

## **AC 2009-970: A PRELIMINARY SURVEY OF ENGINEERING ETHICS COURSES NATIONWIDE**

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# A Preliminary Survey of Engineering Ethics Courses Nationwide

## Introduction

It is not enough that engineering students leave campus and head into a job with only the ability to perform calculations. We live in a world where engineers must not just think about design, but also about the implications of those designs, or how they impact people and the environment. Engineering ethics carries momentous importance. How many undergraduate engineering programs require a full course in engineering ethics? What kinds of topics and case studies do students in these courses examine? What specifically do students learn in these engineering ethics courses? How do programs assess students' awareness of ethical issues and judgment? What kinds of changes may be necessary to improve engineering ethics education? This article presents the findings of a preliminary survey of engineering ethics courses at several campuses.

## The Survey

A survey on engineering ethics was sent to various colleges and universities with engineering programs. The authors teach in civil engineering departments, so consequently most of the initial contacts were also civil engineering faculty who are friends or acquaintances of the authors. The initial contacts were asked to complete the survey or, if they thought they were unable, to pass the survey to a colleague who could respond to the questions more knowledgeably. In all, 16 people from 10 institutions in 9 states provided responses to the surveys. The respondents included all academic ranks, deans to assistant professors.

Several references about engineering ethics education were useful in the development of the survey.<sup>1,2,3,4,5</sup> With this survey, the authors hoped to capture a sense of engineering ethics education in terms of courses, content, assessment, and future plans. The following questions appeared on the survey:

- Do you feel an ethics course taught specifically to engineering students is necessary, or can ethics best be taught to engineering students as a general education requirement or learned on the job?
- Do any of your engineering departments have a full course in ethics?
- Excluding any full courses in ethics, how many additional engineering courses address ethics in some way? What are these courses? How much time is spent on ethics in these courses?
- How do you teach students about engineering ethics? What kinds of topics and case studies do students in these courses examine?
- How do you assess students' awareness of engineering ethical issues? How do you assess students' judgment?
- Do you think your program should improve engineering ethics education? To accomplish this, what changes may be necessary?

The authors found the respondents to be very expressive on the surveys, which suggests that ethics education is an issue of concern at many engineering programs. The data collected with this survey was strictly qualitative. What follows are excerpts from the responses to the surveys. An attempt was made to arrange the excerpts in a coherent sequence. To avoid being overly repetitive, not all responses are shown, as some respondents gave equivalent replies. The authors' main goal was to assemble a variety of viewpoints, and not specifically to build a consensus. Small changes were made to some of the excerpts without altering the respondents' content.

### **Where Ethics Should Be Taught and Learned**

Most of the respondents said ethics should be taught to engineering students by engineering departments.

It is essential to teach a course aimed specifically at engineering students. Most universities have more general courses on ethics taught in philosophy or religious studies departments, or business ethics courses. Although these courses have many constructive aspects, they do not discuss topics and issues relevant to engineering practice. The fact that many states require professional engineers (PE) to have professional development hours (PDH) in engineering ethics indicates how deeply ethics is connected to engineering work.

I would like to see an ethics course that is directed specifically to engineering students. Some ethics questions are general, but there are many ethics questions that are specific to engineering, or to a specific engineering discipline. It is my sense that there are many subtle ethical issues that students do not even realize are ethical issues until they discuss them with others and find out that not everyone thinks the same way.

Since the spectrum of issues that could be considered under the heading of engineering ethics runs the gamut from the totally obvious to the extremely subtle, I feel this topic must be covered to some degree in the engineering curriculum.

While it is possible for students to learn some ethical principles through general education or on the job, a dedicated course provides a better opportunity to cover the topic in a more comprehensive way. Additionally, a dedicated course makes it easier to demonstrate to accreditation boards that ethics is being covered in the curriculum.

With regard to on the job training, of course many engineers will learn about ethical issues through what happens at work. But it is important to give engineers some theoretical structure, and warn them about potential situations they may encounter on the job.

Some of the respondents said ethics courses carry a new importance due to the troubles they see in modern society.

In previous decades, individuals learned ethics from a strong community background which could have included family, church, sports teams, clubs like boy scouts and girl scouts, and entertainment like *The Andy Griffith Show*. Today's youth, however, are beset by a vastly different popular culture where the "do it if it feels good" mantra has become mainstream. We now regularly see dishonorable practices in sports and politics. In business, we have many recent examples where people who have not followed the rules have still succeeded financially. Humility is out, and boldness is in.

In the past, we might have said "engineering ethics" is a redundant term. However, with the collapse of values I see around us, I now believe some instruction in engineering ethics is needed in the engineering education.

