**Ethics Cases and Technical Courses: Some Suggestions**

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**Abstract**

In the two decades following adoption of EC2000, ethics has assumed a prominent position in engineering and engineering technology education. While some schools farm out students to a philosophy department to experience a full course on professional or engineering ethics, others embed ethics in technical classes. Whatever the approach, at the end of the course students should display behavior that reflects Criterion 3(4): “an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts” (ABET, 2022).

This paper examines the use of embedded cases to meet the ABET criterion. Specifically, the paper explores reasons for using cases, resources, and cases appropriate for various curricula.

**Introduction**

Technology is a two-edged sword: on one hand, it enhances the quality of our lives; on the other, it creates numerous questions regarding ethics and consequences. It is no longer sufficient to just design; the engineer must design with an eye to the implications of that design—social, physical, psychological, and financial.

An apt example is social networking, which has conquered the world in the past decade. Initially conceived in 2003 as “a place for friends” (Death, 2017), MySpace offered a convenient spot to share thoughts and artifacts with friends and relatives. Similarly, Facebook “helps you share and connect with the people in your life” (p. 109, n.d.). Both were designed with benign, even beneficent, intent but have devolved over time. MySpace, in fact, no longer exists, and for some users, Facebook currently serves as a haven for social anomalies such as predation, racism, explicit violent images, and hate speech. What began as a significant and novel idea has gone awry.

The field of engineering, as it focuses on the creation and implementation of innovative technology, is particularly susceptible to the dual effects, especially if the emphasis is on production with little probative regard to consequences. Students aspiring to careers in an engineering field could benefit by preparing to deal with the impact of their design efforts by learning about ethical challenges and issues during their academic experiences.

This remainder of this paper examines using embedded ethics cases in technical courses. Specifically, the paper explores reasons for using cases, resources, and cases/issues appropriate for various curricula.

**The Case for Cases**

Case-based learning has a rich history, one that dates to antiquity. In higher education, case methodology in the US can be directly traced to Christopher Columbus Langdell, dean of the Harvard Law School in the 1870s. Langdell wanted his students to extend their intellectual curiosity beyond memorization and recitation to careful thought and deliberation, to “think like lawyers.” Based on Socratic questioning and the use of primary materials collected by Langdell and published as course casebooks, the method initially was highly criticized by his colleagues, all of whom depended on lectures. However, Langdell’s persistence paid off, and so many faculty converted to the “new” method that cases now form the pedagogical basis for all law schools in the US (Weaver, 1991).

From its integration into legal education, case-based learning has spread to virtually every academic discipline, primarily because it offers so many benefits over the lecture method. Some of the major advantages to using cases are listed below; students learn how to

1. Develop their nascent critical analysis abilities, encouraged by the instructor’s insistent poking and prodding (Garner, 2000)

2. “Teach themselves” since they are not reading textbook summaries and commentaries (Garner, 2000)

3. Think independently (Weaver, 1991)

4. Actively engage in course material (Boston, n.d.)

5. Identify and cope with ambiguity (Boston, n.d.)

6. Implement a decision-making process

7. Enhance communication skills and self-confidence (Nohria, 2021)

A final major advantage is that cases allow students to engage emotionally as well as intellectually with real situations involving real people and real consequences (Thiel et al., 2013). Emotional engagement occurs because cases are narratives, which are inherently engrossing because they help us to organize our experiences, adding “meaning and coherence.” Jonathan Gottschall, who has written widely about the impact of narratives, has noted, “Humans live in a storm of stories” that chronicle our days and haunt our nights via dreams. They are also a familiar medium, since we are raised on stories (Gottschall, 2013, p. 277), and hence students can easily relate to narratives.

