

Don't Give Up Good "Teaching Principles" To Teach Ethics

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Abstract

Teaching engineering students professional ethics is a challenge. Most of our students think ethics is common sense and does not need to be taught. Furthermore, the topic is not easy to make interesting. However, principles of good teaching can be applied to any topic, including this one. This paper explores two ways to teach professional ethics; one way is through a mock public meeting, the other is through personal testimony. Both have proven to be interesting to students and effective in revealing the subtleties of compromising situations that arise in engineering practice. The dual goals of exposing students to the ASCE Code of Ethics and applying the Code to an ethical situation are being accomplished based upon assessment results from the RosE-portfolio, the system set up for documenting student learning outcomes.

The two methods we have used to inject enthusiasm and relevance into the topic of professional ethics are proven teaching techniques. One method is the mock public meeting. A student team, working on one of our senior design projects, is instructed to hold a public meeting. Their role is to present their project, which is somewhat controversial, on behalf of their client. Other students are given roles in the meeting such as city or county engineers, state agency representatives, property owners, clients, and representatives of the public, some of which are rather surly. Invariably, the student engineers step over an ethical line when fielding difficult questions. Unbeknownst to the class, this leads into a discussion on the subtleties of professional ethics. The second method involves the personal testimony of a practicing engineer who has faced a career threatening ethical situation. Students love stories, and a true story told by a practicing engineer that involves the vagaries of ethics grabs their attention. It also causes students to reflect on the Code of Ethics in more depth than they generally think is necessary.

Introduction

At Rose-Hulman, we have been exposing our civil engineering students to the American Society of Civil Engineers' (ASCE) Code of Ethics¹ for a number of decades. In the early years, this took the form of a cursory introduction to the code. That is, we let the students know that such a code existed, and they would be bound by this code when they entered professional practice. This exposure was not formalized and ended up the responsibility of whoever taught our senior capstone design class as an add-on. It took the form of a short lecture, and student excitement could hardly be contained!!

In the last decade, there has been a renewed emphasis on teaching the topic of professional ethics. This renewed emphasis is due to three factors:

- the Accreditation Board for Engineering and Technology (ABET) criteria for accrediting engineering programs,²
- Rose-Hulman’s student learning outcomes,³ and
- the new and evolving ASCE Body of Knowledge.⁴

A fourth factor is no less important. Civil engineering faculty members who are registered professional engineers recognize that they have an obligation to teach their students about their professional responsibilities, including the ASCE Code of Ethics.

The ABET 2000 criteria and Rose-Hulman’s student learning outcomes are very closely aligned. The ABET 2000 criteria came out in the late 1990s. Of the 11 required program outcomes that need to be assessed (commonly referred to as a-k), outcome (f) states that engineering graduates should possess “an understanding of professional and ethical responsibility.”² Rose-Hulman’s student learning outcomes³ are a little more explicit and include exposure to and evaluation of professional codes of ethics as one of the 10 focus areas. In addition, the proposed ASCE “Body of Knowledge” (BOK) for the civil engineer of the 21st century has directly adopted the ABET outcome on professional and ethical responsibility.⁴ This came about partly due to the fact that they started with the ABET 2000 criteria as a premise and partly from taking a fresh look at all of the competencies and skills that civil engineers will need to be leaders and innovators in the 21st century.

Ethical Challenges

As previously mentioned, Rose-Hulman’s student learning objectives explicitly include the topic of professional ethics. That is, we require our students to possess “a recognition of ethical and professional responsibilities.”³ The specific learning outcome states, “When given the opportunity, students will:

- demonstrate knowledge of professional codes of ethics and
- evaluate the ethical dimensions of professional engineering, mathematical, and scientific practice.”³

It is written in a general form to accommodate all of our technical majors.

Even though the objectives are relatively straight forward, it is not an easy task to get students engaged in accomplishing them. It may be easier for the reader to understand this challenge by stating the two parts of the ASCE Code of Ethics¹, the “Fundamental Principles” and the “Fundamental Canons.”

*Fundamental Principles*¹

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

1. using their knowledge and skill for the enhancement of human welfare and the environment;
2. being honest and impartial and serving with fidelity the public, their employers and clients;
3. striving to increase the competence and prestige of the engineering profession; and
4. supporting the professional and technical societies of their disciplines.

