ETHICS IN ENGINEERING AND TECHNOLOGY: WHAT TO TEACH AND WHY

MICHAEL DAVIS

Center for the Study of Ethics in the Professions, Illinois Institute of Technology, Chicago, IL 60616-3793

ABSTRACT—While the Illinois Institute of Technology has been experimenting for 4 years now with integrating professional ethics into technical courses in all fields, this paper will focus on what has been accomplished in engineering. Because professional ethics consist of special standards of conduct, they must (and can) be taught like other professional knowledge and, indeed, form a natural part of such teaching. There is no need to make major changes in technical courses to integrate ethics; many small changes are enough (e.g., re-writing of standard problems). Both students and faculty at the Illinois Institute of Technology have been very pleased with the results.

This paper has four parts. First, I explain what I take "teaching ethics" to be in engineering and technology. Secondly, I say what I think teaching ethics can accomplish generally. Thirdly, I focus on specific courses where it is commonly thought that little or no ethics can be taught. I suggest ways that professors can teach a lot more ethics than commonly supposed even in those courses (without slighting anything else). Finally, I give several reasons why professors of engineering and technology should teach as much ethics as they can. Some of these reasons are quite practical. While I shall focus on engineering throughout, because that is where I have the most experience, I believe almost everything I say can be adapted to technology (and science) education without difficulty.

WHAT IS ENGINEERING ETHICS?

I must begin with an obvious but important distinction, that between morality and ethics. "Morality," as I shall use that term, refers to those standards of conduct everyone (every rational person) wants every other to follow even if everyone else following them would mean he had to do the same. Morality is the same for everyone. We were all quite young when we learned such basic moral rules as do not lie, do not kill, do not cheat, keep your promises, do not steal, and so on. We were still quite young when we learned that these rules have exceptions (e.g., "except in self-defense" for "do not kill"). Now and then, we may change our view on how to interpret a particular rule or exception. For example, we may come to think that it is possible to lie with the truth. However, since we entered our teens, such changes have been few and relatively marginal. Our students are much like us. They arrive in class more or less morally mature. We have little to teach them about ordinary morality.

This is not the case with ethics. "Ethics," as I shall use that term, refers to those special morally permissible standards of conduct every member of a group wants every other member of that group to follow even if that would mean having to do the same. Ethics applies to members of a group simply because they are members of that group. Medical ethics applies to people in medicine (and no one else); business ethics applies to people in business (and no one else); and engineering ethics applies to engineers (and no one else).

Ethics is "special morality." Ethics is a higher standard and a moral standard. Ethics is a higher standard because ethics demands more than morality. Ethics is nonetheless a moral standard, not just a standard consistent with morality, because members of the relevant group must have reasons to set themselves a higher standard, reasons beyond what law or market would impose whatever the group in question did. Such reasons must turn maintenance of that higher standard into a cooperative enterprise, i.e., an undertaking the benefits of which depend in part at least on others doing their share of carrying the burdens of maintaining the special standards. That is as true of engineers as of any other group. Your reputation as an engineer is worth more if other engineers generally do a better job than morality, law, and market demand, less if they do not. Professionals never practice alone. For a more extended defense of this distinction generally, see Davis (1987). For its application to engineering in particular, see Davis (1991).

The higher standard that constitutes engineering ethics has been formulated in different codes of ethics, in formal interpretations of those codes, and in the less formal practices by which engineers pass on the special ways they do things to each new generation of engineers. So, except for those students lucky enough to have a mother or father who is an engineer, no one is likely to learn much about engineering ethics except at an engineering school or while practicing engineering. Engineering ethics is as much a part of what engineers in particular know as factors of safety, testing procedures, or ways to design for reliability, durability, or economy. Engineering ethics is part of thinking like an engineer. Teaching engineering ethics is part of teaching engineering.

WHAT CAN TEACHING ENGINEERING ETHICS ACCOMPLISH?

Teaching engineering ethics can achieve at least four desirable outcomes: 1) increase the ethical sensitivity of students; 2) increase their knowledge of relevant standards of conduct; 3) improve their ethical judgment; 4) improve their ethical will-power (i.e., their ability to act ethically when they want to). How can teaching ethics accomplish all this or, indeed, any of this?