While sending students to the philosophy department for a stand-alone course is a convenient (and easy) way to deal with ABET’s ethics proviso, seamlessly embedding cases in technical courses is preferable for a number of reasons. First, it encourages students to directly associate “engineering” and “ethics,” rather than viewing the latter as something alien to their majors. For example, Grosz et al. have developed a program at Harvard called “Embedded EthiCS” for integrating ethics across the computer science curriculum. They use a “distributed pedagogy” to infuse ethics into all core courses, based on the precept that “Students can learn to think not only about what technology they *could* create, but also whether they *should* create that technology.” The overriding goal is to lead students to an understanding that “ethical reasoning is an expected part of a computer scientist's work” (Grosz et al., 2019), echoing sentiments expressed by Zandvoort et al. some 20 years earlier: “The across-the-curriculum approach thus acquaints students with ethics from the start of their studies, so that they will come to perceive ethical considerations and ethical reflection as an integral part of engineering” (Zandvoort, 2000, p. 298).

Second, using the case method also results in a positive change in class environment. Since discussion is a primary classroom technique when integrating ethics (Gill, 2011), instructors must be prepared with a thorough knowledge of the case and be willing to sacrifice lecture to allow students a voice. Because most engineering and technology courses depend on a lecture-lab-test format, this is a major change both for students and instructors. But it has a number of side benefits, including noticeably higher engagement, enhancement of communication skills, and improved problem-solving prowess.

Yet a third major reason for embedding cases is that the technique introduces a degree of ambiguity typically absent in technical courses. In examining situations through an ethics prism, students usually discover that there is no definitive “right” or “wrong” answer to a particular situation but a perhaps bewildering array of potential “right” answers. Their job is to choose the preferable solution, based on concerted research and deliberation.

Choosing appropriate cases can be a daunting task, due to an overabundance of resources available (see following section), that requires some preliminary considerations, including pragmatic concerns such as class time available and course objectives. Big cases, such as Challenger, Bhopal, and Chernobyl, demand more discussion time than smaller cases, such as local occurrences or situations of lesser complexity. The ABET criterion suggests incorporating both types, generally categorized as “microethical” and “macroethical,” microethical referring to the effects of actions on individual engineers (such as whistleblowing) and macroethical signifying those cases with significant social impact (Herkert, 2001). Regardless of choice, using real cases is imperative, as hypotheticals tend to be too simplistic. Real ethics is messy.

**Resources**

Fortunately for instructors, especially those new to the field of ethics, the Internet is replete with cases. This section details a handful that are initial “go-to” sites for both novice and seasoned instructors.

*Center for the Study of Ethics in the Professions (CSEP)*

Located at Illinois Institute of Technology, CSEP (<https://ethics.iit.edu>) is approaching its 50th anniversary as an engineering ethics facility that offers many resources for teaching ethics. Of special note is the subject-arranged “Ethics Code Collection” that features more than 4,000 codes of ethics from a variety of areas, dating from the 1970s to the present.

In addition, the center sponsors a number of events and seminars. Of particular note is its “ethics across the curriculum” NSF-funded series, which is invaluable for instructors wishing to integrate ethics into their technical courses.

*Markkula Center for Applied Ethics*

The Markkula Center at Santa Cruz University, <https://www.scu.edu/ethics/>, has a wealth of cases and teaching resources, in addition to analytic articles. Cases are arranged by subject, relatively short, and easily accessible.

*Murdough Center for Engineering Professionalism*

Texas Tech’s Murdough Center, <https://www.depts.ttu.edu/murdoughcenter/>, offers dozens of cases spanning the gamut of engineering disciplines. Each case includes a presentation of the facts, alternate solutions, survey results, and forum comments. The center also sponsors podcasts, seminars, workshops, and professional development courses.

*NSPE Board of Ethical Review (BER)*

Since 1958, the NSPE’s ethics board has catalogued and archived cases that surface for BER review, available to a general audience at <https://www.nspe.org/resources/ethics/ethics-resources/board-ethical-review-cases> in a searchable database. Each case includes an anonymized recitation of case facts, a summary of the BER’s discussion, references to appropriate code provisions, and the board’s conclusions. The “NSPE Ethics Reference Guide” includes both a comprehensive listing of cases by board opinion and a code of ethics index (NSPE, 2021).

