A Back to the Basics Approach to Teaching Engineering Ethics

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Abstract – One of the essential characteristics of a profession is a set of rules generally defining the conduct of its practitioners in carrying out their special duties. This is true of the practice of law and medicine as well as engineering. Nowadays, most engineering curricula include the teaching of some form of ethics either as a separate course or often as part of the capstone experience. Driven by the spate of financial as well as engineering ethical failures of recent years, there is a pervasive sense among the public that ethics, if not ethical standards, are not what they once were. Given this climate and the notion that education, rightly so, conforms to the perceived needs of society, it is likely that ethics would have found its way into engineering curricula with or without the prompting of ABET [1].

Since it is universally agreed that the teaching of ethics is such a good thing, then regrettably, some have concluded it is so important it should be taught, not by engineers, but by professional ethicists who may be distrustful of technology and the engineers who create it. In this milieu, a lecture on engineering ethics can yield the subliminal and somewhat adversarial message of “what you (the engineers) ought to do to protect us (the non-engineers of society) from you and your technology”. More useful would be to introduce the students to a well defined and articulated set of rules of engineering ethics such as the Canons of Professional Engineering. More often, these are bypassed for the more intellectually stimulating but highly ambiguous case studies, most of which are better suited to a debating society than an introduction to engineering ethics. This paper will discuss the pitfalls of this disturbing trend in engineering education and why we need to stay focused on the basics.

Keywords: Engineering Ethics, Canons of Professional Engineering, Capstone

INTRODUCTION

Engineering is one of the traditional professions that also include law, medicine and the clergy among several others. Although what constitutes a profession depends on who you ask, a true profession is generally acknowledged to have the following criteria [2]:

- has extensive tertiary training and/or education
- practices an art that requires significant intellectual development
- provides an important service to the public
- is certified or licensed by the state
- has an organization that practices self-regulation and controls entrance to the field
- receives power from the state in return for a commitment to the public good
- belongs to an organization that subscribes to a code of ethics

Perhaps the last criterion in the above list—its members subscribe to an established code of ethics—is the most important. In the case of engineering, the code is likely to be the Fundamental Canons of Professional Engineering [3] or one of its many derivatives published, for example, by the various engineering societies [4] [5]. The chief reason

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Given for professional ethics of all types is the special relationship professions have with society. By definition, professionals have special knowledge or skills. These skills may be used for the good of society or unfortunately misused with disastrous results. In return for society’s trust awarded to professionals, society requires as terms of license (here meant in the broad sense) that these professionals promise to subscribe to an ethical code and practice surety and benevolence in their duties. Expanding on this notion, a number of writers, including Martin and Schinzinger [6], have discussed professional ethics in terms of the duty owed to society by the professional. This “duty ethic” derives from the notion that certain individuals are granted extraordinary power which makes them subject to extraordinary restrictions on that power. A good application of duty ethics is the power given to physicians to prescribe powerful medicines in return for which they are held to high standards of accountability.

Additionally, professional practitioners, even in their routine duties, are often compelled to make decisions where several moral values (embodied in their various codes) come into conflict. Many writers of ethics and philosophy, including Adler [7], have discussed how conflicting ethics and their attendant moral dilemmas inevitably arise where moral codes are being applied to human situations. In the practice of engineering, as in the rest of life, the best course of action may not be clear-cut and satisfying but taken from among many competing courses, ultimately yielding the less onerous alternative.

**ENGINEERING ETHICS IN THE CLASSROOM**

Few would disagree that teaching engineering ethics to undergraduates is a good thing. Besides the requirements of ABET Criterion 3(f), most engineering undergraduates are normally exposed to one or more ethics courses in addition to the specific engineering ethics that may be compounded into their capstone design experience. All too often, courses in environmental ethics, social ethics, research ethics or even medical ethics are used to fulfill the requirement for engineering ethics. Certainly the material contained in each of these courses is worthy and useful, but if it does not treat the codes and unique situations found in the practice of engineering, then it is not and should not be substituted and counted for engineering ethics. Further, as is often the case, the instructors in these ethics courses are not engineers or even scientists and, in fact, may possess a distinct anti-technology bias; viewing engineers and engineering as the problem instead of the solution. I doubt there are any medical schools that would allow engineering ethics to substitute for medical ethics. The basic question, then, is what kind of engineering ethics do we teach and how do we teach it?

It seems that the most logical and straightforward way to teach engineering ethics is to base it on the moral authority of some widely accepted code, e. g., the Canons of Professional Engineering or some variation. Codes like these are declarations simply stating what is and is not ethically acceptable as determined by experience and the overall dictates of society. Although they may be subject to different interpretations and occasional conflict of individual parts when applied to complex situations, for the most part, an individual interested in learning the ethics of a certain action should have little difficulty. Of course, knowing right from wrong will never guarantee an individual will choose the right path, but at least being familiar with a code of ethics places the person in a much better position than ignorance.

There is another reason for teaching engineering students engineering ethics based on an engineering code of ethics. It is quite simply that the questions on the Fundamentals of Engineering exam are derived from the Canons of Professional Engineering. One of the most widely used F.E. review books [8] explicitly references the Canon for answers to questions. Undoubtedly, without a working knowledge of the Canon, a student would stand a much smaller chance of getting the correct answer to ethics questions found on the F. E. test. Further, a course in environmental, medical or even research ethics will probably not prepare an engineering student to do well on the ethics part of the F.E.