*Fundamental Canons*¹

1. [Engineers shall](#) hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. [Engineers shall](#) perform services only in areas of their competence.
3. [Engineers shall](#) issue public statements only in an objective and truthful manner.
4. [Engineers shall](#) act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. [Engineers shall](#) build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. [Engineers shall](#) act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession.
7. [Engineers shall](#) continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision

It should be evident to the reader that this is not the most engaging material to introduce to students. As mentioned earlier, we used to do a cursory introduction of the code in the form of a brief lecture in our senior design class. Students objected to this “waste of time” on course evaluations. When they were told that the reason we covered the material was in preparation for their entry into the profession and to help them on the Fundamentals of Engineering (FE) exam, our students responded by suggesting that it was common sense. This was certainly not evident by their scores on the ethics portion of the FE exam.

ASCE recognizes the importance of teaching the Code, but also recognizes the difficulty of teaching it and making it interesting. Recently, ASCE published a teaching aid (flyer) that provides a mechanism for teaching the Code.⁵ It relays the story of a professional engineer who gets into trouble by making seemingly inconsequential decisions in a continuing series of developments in the life of a project. The ethical situation becomes worse and worse, until real trouble develops and a “point of no return” is reached. Breaks in the story appear periodically to ask the reader what they would do if they were the engineer. The story is an excellent example of how ethical situations sneak up on engineers. It is also compelling from the standpoint of generating and holding student interest.

However, this teaching aid appeared only recently. We were struggling with the question of presenting the subtleties of ethics in an interesting format long before ASCE produced their ethics flyer. In this time of need, we developed two teaching tools based on tried and true “teaching principles” that accomplished our goals.

The Mock Public Meeting

In the early 1990s, I decided I had to come up with a better way of teaching the ASCE Code of Ethics. I consulted with the junior author, and she suggested holding a mock public meeting. Since we were working on senior design projects, we decided to use one of the projects as our case study for the meeting. Different groups of students were given different roles. The group who was working on the selected project would take on the role of consulting engineers for the owner-client, yet another role. Other roles included a meeting moderator, state and local government representatives, utility representatives, land owners, and other members of the public.

All groups are given a meeting notice containing general information as to the reason for the meeting. An example of a meeting notice is given below.

PUBLIC MEETING NOTICE THE HULMAN LAKE PROJECT

Hulman Lake Dam has been designated a "high hazard" dam by the Indiana Department of Natural Resources (IDNR). The hazard classification is not applied because the dam is currently unsafe (i.e., in danger of failing). However, if the design storm were to occur, the dam would overtop. If earth dams are overtopped for any extended time, there is always the danger of failure. If it were to fail, significant property damage could result with the possibility of loss of life. The design storm has been designated by the IDNR as the probable maximum flood (PMF).

Dam Engineers, Inc. has been retained by Hulman and Company to study the dam and make recommendations to remove the "high-hazard" classification. They have reviewed the preliminary study and analyzed the hydrology of the watershed. Currently, they are looking into alternative solutions. A preliminary analysis has shown that the construction of an emergency spillway, the most desirable alternative, is infeasible because of land requirements. Other options are still being investigated. One option is to ask the IDNR to reduce the design flood to one-half the PMF, which might make the emergency spillway option feasible. Word of this has leaked to the press and subsequently to the residents of Robinwood Subdivision (just downstream of the dam), and the city and county engineers' offices.

A public meeting has been scheduled to discuss the issue. Representatives from the IDNR, Hulman and Company, Dam Engineers, Inc., the city and county engineers' offices, and residents of Robinwood will all be in attendance. The meeting will be held February 17, 2001, at Rose-Hulman Institute of Technology (Room O-229). Be there!

Now the stage has been set, and it is easy to understand the controversy surrounding this meeting. To add realism and more controversy, each group of students is given a separate position paper with information that is germane to their role and interests. After all, in real public meetings, no one knows all of the facts, and each individual or group are looking out for their own interests. Two examples of position papers are given below.

POSITION PAPER - DAM ENGINEERS, INC.

Your study of Hulman Lake Dam has presented you with a dilemma. You would like to recommend building a grass-lined emergency spillway around the south end of the dam. This is a typical, cost-effective means to prevent an earth dam from overtopping. However, construction of an emergency spillway is not feasible in this case. There is not enough room for a spillway that would convey the probable maximum flood. Armoring a segment of the dam to protect against overflow is very expensive. What can you do? As a young company, you would like to make a good impression on your client (Hulman and Company) and obtain future work.