*National Institute for Engineering Ethics (NIEE)*

Purdue’s School of Engineering Education has sponsored the NIEE, <https://www.niee.org>,

since 1988. In 2001, it integrated into the Murdough Center. The institute is well known for its videos tailored for classroom usage: *Gilbane Gold* (1989), *Incident at Morales* (2005), *Ethicana* (2009), and *Henry’s Daughters* (2010).

*Online Ethics Center for Engineering and Science (OEC)*

This virtual center, <https://onlineethics.org>, is the brainchild of esteemed ethicist Caroline Whitbeck and is a comprehensive collection of cases, teaching resources, curated conference presentations, and various special lectures. It also includes a section on assessment and evaluation that is especially useful for classroom teachers who wonder if their ethics efforts have tangible, measurable effects.

**Curricula-Appropriate Cases**

Cases tend to exhibit common ethics themes. In general, there are clusters of issues across broad categories: some deal with professional behavior (obligations to employers, clients, the general public); others concern general issues in engineering (safety, risk assessment, design). Each engineering discipline, however, tends to feature issues peculiar to that field.

Regardless of the case, researchers should extend their searches to examining the site’s sponsoring organization and author, as some cases exhibit patently false or misleading information. The McDonald’s spilled coffee case provides an appropriate example: in 1994, 79-year-old Stella Liebeck made headlines when she sued the McDonald’s Corporation for millions of dollars for burns to her groin sustained when a hot cup of coffee spilled in her lap. Many sites poke fun at the case, calling Stella a stupid old woman who didn’t know how to use a cupholder (her car had none), and one even described the “Stella Award” for the year’s stupidest lawsuit (Cassingham, 2007). Missing is significant information: Stella is but one of more than 700 who reported being burned by McDonald’s coffee (served at 20-30° hotter than typical restaurants and 35° hotter than a home coffeemaker), she had third-degree burns that in some spots went to the muscle layer, and she had tried unsuccessfully to have McDonald’s simply cover her medical costs, which involved skin grafts and other “extensive treatments,” her recovery lasting about two years (Enjuris, 2022). The “Stella Award” is a fabrication, and McDonald’s, in fact, launched a rigorous campaign to rebut, defame, and humiliate Stella (Enjuris, 2022). Obviously, ethical consideration of any case must be based on facts, not prevailing public opinion on random blog posts.

*Biomedical*

As one of the newer and rapidly evolving fields, biomedical engineering combines engineering and the biological sciences “to improve healthcare by developing engineering solutions for assessing, diagnosing, and treating various medical conditions.” Applications include “medical imaging, prosthetics, wearable technology, and implantable drug delivery systems” (Grove, 2019). It is interdisciplinary in nature, and ethical issues include not only typical engineering issues but those of science as well, which frequently have significant import. In addition, crisis management is more prevalent in this field than in others, as the emergence of COVID-19 illustrates. The pandemic presented a global crisis that coalesced around three major ethical themes: “1. The dilemma of identifying criteria for the allocation of medical devices 2. Responsibilities of science and technology 3. Inadequacy of regulations and norms, which lack universality” (Maccaro et al., 2021).

Cases in this field can involve individuals, industries producing devices such as pacemakers and artificial hips, and research facilities, both industrial and academic. The CSEP site (search for “Biomedical Engineering Ethics”) offers a very useful, albeit slightly dated, bibliography of centers, journals, and articles that detail numerous cases and issues, such as organ transplants, single-use devices, human rights, obligations to patients, and legal considerations (CSEP, n.d.).

Cases involving medical devices are appealing to engineering students, at least given anecdotal evidence. Lewis et al. recount their experiences looking at two companies producing faulty implantable defibrillators, reporting that only 1 student team out of 30 recommended recalling the devices (the real outcome); the other teams were evenly split between notifying the FDA and notifying physicians. Students rated the discussions to be very satisfying and enlightening, underscoring the importance of small group discussion as a pedagogical technique (2010).