Lastly, there is an even more compelling reason for an engineer to have a good working knowledge of engineering ethics. Knowledge of engineering ethics is ultimately as essential to the professional success of a practicing engineer as statics, dynamics, fluids or heat transfer. Again, knowledge of right and wrong is no guarantee that one will take the right path, but for sure, ignorance of the rules is never an accepted excuse for bad behavior.
REACTION FROM OUTSIDE ENGINEERING

On the other hand, there is a reaction to this approach from some outside of engineering. In some ways, contemporary society is loath to express strong moral opinions concerning the actions of individuals. Although individuals are the agents and effectors of moral judgment, few of us feel really comfortable indicting individuals for moral failings. Rather, we greatly prefer to direct our indignation toward the offending institution, be it a company, an association or a government. It is usually clear from a close examination of most engineering disasters that an individual person is ultimately responsible; we just somehow never get around to explicitly saying it. Unfortunately, this attitude spills over into the classroom in how we present case studies of disasters.

For example, the collapse of the Kansas City Hyatt walkway in July, 1981 was ultimately attributed to the failure of an individual engineer to adequately review fundamental design changes to the walkway supports. This fact is well known to anyone familiar with the case, but since the references I used for a lecture to my senior design students did not mention the individual, I had not either. This omission was made clear to me when after the lecture, several students wanted to know “what happened to the guy who goofed”? The thought occurred to me that their question was justified by thoughts of real personal consequences for an engineer responsible for a real ethical failure.

In some otherwise excellent engineering schools in recent years, there have been attempts to take over the teaching of ethics to undergraduates by professional “ ethicists” most likely to be non-engineers. This is done for a variety of reasons including relieving engineering faculty to concentrate on core subjects and to give students another required humanities course. Unfortunately, engineering students taking an ethics course (designed to introduce them to “ engineering” ethics) may find themselves in class with students engaged in a variety of non-engineering majors. To accommodate this broad range of student interest, the ethics taught in such a course may inevitably be of a generic type that falls far from addressing the unique requirements and situations common in the practice of engineering. More often, these are bypassed for the more intellectually stimulating but highly ambiguous case studies, most of which are better suited to a debating society than an introduction to engineering ethics.

An even more fundamental and serious problem arises when we do not expose students specifically to engineering ethics. It is one of definitions. Even an engineer fresh out of school may be put in a position of specifying equipment and services costing many thousands or even millions of dollars. Drawn into the corrupting influence of big sums of money we are all heir to, the young engineer must know what constitutes a conflict of interest, the difference between a bribe and a business gift and what is a kickback. Putting a naïve young engineer in such a position will attract trouble like blood attracts sharks.

SOME CLASSROOM EXPERIENCES

In the Department of Biological and Agricultural Engineering at North Carolina State University, all students are required to take two capstone engineering courses, one in the fall (BAE 451) and one in the spring (BAE 452) of their senior year. Most of the students will arrive in the fall having already taken a course in either environmental ethics or engineering ethics. In addition to satisfying part of their humanities requirements, these courses also help satisfy the requirements of ABET Criterion 3(f). Over the last few years, when I would lecture on the Kansas City Hyatt, Three Mile Island or Bhopal, I would discover the students were very familiar with the facts of the case but were essentially ignorant about its moral implications. If they did associate the disaster to a failure of moral responsibility, it was almost always the failure of some organization (likely government or corporate) to take proper responsibility and provide restitution after the fact.

Somehow, in their previous exposure to the cases, it was never emphasized that the cause of the disaster in the first place was the failure of one or two individuals to properly execute their responsibilities as engineers. When quizzed as to what the engineer’s proper role was in preventing a disaster – large or small, most students could only respond “do the right thing”. Not only were they hard put to explain in concrete terms what the “right thing” was, they were also unable to give any moral authority to back up their notion of right and wrong. Why students (and some educators) find it so difficult to base their feelings of right and wrong on some external authority I will leave to others. However, if a person is going to assume the role of engineer, that person is going to be held responsible by society to some code of professional conduct – most likely the Canons of Professional Engineering. When a disaster
happens and an engineer is asked to explain why they neglected their duty, neither an ignorance of the canons or a
disavowing of them will provide them cover.

For this reason, the first assignment I give in my two semester course sequence is the memorization of the Canons of
Professional Engineering. My students know they are liable to see it on any test and multiple times during the two
semesters. We discuss what constitutes a bribe, a kickback, influence peddling, a business gift and how to practice
due diligence with a client or employer. They know that they will not receive a pass from me until I am satisfied
they know what society expects from them. Knowing what is right will not guarantee good conduct, but it is much
better than ignorance.

At first, I hesitated to assign the memorization out of concerns for criticisms that I was employing an outdated
pedagogy. However, I soon realized that not only did the students not mind, they actually learned the material in a
way they could recall and apply to many different situations in class, and presumably, later in their careers. It has
been rewarding to overhear students explain that they were able to apply the canons not only to my test questions
but also to questions on their F.E. exams.

CONCLUSIONS

Efforts to increase the exposure of undergraduate engineering students to ethics is a good thing. The
interdependence of modern society yields a never-ending parade of opportunities for wrongdoing. Certainly,
knowledge of right and wrong will never guarantee an individual will choose to do right, but sending forth new
engineers ignorant and thus unarmed concerning the ethics unique to engineering is both wrong and dangerous for
society. As educators, we have a responsibility to prepare our students for the world as it is, and not the way we wish
it was.

REFERENCES

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