

**Professional Practices in Engineering,
An Introduction for Second Year Civil Engineering Students**

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The Department of Civil and Environmental Engineering at Villanova University recently introduced a new required course, Civil Engineering Fundamentals, in the fall semester of the sophomore year of its civil engineering curriculum. One of the primary objectives in the course is to introduce students to the professional practice of civil engineering. This paper focuses on the professional practices component of the course. In particular, the paper discusses three aspects of professional practice that are embedded in the course: (1) a mentoring program; (2) leadership exercises; and (3) communications skills.

Background

During the 2010-2011 academic year the Department of Civil and Environmental Engineering (CEE) at Villanova University began introducing a new curriculum in the civil engineering program. One of the notable features of the new curriculum is a reduction in the total number of credits required for the BSCE degree. In order to make this reduction the faculty made a conscious effort to prioritize and consolidate material from the previous curriculum. One outgrowth from that consolidation process was the creation of a new fall semester, sophomore-year course titled Civil Engineering Fundamentals. Fundamentals is a 4-credit course that has three 50-minute lectures and one 150-minute laboratory session each week. There are two sections with a limit of 30 students per section. The course includes material that had been previously presented in four courses, two of which are no longer part of the BSCE curriculum. Fundamentals is designed to help the students develop analytical, experimental, interpretive and field-based skills and procedures for use in subsequent courses. Fundamentals is a critical course in the curriculum because it serves as a foundation for most of the technical courses that follow. The faculty in the CEE Department provided input for the selection of material to be included in Fundamentals.

The authors, in collaboration with Frank Hampton, another member of the CEE faculty, used the Body of Knowledge (BoK) approach in developing the Fundamentals course. The BoK approach had been used in previous years to restructure the Engineering Mechanics sequence in the curriculum¹. The authors prepared a list of possible Fundamentals topics that was largely based on the material that had been presented in the four CEE courses that were to be either eliminated or extensively modified. The items on the list were written as learning outcomes and encompassed many areas of study including surveying practice, map reading skills, probability concepts, numerical methods, oral and written communications, laboratory skills and professional practice issues. The CEE faculty reviewed the list and, in some instances, suggested additional items. The final list was circulated to the CEE faculty and each individual was asked to prioritize every item on the list as to whether that item, relative to the new course, was (1) appropriate and important, (2) appropriate, but not essential, or (3) inappropriate. The results of the survey provided much of the rationale for developing the course syllabus.

Professional practice issues constituted one set of items on the list that were deemed appropriate and important by virtually all members of the CEE faculty. The issues included such diverse topics as engineering ethics, career development, group dynamics, leadership issues and communications skills. The authors agreed with their colleagues that sophomores should be exposed to these professional practice issues; the challenge was how to do so in a course that is largely devoted to technical topics.

The Fundamentals course is structured around five group projects: surveying a closed traverse, mapping and gauging a stream, conducting hydraulics experiments in a flume, measuring the properties of civil engineering materials, and the design/construction/testing of a model truss. The professional practices component of the course is integrated into and among the five projects. It includes three activities: (1) a mentoring program; (2) leadership exercises; and (3) communications skills. The three activities are discussed in detail in the subsequent sections of this paper.

Mentoring Program

Each student in Fundamentals has been assigned two individuals who are graduates of Villanova's BSCE program and who have volunteered to serve as mentors. The students contact their mentors via email during the semester to discuss such issues as career paths, group dynamics and engineering ethics. The mentoring program gives the students an opportunity to interact with practicing engineers. It gives them a chance to view the civil engineering profession from a perspective other than those provided by the CEE faculty.

The inspiration for the mentoring program came from a faculty workshop on engineering ethics organized by the College of Engineering in June of 2009. The authors were involved in the planning of the workshop which included an email survey to the College of Engineering alumni. The survey asked the alumni to identify the ethical and professional responsibility challenges that they felt undergraduates should be prepared to address. The results of the survey have been presented in a previous publication². The authors' inspiration came from the fact that almost 100 alumni responded to the survey and many volunteered to participate in class discussions.

In August of 2010, the authors crafted an email soliciting volunteers for the mentoring program and asked Villanova's Alumni Relations Office to send the email to all civil engineering alumni. As of late September, 120 alumni have volunteered. The responses ranged from the Class of 1957 to the Class of 2010. In some respects, the program is almost too successful. There are 48 students in the two fall sections of Civil Engineering Fundamentals. Each student was assigned two mentors, a "recent" graduate and an "experienced" graduate. There were not enough students to accommodate all the volunteers. The first 96 volunteers were used; all the subsequent respondents were profusely thanked and encouraged to volunteer again next year.

The mentoring program will involve the students' contacting their mentors three times during the semester. As of early October, the initial contact has been made, the second mailing is in process and the third will be conducted in late October.

The first contact was designed to be an ice-breaker and to develop a comfort level between the students and their mentors. The students were instructed to ask their mentors four questions:

1. How did you choose engineering as your undergraduate major in college?
2. Do you find that your undergraduate engineering education prepared you well for your professional career?
3. Is your career following a technical or a leadership/management path?
4. As we begin our dialogue, can you offer some initial ideas or thoughts, while I'm still in college, that might help me as I begin my engineering career?

