

# Cases for Teaching Engineering Ethics

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**Abstract- This paper offers suggestions for integrating ethics education into engineering classes, primarily by using a case-based approach. It focuses on both micro and macro cases in three engineering disciplines: software, civil, and mechanical.**

early in a student's academic career and be interwoven through his/her college experience, with added levels of complexity in upper-division courses. There is no need to "save" ethics until a student's senior year.

*Index Terms* - engineering ethics, the case method, pedagogy

## INTRODUCTION

ABET Criterion 3, stating that students should demonstrate an understanding of appropriate professional and ethical responsibility, represents a step forward in formalizing engineering ethics education. While ethics training cannot guarantee more ethical workplace behavior, it certainly can prepare students for facing thorny professional situations.

Instructors new to the ethics arena, however, may be at a loss where to start, since an almost overwhelming abundance of material is available. This paper proposes to orient instructors by exploring micro and macro cases in three engineering disciplines--software, civil, and mechanical--in relation to the issues of professional responsibility, loyalty, and disclosure.

Accreditation provides a pragmatic reason for including ethics in engineering curricula, but other reasons, as suggested by Michael Davis at Illinois Institute of Technology's Center for the Study of Ethics in the Professions, are equally compelling from a professional perspective. According to Davis, teaching ethics within the context of an engineering class can result in several outcomes:

- increased ethical sensitivity
- increased knowledge of relevant standards of conduct
- improved ethical judgment
- improved ethical will power [1]

ASEE's "Statement of Engineering Ethics Education" also supports the necessity of including ethics components, either as stand-alone courses or integrated in technical courses: "[T]o survive in the work world of the 21[st] century and to carry out responsibly their roles as agents of technological change, new engineering graduates need substantial training in recognizing and solving ethical problems" [2].

To underscore an awareness of the symbiotic relationship of ethics and engineering, ethics education should ideally begin

## THE CASE FOR USING CASES

The pedagogical value of the case method dates to antiquity and the use of parables [3]. Its more recent incarnation appeared in the 1870s, under the leadership of Christopher Langdell, dean of Harvard Law School [4]. For more than a century, the case method has been a staple in legal and medical education and is also a successful teaching methodology in other fields as well, including engineering.

Pedagogically, the case method offers a number of advantages over more traditional methodologies: it allows students to actively and cooperatively engage in problem solving, rather than passively listening to lectures [5]; it allows students to learn from others' experiences [6]; and, most important for ethics education, it allows students to exercise their moral imaginations, the ability to examine a problem from multiple perspectives. "Through cases," note Harris, Pritchard, and Rabins, "we learn to recognize the presence of ethical problems and to develop analytical skills necessary to resolving them" [7].

The case method yields a number of benefits for instructors as well, primarily the virtue of versatility. Rather than relying on lectures to convey information, instructors using the case method can lead students to discovery by having them exercise their engineering problem-solving skills. Class activities, easily implementable in small or large classes, include debates, small group discussions, roleplaying [8]. Outcomes include both written documents and oral presentations.

The case method is a powerful teaching strategy because of its holistic effect. As Angelo and Boehrer explain, "the case method involves the whole person, the emotions and intuitions as well as the intellect. Such qualities as persistence, patience, and persuasiveness count, along with mental agility and power, just as they do in the real lives of professionals. Case learning educates the person who will become the professional, not just the mind" [6].

## SOME DEFINITIONS

All engineering ethics cases are not created equal. Some are real; some are fabricated. Some involve social considerations; others concern individual decision-making.

Generally, microethics focuses on the issues that affect individuals. As William Wulf suggests, “micro [doesn’t] mean small and unimportant, but simply that they are individual” [9]. A glance at any engineering code of ethics reveals issues that involve individual behavior, including loyalty, duty, autonomy, conflicts of interest, gift-giving, and whistleblowing.

Macroethics deals with larger societal concerns, or, as Wulf explains, “pose[s] ethical questions for the profession” [9]. Macro issues include public safety, product liability, risk, sustainable development [10]. Rather than affecting the lone individual, macroethical considerations include effects on others and the environment. Since engineering is, in a sense, a very public profession, engineering decisions affect us all [11].

Either type of case is suitable for the classroom: micro cases will acquaint students with expectations regarding professional conduct, and macro cases will help students understand the impact of engineering on society. A combination will impress upon students the “ripple” effect of ethical decision-making: a seemingly simple decision may have unintended consequences that extend far beyond the individual engineer.