While they would like to see ethics taught to engineering students by engineering departments, several respondents expressed doubts about the ability of instructors to teach ethics.

Ethics is a subject area only as good as those who teach it. Most engineering professors lack the expertise necessary to present the material. I would support an engineering ethics course if competent instructors can be found.

We would like to start an engineering ethics course, but we need to find faculty who have the interest and the experience to teach it.

Finally, one respondent thought ethics education to be an exercise in futility.

Students' sense of ethics comes from their family and upbringing more than what can be taught at a university. At this point in life, it may be impossible to teach students how to act ethically.

### **Full Ethics Courses**

Only a few respondents said they have a full course in engineering ethics, and many of these seem to exist precariously within a crowded curriculum.

Two engineering departments share a common, required course in engineering ethics that counts as one credit. The other engineering departments previously put students through the same course, but with a recent change in curriculum, they now incorporate ethics throughout the design course sequence.

At one time, three departments required a one credit course on ethics, but now only the civil engineering department does. Most departments now try to incorporate ethics into the design courses, or try to sprinkle it elsewhere in the curriculum.

Currently, we do not offer a full course in ethics within our engineering curriculum.

The harsh reality is with the number of hours we currently have in our curriculum trying to squeeze in a standalone ethics course would be problematic.

Sometimes engineering students can find engineering ethics courses offered elsewhere on campus.

A special engineering ethics course is taught through the philosophy department, which engineering students are encouraged to take to fulfill a general education requirement.

About 10 years ago, the philosophy department taught a course called Engineering Ethics and many of our students took this course as one of their general education requirements. However, the faculty member who taught the course retired and the course simply disappeared.

Not all respondents thought a full course in engineering ethics is necessary.

I don't know if a full course is necessary, but I do think all students should be involved in some discussions on ethics.

### **Additional Courses Where Ethics Appears**

Though few respondents said they have a full engineering ethics course, ethics still turns up in a handful of engineering courses.

Students take a course called Professional Practice Issues where about five hours of class time is spent on ethics.

One lecture is dedicated to ethics in the Introduction to Civil Engineering course and ethics is incorporated into the capstone course.

Some ethical issues are introduced in the capstone course primarily through the use of external guest speakers.

We teach a component or module of ethics in the capstone course.

In the capstone course, perhaps one to two classes are spent on ethics. Ethics is also covered in the Fundamental of Engineering (FE) review course.

Students see engineering ethics at both the start and end of the undergraduate program. We have an ethics module in the Introduction to Engineering course,

where instructors allot about three hours of class time, and we weave ethics into the capstone course. In between, students are required to take at least three courses offered by the religious studies department.

I will discuss ethics in various courses by providing examples of situations in which ethics is a frequent concern.

We have five courses in the curriculum that have distinct ethics modules.

A few of my colleagues post ethical situations on BlackBoard and ask students to comment. I understand the online discussions can become quiet lengthy.

Many respondents said the amount of time spent on ethics in these courses varies.

The faculty is encouraged to spend some time on professionalism and ethics in every civil engineering course. Some do, but some do not.

The extent to which ethics is taught in courses that I do not teach, I am not sure.

Most of the departments that do not have a standalone course cover ethics in the design courses, with maybe a little taught in the introduction courses. How much time is spent on ethics depends on who is teaching the course; the faculty has a great deal of freedom in designing their own syllabus, even for required or core courses in the curriculum.

I have many vignettes where I communicate ethical ideals. I suppose my colleagues do the same, but I am not sure of this. I also hope to convey ethics by demonstration, in how I conduct my work and my life.

Ethics education should have more emphasis in many courses. Brief discussions are all that is necessary to capture the students' imagination.

## **Topics and Case Studies**

A variety of techniques are employed to teach ethics.

In the standalone ethics course, the format is 50% lecture on basic topics such as professionalism, ethical theory, safety, and the environment, and 50% of the class time is spent on group discussions of case studies. In other courses where engineering ethics appears, the delivery method varies according to the interests and skills of the instructors. It may be lectures and discussions, or reading and writing assignments.

In the FE review course, the instructor goes over questions from the review book. In the capstone course, it varies; sometimes a practicing engineer is brought in to discuss ethics.

Most engineering professional societies have developed codes of ethics, and the one offered by the National Society of Professional Engineers (NSPE) is thought to be especially applicable in courses.<sup>6</sup>

The NSPE Code of Ethics is broad enough to be useful to students in all disciplines of engineering.

Several of the respondents said they use the materials found at the National Institute for Engineering Ethics (NIEE) at Texas Tech University.<sup>7</sup>

Ethics videos with follow up discussions are the main teaching methods. There are several good ethics videos available from NIEE that noticeably improve students' understanding. The NIEE offers guidelines to instructors as well.