The students had to send copies of their letters to the course instructors, but they did not have to forward their mentors' responses. All the students in the course received a response from at least one mentor.

The second contact involved group dynamics and conflict resolution. The students were instructed to ask two questions:

1. How would you establish a group of individuals to work as a Project Team such that each individual is motivated to do his/her best all of the time?
2. How do you address the issue of *Conflict Resolution* as it applies to *Group Dynamics*?

The students must provide the instructors with copies of both their emails and the mentor's response. As will be noted later, the responses are intended to be an integral part of class discussions in a future meeting.

The third and last contact will occur in late October. This email will focus on engineering ethics and, to a certain extent, will be patterned after questions from January 2009 survey on engineering ethics. Once again, the responses will be used during classroom discussions on engineering ethics.

Leadership

Leadership has become an increasingly important aspect of undergraduate engineering education. The structure of Fundamentals is ideally suited to give the students an introduction to the roles of leader, manager and producer on a team. The course focuses on five group projects which involve teams of five students. The teams are rostered in such a way that every student serves as a team leader and as a team manager on at least one of the five group projects. These projects, in conjunction with classroom discussions, highlight the distinctive responsibilities associated with leaders, managers and producers on teams.

During one of the initial class meetings the students were asked to write down what they felt were the important attributes of a leader. The instructor then discussed the roles of leaders, managers and producers on teams. He pointed out that every student will serve as a leader and as a manager on at least one of the five group projects. The instructors assign the teams and identify both the leader and manager on each project. Students should use these opportunities to assess their interests and capabilities in the various roles.

As of early October, the students have completed one of the projects, surveying a closed traverse. The traverse project provided a special aspect of teamwork. Each five-person team surveyed one course of the traverse and the teams in the laboratory sessions had to share their data so that each team could balance the traverse and submit its own report. The organization and clarity of the field notes were critically important because each team had to interpret notes prepared by other teams. The instructors made it clear that communications among teams should be conducted by the respective leaders. In one instance, a team recognized a mistake in its field notes and the leader notified the other teams about the correction. The students are currently working on their second group project, mapping and gaging a stream. The groups are the same as the first project; however, each group has a different leader and a different manager.

During a future class the students will conduct a peer review of their teammates during the closed traverse project. The students will also rate the performance of the group leader. In particular, the students will receive copies of the sheet on which the team leader listed the attributes of a good leader. The students will be asked to comment on how well the individual performed as a leader according to his/her criteria. By the time the course concludes, every

student will see how well he/she performed as a leader.

Two lectures in the near future will be devoted to group dynamics and conflict resolution. The first session will follow the peer review from the closed traverse project. The classroom discussion will review the roles of the leader, the manager and the producers on a team. The teams will be asked to relate any difficulties they encountered in performing as a group and how they resolved any conflicts, particularly conflicts related to inequitable workloads. The instructors will try to provide some guidance in addressing these types of problems in the remaining group projects within the Fundamentals course. The second lecture period will focus on the responses from the students' mentors. The students will be asked how their mentors deal with conflict resolution in professional practice. The instructors will have access to the emails submitted by the mentors so the instructors can ask specific students to summarize what they learned from their mentors. The copies of responses should be very useful in helping to stimulate the discussions and in highlighting particularly informative comments from mentors.

Communication Skills

As evidenced by accreditation criteria³, the development of oral and written communication skills in an essential component of every undergraduate engineering program. The Fundamentals course addresses communications skills in several ways.

Every student receives a copy of Heather Silyn-Roberts' *Professional Communications*⁴. (Because of the diverse nature of the course, Fundamentals does not have a formal textbook. Rather, students pay a course fee of \$75 which covers the cost of expendables and other items such as *Professional Communications* which are distributed in class.) The Silyn-Roberts' volume serves as a basic reference for all work in Fundamentals. The CEE faculty are encouraged to use *Professional Communications* in all subsequent CEE courses.

Fundamentals involves an extensive use of emails and the instructors consider emails sent by students to either them or to the mentors as part of the students' professional development. The course syllabus addresses this issue:

All correspondence, including emails, should be done in a grammatically correct and professional manner. This means including a formal salutation and a complementary close and not using IM short-hand for words. Any emails that do not conform to these professional requirements will not receive responses.

As indicated earlier, the instructors monitor the emails students send to their mentors and verify that the correspondence is courteous and professional in nature.

Fundamentals includes group presentations to help students improve their oral communication skills. The last full week of the semester is devoted to group presentations. Each student will be part of a team that gives a 20-minute oral presentation on one of the five projects. The instructors will match the teams with one of the five projects in order to ensure some variety in the subjects during these sessions. The students will make the presentation to their peers in the

course as well as invited guests, possibly including mentors. The presentations will be archived and every student must review and critique his/her presentation. A lecture session during the week prior to the presentations will be devoted to providing students with tools and techniques for preparing oral presentations.

Conclusions

The Department of Civil and Environmental Engineering at Villanova University has developed a new sophomore-level course, Civil Engineering Fundamentals, that is designed to help students develop basic skills used in civil engineering practice. One of the skill sets focuses on professional practice. In order to nurture these particular skills the authors instituted a mentoring program, developed leadership exercises and integrated communication skills within the technical confines of the Fundamentals course.

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