What are your options? You could inform your client of the problem. But didn't they hire you to solve this problem? How about going to the IDNR and getting the spillway design flood reduced to one-half the probable maximum flood (PMF)? (But what effect would this have on the people in the Robinwood subdivision?) Preliminary calculations do show that the PMF produces the same downstream flood levels for two hypothetical scenarios; an adequate emergency spillway in place at the dam or no dam at all on the stream! Now a public meeting has been called. What is the best course of action and how should you prepare for it?

POSITION PAPER - CITY/COUNTY ENGINEERS

Complaints of flooding by Robinwood residents are nothing new. They have been appealing to the City of Terre Haute for years to keep debris off downstream railroad bridge pilings. The bridges are in the city limits and back water up into their subdivision when the waterway openings are partially blocked. Equally distressing is upstream development (in the county). With more development taking place in the watershed, they seem to get flooded more and more often.

The engineering staffs have been trying to address these needs. The city engineer is attempting to keep the debris removed from the railroad pilings. The county engineer is trying to implement voluntary stormwater management practices upstream. Without a law however, he has to rely on the good will of the developers. Both engineers understand the residents' concern with the upstream dam. Both also understand the power of the Hulman family in local politics. (They are both appointed positions!)

Other position papers were given to student groups taking on the other roles: Hulman and Company (dam owners), the IDNR who have control over regulations, and citizens from Robinwood subdivision. They are also given facts pertinent to their situation, interests, and responsibilities. Each group is given a few days to discuss their position paper and their approach to the meeting. Suggestions are written into the citizen position paper (or relayed to the group orally) as to questions that could be asked and arguments that could be made to the various constituencies. I always inform the citizens that they are not engineers and do not have to make reasonable arguments. Many of my suggestions come from the public meetings I have attended in the past. Students are always eager to take on the role of a private citizen.

The moderator opens the public meeting by giving each constituency a few minutes to make a position statement. This is often an amplification of their position papers and their group

discussions. Then the meeting is opened up to questions from the floor by the citizens to any of the other constituencies. Many good questions are raised and valid arguments are presented. Once students warm to the situation, humor is sure to follow when ridiculous questions are asked.

Students are never aware that this mock public meeting will lead into a discussion on professional ethics. It is couched as a learning experience about solving problems in public forums. However, the engineers in the various constituencies are almost always backed into a corner and make statements that compromise the code of ethics.

After the public meeting, I lead a discussion on the topic of professional ethics by asking the following questions:

- Was the meeting realistic (they are not aware of how realistic it is)?
- Do you think the engineers handled the questions well?
- Did the engineer's face any ethical concerns?

Invariably, the class fails to see any link to ethics in the public meeting.

I then break the class up into groups of three or four and assign one the engineering constituencies to each. Again I ask them if any ethical issues were involved for that constituency. After a few minutes, a class discussion reveals some minor possibilities of ethical concerns. Then I hand out the ASCE Code of Ethics,¹ have them review it in groups, and ask the same question. The class discussion that follows produces a lively debate about the ethical lapses of most of the engineering constituencies. This is followed with a summary of the code of ethics and a framework for ethical decision making.⁶ Then the students are asked to write a two-page essay on the ethical situation faced by the consulting engineers before and during the mock public meeting, the fundamental principles and canons that apply to the situation, and the appropriate action(s) that should be taken by the consulting engineers. These essays are then submitted to the Rose E-Portfolio system for documenting student learning outcomes.

Personal Testimony

Another successful technique that I have used to introduce my students to the topic of professional ethics is personal testimony. The success of this technique is probably related to the degree of drama in the story and whether the engineer affected can tell the story personally. In this respect, I was lucky.

A relatively recent Rose graduate (1995) named Patrick Goodwin was the city engineer for Terre Haute, Indiana. The city is dominated by one political party and the city engineering position is appointed by the mayor. In 2001, Patrick had an opening for an inspector position. He was told to advertise the position, conduct interviews, narrow the field, and hire the mayor's son. However, very few people knew of the hiring process until two years later.