*Civil*

Civil engineering in itself is a collection of sub-disciplines, including structures (buildings, bridges, dams), transportation, environmental/public works, geotechnical, construction, to name but a few. The possibilities for failures stemming from ethical considerations are vast.

Smaller cases work well for an introduction to ethics in particular fields. In civil engineering, numerous university websites have descriptions of easily manageable brief cases: Texas A&M, the Markkula Center at Santa Cruz University, University of Pittsburgh, University of Delaware, and University of Buffalo. And the ASCE’s *Civil Engineering Magazine* publishes a monthly column, “A Question of Ethics,” that recounts situations investigated by its Committee on Professional Conduct.

Larger cases include structural, dam, and bridge collapses. An in-depth look at the Hyatt Regency Walkways Collapse (1981), deemed the worst structural failure in US history (Levy & Salvadori, 1992), reveals violations of professional conduct that caused the death of more than 120 people. Examining the St. Francis Dam collapse (1928) exposes the origins of professional registration for engineers, as the autonomy given to William Mulholland as sole designer, was directly responsible for the deaths of up to 1,000 people and the destruction several small towns and hundreds of acres of fertile agricultural land (Dyrud, 2013).

*Computers*

Cases in computer engineering involve both hardware and software. Cases in the former tend to be cross-disciplinary and also involve mechanical engineering concerns, such as autonomous technologies (self-driving cars) and the Volkswagen emissions controversary. Others are squarely tethered to software: privacy and data management issues, AI, and surveillance, especially facial recognition technologies. Assigning responsibility when something goes awry is vexing, as teams, rather than individuals, engage in design. Loui and Miller note the example of the Therac-25 case from the mid-1980s. The machine, used for cancer radiation treatment, overdosed six patients, three of whom died due to software-based errors. Who, they ask, is responsible? Several possibilities exist: machine operators, software developers, the manufacturer, systems engineers (Loui & Miller, 2007).

A seminal site for instructors is ComputingCases.org, which features a number of large cases, such as Therac-25, smaller cases, and several very useful links. In addition, the Public Sphere Project, sponsored by Computing Professionals for Social Responsibility (cpsr.org) has literally hundreds of cases categorized by “patterns.”

*Electronics*

Rarely, notes Charles Fleddermann, do typical engineering ethics cases involve electronics, leading to a lack of student interest and a paucity of resources (2000). This does not indicate, however, a general lack of interest or cases in that field. Many electrical engineering concerns are subsumed by other fields, particularly computer science. And electrical failures tend to be much less dramatic than a building collapse, resulting in a lack of publicity when failure occurs. In addition, IEEE is attempting to overcome a decidedly anti-ethics bias in its governing groups between 1996-8, when the society withdrew support of ethics-related activities (Elden, 2016). In this particular field, the professional organization has substantial clout, as IEEE is the largest professional society in the world.

Prior to that time, IEEE was actively engaged in ethics, which included an Ethics Committee to review cases and an Ethics Hotline, an anonymous reporting mechanism. Versions of the EC cases are available in Elden (2016) and Unger (1999) and include smaller cases involving engineers dealing with intensive care equipment failures, airbag safety, and wafer stability.

Larger cases include the flawed Intel Pentium 5 chip, which caused incorrect calculations. At first, Intel responded that it would replace chips if users could show a demonstrated need. After media publicity, the company agreed to replace all of the chips (Fleddermann, 2000). The larger issue is an important one for users: should companies report flaws to consumers?

Another large case involved the BART system in the San Francisco mass transit commuter rail, one the few cases in electrical engineering involving whistleblowing: three BART engineers discovered a glitch in the innovative automatic train-control system that caused trains to overshoot their stations. Unable to persuade BART management of the problem, they approached BART’s board of directors. While the engineers were dismissed, the problem was repaired (Fleddermann, 2000), primarily due to the public safety issues involved.

