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Professional Skill Development for Engineering Management Students

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Abstract

The employers in the construction engineering and management fields have very high demands regarding students' professional skills. However, the majority of the courses in the construction engineering and management programs have been focusing more on textbook theories than on industry professional skills. This paper studies the different approaches in developing students' professional skills in the classroom by working together with engineering firms. It is believed that such a study can provide a vision for engineering management education that can better provide for students in the industry. These approaches can be applied to many similar engineering management programs.

Introduction

Construction has become a profession from the traditional civil engineering. In this industry, all new hires are still expected to have the fundamentals of engineering theory and knowledge; however, it requires much less designing and computing capacity. Instead, it requires more hands-on professional skills. In other words, the construction employers want their new hires to be ready for the field. Furthermore, they want these skills to be developed in school instead of relying on job training. On the other hand, most of the current courses in many construction engineering and management programs have been focusing more on textbook theories but lack the skills that allow one to gain success immediately in the workplace[1, 2, 3]. In the recent Industry Advisory (IAC) Council meetings, many industry members have pointed out the need of professional skill development for construction engineering and management students. Therefore, an opportunity of professional skill development in the classroom should be provided to the students, in order to better prepare them for the construction industry. This paper addresses several approaches to help students develop their professional skills.

Faculty Professional Development

Due to the university's requirements, faculty members in the construction engineering and management programs must hold Ph.D. degrees. However, by obtaining a Ph.D. degree, most faculty members have given up opportunities to gain enough industry work experience due to the

time limitation. To solve this issue, two methods were used to provide the professional skills in the classroom:

- Team teaching approach – the department of Construction Management and Engineering (CME) at North Dakota State University (NDSU) hired several adjunct instructors from the construction industry. They usually are current construction engineers or managers who have many years of construction experience and are rich of professional skills. Then these instructors teamed up with full-time faculty to co-teach courses. This approach combines the high quality of engineering theory with valuable professional skills to provide students with an excellent learning opportunity.

- Professional development in the industry – faculty members were encouraged to obtain summer internships in the local construction firms to develop professional skills such as surveying, project control, field management, etc.

The implementation of these approaches makes sure that there are sources of professional skills available to the students.

Industry Advisory Council (IAC) Feedback

In order to provide current professional skills to the students, IAC has monitored teaching in two perspectives:

- IAC meets regularly to determine what should be taught in the classroom based on the current industry trends and to provide the results to the faculty. IAC also tracks the skill requirements of certain engineering and management positions, and to provide the summary of these requirements to the faculty.

- IAC member regularly sit-in on the CME classrooms to observe and to provide detailed feedback about the class instruction.

The implementation of these two approaches significantly enhances the availability of professional skills to students.

Industry-Classroom Collaboration

In order to teach students professional skills, real project data is much needed. Many construction firms, which are potential employers of the construction students, approach the instructors and provide the construction project data to the CME403 Scheduling and Project Control and CME453 Concrete Design and Construction classrooms to help better prepare students for the industry. This kind of university/industry collaboration has been proved as an effective and efficient method, and allows students to learn construction engineering and management using "live" project data. A typical process of acquiring real project data is summarized below:

- Instructors contact potential construction companies and review their projects and data formats.
- Companies and the university establish an agreement of collaboration between the

selected companies and classroom teaching. The collaboration assigns responsibilities for each party.

- Instructors obtain the initial project data and establish the data server. The raw data will be sorted and processed to make sure the data used for classroom is live, real and reflects the actual construction practice, i.e., typical construction processes that are critical for students learning are selected.
- Instructors establish the frequency and channels to update the project data with selected companies. This step will guarantee students in the future semesters the live data after this project ends.
- Instructors use project data for teaching the construction engineering and management courses. These materials are incorporated into all of the core construction courses.
- A statistical analysis will be performed on student learning based on the data.

Furthermore, course instructors used two more approaches to provide students with additional exposure to real construction data. The first is to use one or two guest speakers (i.e., construction managers) in the classroom when available, such as one from Strata Co. in West Fatgo, ND. The second is to ask students to interview a construction company to learn more about a set of real project data. This has been done in CME403 and more than 10 local and national construction forms are involved. Both of these approaches add value to the student learning experience and skill development.