## EXAMPLE CASES

Deciding which type of case to use depends on course goals. If a goal is to examine professional conduct, micro cases are appropriate. If a goal is to explore the impact of engineering as a profession, instructors should adopt macro cases.

Other considerations include complexity of issues and consequences, technical difficulty and scope of the problem, and interdisciplinary. Pragmatic concerns include the amount of course time devoted to ethics, whether or not active learning methods are used, and what skills the instructor wants to emphasize (critical thinking/reading, problem solving, ethical issue identification, decision making, etc.).

The following explores examples of both types for three engineering disciplines: software, civil, and mechanical. Appendix A offers a list of websites that have many cases appropriate for classroom use.

### *Software*

As noted in a recent session at the annual meeting of the Association for Practical and Professional Ethics, software engineering, ethically speaking, bridges the gap between computing and engineering, as these cases often concern both micro and macro issues [12].

Consider the following short case, based on a real problem, to examine the effects of illegally accessing database information

An engineer working as a computer programmer plays a minor role in developing a computer system for a state department of health. The system stores medical information on state employees, identified by name. Through no fault of the programmer, few controls are placed on the system to limit easy access by unauthorized people.

When the engineer learns of this, he first informs his supervisor and then higher management. All refuse to do anything about the situation because of the expense required to correct it.

In violation of the rules for using the system, the engineer easily obtains a copy of his own medical records. He sends them to his state legislator as evidence for his claims that the right of citizens to confidentiality regarding such information

### *Questions:*

- Does the engineer’s action constitute a breach of confidentiality?
- Is his behavior proper?
- What, if any, action against the engineer would be appropriate?

FIGURE 1  
Software microethical case [13]

Students work through the questions in small groups and then report back to the larger group. The case presents an effective lesson in ethical decision-making and case reading, as the engineer was actually fired for his actions. While typically students contend that he wasn’t doing anything wrong because he accessed his own records to illustrate the lax system security, a careful reading of the case notes that even this action was “in violation of the rules for using the system.”

This case also allows students to explore alternate courses of action: once the engineer has exhausted the internal chain of command without corrective action, what can he do? Students generate some very workable solutions, such as consulting colleagues, contacting the corporate ethics office, and, as a last resort, contacting interested outsiders.

Short cases such as this can lead into a discussion of larger issues: privacy and confidentiality, piracy and intellectual property rights, cybercrime and abusive behavior, such as developing malware [14].

### *Civil*

Often, local or state engineering oversight boards’ websites can

A complaint was filed with the Board alleging that the Respondent was representing himself without as a professionally licensed engineering firm . . . but was practicing without a license. Complainant provided the Board with copies of the Respondent's business card and telephone directory advertisement stating that it performed Civil, Structural, and Mechanical engineering work. The Respondent provided to clients, engineering services and structural reports on numerous occasions without a license.

*Question:*

How does the Respondent's actions violate the ASCE Code of Ethics?

provide classroom-friendly micro cases, as illustrated in Figure 2

FIGURE 2  
Civil microethical case [15]

A case such as this provides an exercise in examining both engineering codes and applicable state laws. While students are probably familiar with the former, the law may still be a mystery. After some research, students will discover that this engineer was transgressing not only the dictates of his professional code but breaking several state statutes as well.

The ASCE Code of Ethics, Canon 2a guidelines, note, "Engineers shall undertake to perform engineering assignments only when qualified by education or experience in the technical field of engineering involved" [16]. Since this engineer was operating without a license, his actions violate his professional code. However, the case also indicates that the engineering firm has violated Oregon Revised Statutes 672.020, 672.025, and 672.045. The engineer was fined a civil penalty of \$9,000.

In the macro arena, a focus on public safety and the implications of design failures can yield some very enlightening class discussions, as in an examination of the Kansas City Hyatt Regency walkways collapse or various bridge collapses. Environmental cases, such as Love Canal and Times Beach, Missouri, impress upon students the necessity of legislation to help control disposal of toxic wastes.

Some environmental issues, such as dealing with computer trash, have international import. Currently, many outdated computers are shipped overseas, and villagers are paid a daily pittance (\$1.50 in China) to root through the wreckage for tiny bits of precious materials [17]. In addition to trace amounts of gold and silver, however, computer components also contain

toxic ingredients such as lead and mercury, which are contaminating ground water and wreaking a human toll as well [18].

Indeed, the whole topic of third world product dumping is ripe for student research and discussion, centered around this question: Do rich nations, such as the United States, have a right to dispose of undesirable or dangerous products or by-products in developing nations, even though the finances involved with such transactions may be economically advantageous for those countries?