Teaching ethics can increase student sensitivity simply by making students aware that they, as engineers, will have to resolve certain ethical problems. Just being exposed to a few examples of a particular problem, having them identified and explained, will make it more likely than otherwise that the students will see a problem of that sort when it arises on the job. Why teaching ethics might have that effect is not hard to understand. The mechanism is precisely the same as for learning to see technical problems. Practice sharpens perception.

How can teaching engineering ethics increase student knowledge of relevant standards? Again, the answer is much the same as for any other engineering standard. A student who reads a code of engineering ethics is more likely to know what is in it than a student who does not read it. A student who has to answer questions about the code is more likely to recall the relevant provisions than one who has not and so on.

"Knowledge of standards" includes more than just knowing what is written in codes or handbooks. Part of knowing standards is understanding the rationale for them (especially the consequences of departing from them). For example, part of teaching students to take operating costs into account when designing sonething is pointing out how uneconomical it can turn out if they do not.

How can teaching engineering ethics improve ethical judgment? Ethical judgment, like technical judgment, tends to improve with use. If a professor of engineering gives students a chance to make ethical judgments, explain them, and compare them with those other students make, the student is more likely to judge well than if he or she gets no such experience. The classroom or laboratory provide a safe place to make mistakes and learn from them (ethical mistakes as well as purely technical ones).

How can teaching engineering ethics increase a student's ethical willpower? Surely, the classroom or laboratory is not the place for that. Think again. Is not an engineer who knows that he shares a particular standard of conduct with other engineers more likely to follow it than one who believes himself alone? One benefit of discussing ethics in the classroom is that it shows students how much consensus there is (among engineers) on most standards of engineering ethics. There is power in numbers, i.e., one source of willpower. While there are others, space will not allow me to give any other examples. We must get on to what you can actually do.

Finding Room for Engineering Ethics

There are at least eight ways to teach students engineering ethics during their undergraduate career. They are more or less consistent with each other, indeed potentially mutually supportive.

Two are outside the curriculum. One is independent study. Give a student the code of ethics and tell him to read it. The other is extra-curricular events, e.g., a public speech on professional ethics or a movie like *China Syndrome* or *Emerald Forest* with a discussion afterward of the ethical issues it raises.

One method of teaching students professional ethics is supra-curricular, holding students to their profession's code while they are still students. I am not talking about an "honors code." Honors codes are codes of student ethics, not of professional ethics. An engineering student will learn more about the profession's code by living by it than by living by an honors code.

The other methods of teaching students professional ethics are all internal to the curriculum. The easiest is the guest lecture. If the guest stays all semester, the course is "team taught." By itself, the guest lecture makes professional ethics look optional: "If all engineers are supposed to know this stuff, why doesn't my prof know enough to teach it." The same question arises for the free-standing engineering ethics course taught outside the department, whether optional or required. A different question arises when the course in engineering ethics is, while optional, taught by an engineer: "If this stuff is important, why isn't it required."

The free-standing, required, in-house course answers all these questions but only at the cost of raising another: "How do we fit this into the curriculum." The last of my eight methods, the pervasive, provides an answer to that question: "You don't, but you do something even better. You teach engineering ethics in a way that brings home how integral engineering ethics is to engineering practice."

How can you make room for engineering ethics in engineering courses, courses notorious for being too full already and too technical for ethics? I propose to answer this question by giving a few examples of what can be done. To make that answer convincing, I shall avoid easy examples. I shall not draw my examples from a field (such as civil engineering) where the ethical issues seem relatively obvious nor from courses (such as design or introduction to the profession) where technical content seems to have left some room for practical considerations nor from laboratories where issues of research ethics and safety are relatively obvious. Instead, I shall take my examples from 2nd- and 3rd-year lecture courses in electrical engineering, hoping that you will agree that, if there is room for engineering ethics in those courses, there is room for it in any engineering course.