Like computers, electronics are integrated into our lives: we all use electronic devices for everyday living, whether they be toasters or complicated electric vehicles. So it behooves electrical engineering instructors to integrate ethics into their courses to ensure their students receive the same benefits from that instruction as do others enrolled in engineering programs.

*Mechanical*

The field of mechanical engineering has some spectacular disasters on the record: the DC-10 cargo door latch failure and the Challenger. Indeed, these are now part of the standard litany of engineering ethics cases presented in classrooms across the nation.

Cost is a major issue in this field, one that often leads to conflict with management. The “Ur” case is the Ford Pinto, which management was hell-bent to rush into production (25 months instead of the standard 43) and keep the retail price under $2,000. Safety was not a concern with CEO Lee Iacoca, who famously stated “safety don’t sell”; he focused instead on cost-benefit analyses that set the cost of a human life as $200,000 and predicted that settling lawsuits would be cheaper than fixing the problem, with solutions ranging from $1 to $11 per car. Engineers, who were fully aware that the gas tank placement could rupture in read-end accidents, were reluctant to speak up. Eight years later and after between 500 and 900 burn deaths, Ford Motor Company finally started settling suits out of court, noting that juries were “too sentimental” and awarded high-dollar damages (Dowie, 1997). The callousness displayed by Ford management is truly shocking. As consumers, we believe that companies would not deliberately market a product that endangers users.

Smaller cases deal with issues like product liability and are readily available on the Internet, for example, on sites such as a listing of cases on the supplemental CD for Harris et al.’s *Engineering Ethics: Concepts and Cases* (Wadsworth, 2000). For instructors who prefer a quantitative approach to ethics, Texas A&M developed a number of mathematically based cases for an NSF grant (Texas A&M, 1995).

*Accentuate the Positive*

While most ethics cases tend to focus on negative actions and outcomes, such as code violations or harm inflicted upon persons or entities, it is helpful to temper criticism with stories of courageous engineers and scientists who chose to do the right thing. These include Roger Boisjoly, a mechanical engineer and whistleblower in the Challenger disaster; Fred Cuny, a civil engineer and disaster relief worker who specialized in humanitarian enterprises and disappeared in 1995 during the Chechnya conflict; William LeMessurier, the structural engineer for New York’s Citicorp Tower, who acted on questions from students and managed to prevent the collapse of the structure in downtown Manhattan (OEC, 2022); and Cate Jenkins, an EPA scientist who openly challenged the EPA’s assessment of air safety in Manhattan following the 9/11 disaster, accusing several agencies of data manipulation (Jenkins, 2007).

**Conclusions**

This paper has included numerous examples to persuade readers that integrating ethics content via cases into technical courses is a painless way to educate students about their ethical duties and responsibilities without sacrificing technical content. In addition, this technique circumvents a number of institutional or personal obstacles, such as

1) The curriculum is already full, and there is little room for ethics education,

2) Faculty lack adequate training for teaching ethics,

3) There are too few incentives to incorporate ethics into the curriculum,

4) Policies about academic dishonesty are inconsistent, and

5) Institutional growth is taxing existing resources. (Walczak et al., 2010)

All of these are easily overcome, and for faculty concerned about their own ethics education, talking with other faculty in appropriate departments, such as philosophy, combined with self-study, can overcome perceived deficiencies. And once faculty experience the engagement and obvious enthusiasm that students display in response to an ethics problem, concerns of the past disappear.

A political science professor at Stanford University, Rob Reich, has stated, “The profound consequences of technological innovation…demand that the people who are trained to become technologists have an ethical and social framework for thinking about the implications of the very technologies that they work on” (Wykstra, 2019). Technology has insinuated its way into virtually every aspect of our lives, influencing how we interact with others, how we spend leisure time, how we perform at work, how we think—basically, who we are. Engineering education demands a simultaneous study of ethics to acquaint students with professional expectations regarding workplace behavior.

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**Biography**

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