### *Mechanical*

Another convenient source for micro cases is the NSPE's Board of Editorial Review (BER). The BER regularly examines cases involving professional conduct, indexed by area of review, such as confidentiality, conflict of interest, etc. In addition to the actual cases, stripped of identifying information, the website includes the BER's discussion and conclusions. Figure 3, below, is an example of a case involving confidentiality and voluntary release of proprietary information.

This case offers the opportunity to discuss an issue that is extremely important in most professional fields, that of confidentiality. When is it permissible to voluntarily release proprietary information? When is it morally obligatory to release confidential information?

In this particular case, the BER's conclusion was that the engineer is under no obligation to release his files to the defense counsel, as such an action would be contrary to section III4b of the NSPE Code of Ethics: "Engineers shall not, without the consent of all interested parties, participate in or represent an adversary interest in connection with a specific project or proceeding in which the engineer has gained particular specialized knowledge on behalf of a former client or employer" [20].

Using a BER case has the advantage of impressing upon students an understanding that professional misconduct is not simply ignored in some organizations. While it is true that one of the problems associated with professional codes of ethics is the difficulty of enforcement, the NSPE is quite conscious of reviewing questionable behavior and dispensing appropriate judgments. The cases also have the virtue of being real.

Macro cases in mechanical engineering abound, and those that yield fruitful classroom discussion involve public safety issues, since our students are also consumers. Examining the cargo door latch problem on the DC-10, which failed a number of times in flight, is a useful way of approaching the whole area of social responsibility of business. Once students learn that the latch had failed in tests and McDonnell-Douglas chose to sell the plane anyway, they become indignant. Someone always raises the question of safety and our right as consumers to expect that the products we use won't harm us. These tend to be very energetic discussions, which point to the necessity of

engineering firms, as well as individual engineers, maintaining a firm commitment to public safety, as opposed to bottom line of considerations of maximizing profit.

Several years ago Engineer A, a mechanical engineer, consulted for Company A, a pressure vessel manufacturer, on a specific pressure vessel problem relating to the design of a boiler system. Engineer A's work focused on specific design and manufacturing defects that caused deterioration of the boiler system. Engineer A completed his work and was paid for his services.

Ten years later, Engineer A was retained by Attorney X, plaintiff in a case involving the fatal explosion of a recently designed and manufactured pressure vessel at a facility previously owned by Engineer A's former client, Company A. The facility was sold to Company B seven years before the explosion. The litigation does not involve any of the issues related to the services Engineer A provided to Company A ten years earlier. The defendant's attorney discovered through Engineer A's deposition and statements relating to his professional experience that Engineer A had worked for Company A on a pressure vessel problem. Engineer A explains to the defendant's attorney that he is not relying upon any of his prior work for Company A in this case. Nevertheless, the defendant's attorney requests that Engineer A provide his files from the previous work performed for Company A.

*Questions:*

- What ethical issues are involved in this case?
- Would it be ethical for Engineer A to voluntarily release the files to defense counsel?

FIGURE 3  
Mechanical microethics case [19]

### CONCLUSIONS

Teaching engineering ethics, whether as a stand-alone course or as part of an ethics across the curriculum effort, is challenging. It requires much time, research, and an awareness of the enormous responsibility of engineers, especially in a global context.

"One has to watch out for engineers," Marcel Pagnol, a noted French playwright, has stated, "they begin with the sewing machine and end up with the atomic bomb" [21]. As engineering educators, we would do well to heed Pagnol's admonition by

enlightening our students that they, as shapers of the future, face an onerous task: building a world for us to live in. The products they will create, the infrastructure they will design, all impact quality of life.

As Stephen Unger has noted, "Those who are developing and applying technology must take responsibility for the consequences of their work and play an active role in directing it toward humane ends" [22]. Through an active examination of micro and macro cases, our students will hopefully come to the understanding that ethics is not ancillary to engineering education; it is essential.

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#### APPENDIX A: ENGINEERING ETHICS CASES ON THE WEB

Carleton University  
<http://www.civeng.carleton.ca/ECL/>

Case of the Month Club  
<http://www.niee.org/pd.cfm?pt=AECM>

Chowan College Center for Ethics  
<http://www.chowan.edu/acadp/ethics/studies.htm>

ComputingCases.org  
<http://www.computingcases.org/>

East Tennessee State University  
<http://csciwww.etsu.edu/gotterbarn/ecases.htm>

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