semester, a three-story, 40,000 sq. ft. office building was selected. Two of the stories will contain the office of a local architectural engineering firm, which is intended in part to be a laboratory space to showcase innovative building systems. The remaining story will be a space for other tenants.

This real-world building was under construction while students were working on the project. Though the students did not design the building systems used in the actual project, the architect and owner's representative for the project participated extensively in the course. They communicated the owner's goals and requirements for the project, which included an emphasis on incorporating sustainable design features. They also participated in an open discussion forum with the students and responded to questions about the project throughout the semester.

During the design development phase of the project, the students were presented with revised project parameters, similar to those that might occur on a real-world project. The revised parameters included a change in the building space layout and the acquisition of additional grant money for the implementation of wind and/or photovoltaic renewable energy systems.

Collaboration of Faculty, Students, and Professional Engineers

Prior to the start of the course, the faculty recruits professional engineers and architects from different AE and individual consulting engineering and architecture firms to participate in the course. One firm is selected to provide the project for the semester. Other engineering firms are recruited to provide a team of professionals to mentor each student team. A different company or group of companies is paired with each of the different student teams. For the spring 2010 semester, there were six student teams and six industry teams.

The faculty meets with industry teams prior to the start of each semester to introduce the project and the course. Feedback from the professional engineers is encouraged throughout the semester, so that the course may continue to evolve to better approximate a real-world experience for the students.

Design Teams

Each interdisciplinary student team typically consists of 5 – 6 members per team, composed of students specializing in each of the following areas: structural systems; electrical and lighting systems; and mechanical and acoustical systems. The corresponding industry teams also consist of AE professionals working in each of these disciplines, along with one practicing architect. For the spring 2010 semester, there were 34 students in the course, split into six teams. There were more than with 31 industry mentors involved in the course during the semester.

Throughout the course, the students interact closely with the industry members on the design teams. There are nine class times scheduled for this interaction, during which the industry teams come to the Peter Kiewit Institute. In addition to these scheduled class meetings, the students are encouraged to contact the professionals with questions and meet with them in their offices as needed to get direction on the project. Each professional typically contributes a minimum of 40 hours throughout the semester helping with the course.

Assessment and Feedback

In addition to the feedback the students receive on their work from the industry members on their own team, each team's work is evaluated by their peers and industry members from other teams. Each student team prepares and delivers a verbal presentation with supporting visual aids after the architectural design, schematic design, and design development phases of the project. All of the students and industry assess these presentations by providing performance ratings in various areas along with written comments.

The student teams also submit written documentation and drawings for the schematic design, design development, and construction document phases. These submittals are reviewed by students and professionals on other teams as well. The ratings and comments from these reviews are compiled by the faculty and made available to the students and industry members on each team. The industry team members meet with the students on their team to review the comments and ratings they receive from the schematic design and design development phases.

Individual assessment of each student's contribution to the team's work is provided by the student members on each team. Following each phase of the building design, the students complete individual performance reviews for each member on their team. These ratings are converted to individual performance multipliers, which are applied to the overall team ratings to assign individual grades. The faculty monitors these individual performance reviews and takes appropriate measures to ensure all students are contributing to the team's work.

Multidiscipline Participation

The members on each team include students specializing in structural; lighting and electrical; and mechanical and acoustical system design. The students in these various areas must work together to create cohesive building systems. This fosters a better understanding of all disciplines by each student, as they must assess the impacts of the other systems on their own system design. Also, the inclusion of an architect on each industry team brings a different perspective on the building design to each group. The students must ensure their system designs are acceptable from an architectural perspective. A representative from the project's general contractor is invited to attend the final student presentations and provide feedback on the constructability of the systems selected.

Knowledge and Skills Gained

The partner teaching provided by the industry mentors allows the students to gain exposure to the professional industry in a structured, nurturing manner. By completing each phase of the design process, the students are able to piece together all of the knowledge they have gained in their previous coursework to develop an integrated solution to a complex design problem. The students gain professional practice skills, such as communication, presentation, and software proficiency. These skills will help enable them to successfully navigate the architectural engineering industry.

Conclusions

The industry participation in the architectural engineering Interdisciplinary Team Design Project course at UNL provides the students with knowledge and skills useful in the AE profession. This course integrates professionals from many of the local AE firms into the instruction, mentoring, assessment, and feedback students receive as they design a real-world project. This type of course model will continue to be utilized in the UNL MAE program in subsequent years.

Biographical Information

LAUREN M. RONSSE

Lauren M. Ronsse is a PhD candidate in Architectural Engineering at the University of Nebraska – Lincoln. She was the primary instructor for the AE Interdisciplinary Team Design Project course during the spring 2010 semester. Her current research includes the investigation of the effects of room acoustics on elementary student learning. She plans to complete her PhD in May 2011.

LILY M. WANG
Lily M. Wang, PhD, PE, FASA is an associate professor of Architectural Engineering, part of the Durham School of Architectural Engineering and Construction at UNL's Omaha Campus. She was the primary instructor for the AE Interdisciplinary Team Design Project during the spring 2009 semester. Her area of expertise is in room acoustics and noise control.

CLARENCE E. WATERS
Clarence E. Waters, PhD, PE, FAEI is a professor of Architectural Engineering, part of the Durham School of Architectural Engineering and Construction at UNL's Omaha Campus. He is past Director of UNL's AE program and served as a secondary instructor for the AE Interdisciplinary Team Design Project. His role in the team design project is to develop industry participation.