In early 2003, the local paper published an article about the mayor's son doing subcontract work for city, certainly a conflict of interest and possibly a class-D felony. Once this story broke, the local reporters dug deeper into how the mayor's son was hired in the first place. Patrick answered honestly, revealing how he was instructed to hire the mayor's son, subtly by the mayor and directly by the mayor's chief of staff. The mayor's response was "Goodwin is young; he

doesn't know any of the political ramifications. I've been trying to make him political for three years.”⁷

This brouhaha continued in the editorial pages for weeks and eventually spilled into the primary season. After the mayor was defeated in the primary, Patrick was summarily dismissed from his position with less than six months left in the administration. Fortunately, Patrick picked up a facilities engineering position for a half year and was appointed by the new mayor to the position of city engineer.

The story turned out to be a wonderful vehicle for teaching professional ethics. I divided the class into groups of three or four students and asked them how they would handle the following two situations:

- You are the City Engineer of Terre Haute. A low level position in one of your satellite offices needs to be filled, and you have advertised for the position. A total of 18 applications come in. The mayor (your boss – your position is appointed by the mayor) calls and asks you to consider her son for the position. In addition, the mayor's chief of staff calls and makes the same request.
- You are still the City Engineer of Terre Haute. You contract out millions of dollars of engineering design and construction work each year. You recently heard that an inspector in one of your offices subcontracted to do some concrete work on a city contract. (The inspector runs a side business as a contractor.) The work involved 50 feet of sidewalk replacement.

This is followed by a class discussion with each group reporting their ideas. Then I hand out the ASCE Code of Ethics, have them review it in groups, and ask the same question. The class discussion that follows produces a lively debate about what is and is not in violation of the ASCE Code. Then I pass out the newspaper articles that relate how the case played out in the public eye. Patrick Goodwin was brought in at this time and an interesting dialog ensued as the students asked questions and probed the issues. This is followed with a summary of the framework for ethical decision making.⁶ Again, the students were asked to write a two-page essay to briefly summarize the issues faced by the Terre Haute City Engineer, evaluate the ethical dimensions of the situation and the actions they would take if they were the City Engineer, and justify their decisions based on knowledge of the ASCE Code of Ethics.

E-Portfolio Assessment Results

The RoseE-Portfolio is a computerized portfolio system for Rose-Hulman students to archive samples of their best college work. It is also an assessment tool used by Rose-Hulman to measure our success in meeting student learning outcomes. It represents the culmination of over five years of work by the Commission on the Assessment of Student Outcomes (CASO) and our Technical Services Center. CASO is made up of faculty, students, and staff members who worked in teams to develop, institute, and modify the on-line portfolio system.

Our first institute-wide round of assessments was completed last summer. For the purposes of this paper, I want to report on the specific learning outcomes on the topic of professional ethics. As previously mentioned, the specific learning outcome states, “When given the opportunity, students will:

- demonstrate knowledge of professional codes of ethics and

- evaluate the ethical dimensions of professional engineering, mathematical, and scientific practice.”³

Submittals from the ethics essay on the Pat Goodwin case study (personal testimony) were used by the students to try to meet these learning outcomes.

The assessment process relies upon faculty raters from across the institute. A modest amount of training is completed, inter-rater reliability exercises are performed, and the raters then judged whether students meet the objective or not. In this case, 85% of our students achieved success on the first learning outcome, and 85% on the second. In a related assessment check, our students achieved an 83% success rate on the ethics portion of the 2003 Fundamentals of Engineering (FE) exam as compared to a 75% success rate for test takers nationally. That was the year I used the personal testimony technique to expose our students to the topic of ethics. The previous year, when I used the mock public meeting, our student achieved a 71% success rate on the ethic portion of the FE exam as compared to a 66% success rate nationally.

Conclusions

There are many good reasons for teaching civil engineering students the ASCE Code of Ethics. Teaching the Code is necessary for institutions to achieve ABET accreditation and meet their own student learning outcomes. However, more noble reasons include helping students recognize their professional responsibilities and giving them the knowledge base they will need for successful careers. The challenge is to teach the Code in a manner that will achieve the greatest impact in student learning.

Two techniques that have proven successful in teaching the ASCE Code of Ethics are mock public meetings and personal testimony. Mock public meetings can be set up within the senior capstone design class using one of the student projects as a case study. With very little effort, you can engage the students in a lively meeting that invariably leads to ethical lapses by the engineering role players. Interest in the Code and the application of it follow naturally from this exercise. The second successful technique is through personal testimony. It does not take very long to track down engineers who have had brushes with the Code of Ethics, and they are often very willing to share their stories with students. Once again, it is more effective if the story can be woven into some kind of active learning exercise. Both techniques have proven successful using independent assessment results.

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