Students review and report on the case studies found at the NIEE.

The content is delivered with the help of a range of case studies. The case studies may vary from year to year.

Extensive use is made of case studies, mostly real cases but with a few hypothetical ones too.

Students in some engineering courses examined the following historical cases in depth.

- Space shuttle Challenger
- Kansas City Hyatt Regency Hotel
- Union Carbide Plant in Bhopal, India
- Citicorp Building in Manhattan
- Ford Pinto and vehicles with safety hazards

The following contemporary case studies were found to elicit lively debate.

- New roadways through old neighborhoods
- Reconstruction of New Orleans
- Development and water supply in arid regions
- Dams
- Bottled water
- SUVs and vehicles with poor fuel efficiency
- Private vehicles or mass transportation
- Weapons of mass destruction
- Surveillance

- Sending engineering work out of the country
- Video games with violence and gratuitous sexual content
- Conflicts of interest and corruption in the job award process
- Chemical fertilizers and pesticides
- Mobile phones and health and safety issues
- Disposal of hazardous wastes
- Power generation
- Nanotubes in cosmetics and sunscreens

## **Assessment**

Respondents had several ways to assess students' understanding of ethics, but many said assessment of students' judgment would have to wait.

Students are assigned an essay on engineering ethics. They are asked to choose an important case or issue. It may be historical or contemporary, and it must involve some aspect of engineering but may also fall within the realms of politics, economics, and law. To learn more about the topic, students must consult with at least 10 references. References commonly include books, journals, magazines, newspapers, or authentic online sources. Students must present multiple arguments. What are the various courses of action and the consequences of each? They must support the best argument with specific clauses from the NSPE Code of Ethics.

Surveys can be used before and after instruction to see changes. Students' judgment is a function of exposure to good practices.

The students respond to a case study with a summary, which is reviewed by the instructor for clarity and judgment.

Assessment of students' awareness of ethical issues is done through discussions at various points throughout the course.

I do not test my students on ethics; I only discuss ethical issues in the lectures.

Discussion sessions provide some insight into students' awareness of ethical issues. However, I am not sure I can properly assess the students' judgment, especially how they would respond to a real ethical dilemma.

Assessment varies but is usually based on writing assignments. I do not know how to assess judgment.

Several respondents said they made no effort to assess student's understanding of ethics.



## **Suggested Improvements to Ethics Courses**

Many respondents feel ethics education is sufficient. Others said they would like to improve, but they see impediments.

Students are not too enthusiastic about having to take a course in engineering ethics. Faculty must work hard to make the course both informative and interesting.

We probably should start an engineering ethics course, but it is hard to add any courses or lectures to an already crowded curriculum. To accomplish this, what courses do we cancel or modify? The biggest obstacle would be to convince the faculty that ethics is important.

As with any topic covered in our curriculum, we are always looking to improve how the content is delivered and received. I ask this question to the seniors in exit interviews, but to date I cannot identify any reasonable suggestions on what improvements should be made.

A few respondents had questions about where to find ethical case studies to match the courses.

We should put much more emphasis on ethics in the engineering curriculum. Where can I find references that provide ethical issues specific to each of the subjects we teach?

One respondent suggested ethics could be team taught by faculty from two departments.

One idea is to pair faculty from engineering and philosophy departments to share the load and, perhaps, present a unique perspective.

## **Summary and Conclusions**

A survey on engineering ethics was sent to 10 institutions with engineering programs. With this survey, the authors hoped to capture a sense of engineering ethics education in terms of courses, content, assessment, and future plans. The data collected with this survey was strictly qualitative. The authors' main goal was to assemble a variety of viewpoints, and not specifically to build a consensus.

The authors found the respondents to be very expressive on the surveys, which suggests that ethics education is an issue of concern at many engineering programs.

No one will deny the importance of ethics in the field of engineering, and most respondents said ethics should be taught to engineering students through engineering departments. But this survey revealed differences and uncertainties about where ethics is taught and how much time students spend on ethics in these courses. Most engineering programs do not have a full course in ethics but choose to sprinkle ethics into various courses, usually the capstone course and sometimes an

introduction course as well. Students in most programs study the NSPE Code of Ethics and apply it to historical cases, while some students tackle contemporary issues. Assessment of students' knowledge of ethics is typically through discussions and essay assignments. While most respondents declared the need to improve ethics education, they recognized as hurdles a crowded curriculum and lack of qualified teachers.

## Bibliography

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<sup>6</sup> [www.nspe.org/ethics](http://www.nspe.org/ethics)

<sup>7</sup> [www.niee.org/murdoughcenter](http://www.niee.org/murdoughcenter)