Early in 1990, the Illinois Institute of Technology (IIT) received a major grant from the National Science Foundation to integrate ethics into the technical curriculum. The primary means of doing this was a 30-h summer workshop which taught faculty in engineering, science, business, law, and other professional fields what we thought they would need to integrate professional ethics into their usual courses. The workshop required them to develop something to do in class and try it. We have had three such workshops: one in 1991; one in 1992; one in 1993. About 45 faculty have now gone through these workshops. This summer, we held a similar workshop for 21 faculty from other institutions. The examples I am about to give are not my inventions but theirs. For additional information about what has been accomplished at IIT, see Davis (1993) and the February issue of volume 13 (1994) of *Perspectives on the Professions*.

One way to integrate ethics into a course is simply to enhance student awareness of ethical issues. For example, in a course on electric circuits, you might take a moment now and then to point out the practical effect of getting a problem wrong. "These circuits are typically used in aircraft navigation systems; a small error here, combined with two common errors of pilots, could cause a crash. In practice, your calculations will be checked many times, but some errors slip through. The easiest way to prevent disaster is to get the problem right the first time. Next problem." Even a few such comments in the course of a semester can help engineering students see the practical context of highly abstract calculations, both the relationship of those calculations to such ethical concerns as safety and the relationship of their education to what they want to do after graduation.

Another easy way to provide information about ethics is to pass out a code of ethics at the beginning of the term and refer to it often enough during the term so that students get the idea it would be good to read it. For example, mention that such-and-such a provision makes engineers responsible for the safety of what they help to make. I am still surprised at how many engineering faculty have not read a code of engineering ethics. Needless to say, their students are likely to have read even less. Just exposing students to a code, therefore, is a significant contribution to their ethics education.

You can do even more. Much of a course in electrical circuits consists of solving problems. Often, several problems assigned on a given night differ little. They, in fact, can be interpreted as several solutions to the same design problem (e.g., three ways of designing the same turn signal for an automobile). You, then, could provide a little "background information" about the design problem, including not only the use to which these solutions will be put but also some factors relevant to cost, safety, reliability, and even manufacturability, and then ask the student (as a fourth step) to recommend one of the solutions and briefly state reasons (as one might in a memo to a supervisor). The student then has an opportunity to exercise engineering judgment, including ethical judgment (and to practice writing, too).

Lastly, if you can find the time, you might take a few minutes in class to let students discuss their recommendations. This will not only improve their public speaking but also help them see how much agreement there is among engineering students in their class (and, by extension, engineers generally) about what the code demands (and also how many different ways there may be to satisfy the code).

REASONS TO INTEGRATE ETHICS INTO TECHNICAL COURSES

I have already touched on one reason why engineering ethics should be integrated into the technical curriculum. Such integration reenforces what is taught about engineering elsewhere both in the curriculum and outside. Another reason to integrate ethics into the technical curriculum is that, as a matter of fact, many engineering students will get no ethics training unless it is part of the technical curriculum. Required ethics courses are unlikely at most schools, and other methods tend to miss most students. However, there are two more reasons why engineering ethics should be integrated into the technical courses, one you may have guessed from the examples I have given and another for which I have a great deal of empirical evidence.

The reason you may have guessed is that integrating engineering ethics into a course like electrical circuits can remind students what attracted them to engineering. The analytic courses of the 2nd and 3rd year are a perpetual problem in engineering education, tending to weed out students who went into engineering because they wanted to make things, leaving behind those who think engineering is only "problem solving" (in the narrowest sense of that ambiguous term). Integrating ethics puts analysis in context, making clear its instrumental importance and, thereby, livening up the problems.

My last reason for integrating ethics into the technical curriculum, the one you probably did not guess even though I now have lots of empirical evidence for it, is that students like it. We have required graduates of our seminar to have their students evaluate the ethics component. Class after class and year after year, the great majority of students expressed appreciation for the concern shown ethics, some because they thought ethics important, some because it helped them to understand what they would be doing as engineers. This last reason seems to me as good as any for doing as much engineering ethics as we can.

LITERATURE CITED

DAVIS, M. 1987. The moral authority of a professional code. NOMOS, 29:302-337.

——. 1991. Thinking like an engineer: the place of a code of ethics in the practice of a profession. Philosophy and Public Affairs, 20:150-167.

——. 1993. Ethics across the curriculum: teaching professional responsibility in technical courses. Teaching Philosophy, 16:205-235.