Use of New Technology

Use of new technologies developed in the construction industry will significantly improve the students' professional skill development. Such technologies are, for examples, Virtual Reality (VR), Building Information Modeling (BIM) and Laser Scanning. VR is a synthetic environment that can be used to investigate complex three dimensional (3D) data with human interaction. Many applications with Virtual Reality have been developed in the area of construction engineering. A simple wall-and floor- projection VR tool allows students to simultaneously interact with the virtual design and construction processes.

BIM is "a model-based technology linked with a database of project information" (American Institute of Architects) which "allows all the users of building information models to be able to easily utilize the information". However, the construction industry does not only treat BIM as a tool, but rather defines it as a process. Information carried by BIM models are reused over and over throughout the entire design and construction process among different project parties. BIM is integrated with many existing computer programs in the construction industry such as software for construction estimating, scheduling, and project management. These functions of BIM ultimately allows updates on construction documentation done directly on BIM models and therefore provides for much better project scheduling and control – a key component of managing a construction project.

The 3D laser scanner is a powerful data acquiring and capturing equipment with the ultra-high-speed laser scanner. Working together with software, it provides a full set of geo-referencing, surveying, and CAD integrated engineering tools for creating accurate drawings and models.

These three technologies can be integrated together for new construction and major remodeling projects. By putting together the VR, the BIM and the 3D Laser Scanner, students will have the cutting edge capacity to seek potential nationally competitive jobs. These technologies have been implemented in the CME403 course and CME670 Construction Information Technologies for Construction Managers and were welcomed by the students.

Industry Training Standards and Facility

In order for students to develop a sense of a real professional job, it is critical to establish an industry-standard facility but not to focus on theory. For example, when teaching a CME453 concrete course, the laboratory component follows the American Standards of Testing and Materials (ASTM) cement, aggregate and concrete standards. The major experiments conducted are the tests specified in the American Concrete Institute field and laboratory testing certification program, including: Sampling Freshly Mixed Concrete, Making and Curing Concrete Test Specimens in the Field, Temperature of Freshly Mixed Portland Cement Concrete, Slump of Hydraulic Cement Concrete, Unit Weight, Yield, and Air Content (Gravimetric) of Concrete, Air Content of Freshly Mixed Concrete, and Compressive Strength of Cylindrical Concrete Specimens.

The establishment and use of such a laboratory provides hands-on experience for the students and equips them with a better capacity and skills of concrete testing. More importantly, what they are doing in the classroom is what they will do on the job site in the future.

Teaching on Site

Teaching on site or taking field trips is always helpful for teaching professional skills. First, it allows the students to see an actual construction business in operation. To do this, for example, one would bring CME380 estimating class to the local Builder Exchange center to observe its bidding operation process. Second, it gives the students an opportunity to see the production process of construction materials. The instructor, for example, has brought the CME453 concrete class to a local ready-mix concrete maker – Strata – to see the entire process of how concrete is made and how it is ordered and delivered to construction sites. Last, but not least important, it allows the students to use the construction professional's facility at Strata, Co. and Midwest Testing Laboratory, Fargo to conduct their class work in a professional environment. In order to accomplish this, for example, the instructor would bring the concrete class to a local concrete testing firm to see and to conduct the concrete tests.

Impacts on Learning and Teaching

The Student Rating of Instruction (SROI, i.e., course assessment survey) for the courses using these approaches indicated that the students were able to fully accomplish the objectives. Using a concrete course as an example, more than 75% of the students reported that they were 80% confident that after the semester they were able to:

- Understand and describe fundamentals and properties of Portland Cement Concrete ingredients.
- Determine properties of fresh and hardened concrete and applications.
- Design economic concrete mix proportion for different exposure conditions and intended purposes.
- Describe and conduct field and laboratory concrete tests.
- Manage concrete construction based on differing structural elements and conditions.
- Understand current technology in concrete construction.
- Describe and utilize formworks for concrete structures.

The last four items are critical components of the concrete professional skills.

Conclusions

This paper reports several practice approaches within a construction program to help students develop professional skills. The approaches are validated by the student learning outcomes. Industry professionals and students benefit each other during the process and it is believed that such a study can provide a vision for engineering management education that can better the students for the industry. These approaches can be applied to many similar engineering management programs.

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