Proceedings,
The 2014 ASEE North Midwest Section Conference, ASEE-NWMSC2014-4C4
October 16-17, 2014, Iowa City, IA.

An Ethical Framework for Engineering Faculty: Motivation, Examples & Discussion

Rebecca A. Bates
Minnesota State University, Mankato
Mankato, MN 56001
bates@mnsu.edu

Introduction

Engineering faculty address the topic of ethics from two different perspectives. The first is as required content related to the ABET outcome that engineering graduates will have an understanding of professional and ethical responsibility. The second is as practitioners who face a range of ethical dilemmas and challenges, from plagiarism to "passenger" team members to professional relationships with colleagues to responsible conduct of their own research. As citizens, engineering professors and students alike face issues beyond the scale of personal practice. Ladd[1] subdivided engineering ethics into microethics and macroethics. Microethics considers individuals and internal relations of the engineering profession valuing individual liberty. Macroethics pays sufficient attention to larger societal problems and value the collective social responsibility of the profession to make societal decisions about technology.[2] This paper provides an overview of background information that can support faculty in teaching and practicing ethics. This is followed by a framework that can be used to address personal and professional (micro) ethical issues, and examples of using the framework in classes. Suggestions for incorporating discussions about societal-level (macro) ethical issues within the context of engineering courses are described. Links to online resources are also provided.

Background

An issue that individual faculty members may struggle with is that ethics is frequently held aside in our curricula rather than incorporated throughout the curriculum. When ethics education is incorporated, it is typically focused on microethics.[3] Many programs include a brief segment during introductory courses, more significant time during senior projects, and may require an ethics course taught in the philosophy department. By discretely binning topics like ethics, technical writing and technical subjects, we systemically reinforce the idea that ethical thinking and technical writing, key professional skills for working engineers, are less important and should be distinct from topics like fluid mechanics and control systems. Teaching ethics across the curriculum, whether in modules or as part of regular community conversations, has the benefit of showing students that ethical thinking is seen and valued by engineering faculty and administrators.[4]

As faculty members and professionals, we have multiple guides in ethical codes of professional societies (e.g., ASME,[5] ASCE,[6] IEEE,[7] ACM[8]) including the recently adopted ASEE Code of Ethics (http://www.asee.org/member-resources/resources/Code_of_Ethics.pdf). These codes provide guidelines for our own practices, both as professionals and to support student learning. The codes are statements of behavior and actions, but putting them into practice throughout a

career requires skill development that should grow with all other skills required for entry-level engineers. As members of professional societies, we also have the responsibility to provide feedback and review of unethical behavior so that the system is self-correcting, rather than losing the power of community pressure to support ethical behavior.

A typical approach to studying ethics is to use case studies as seen in a variety of available textbooks[9,10,11,12] and online repositories of cases (see examples listed below in Available Resources). A positive aspect of this approach is that cases are typically drawn from real world examples and stories, which can engage learners more deeply than hypothetical situations that lack the breadth of a true story. A good case study provides enough information to describe the case, including points where information may or may not be available to the stakeholders, but also leaves points open to discussion.[13] Negative aspects include the fact that students may feel the "correct" answer is obvious, especially when a difficult case is boiled down to the size needed to quickly cover the main points. Another aspect is that case studies are typically presented as microethical dilemmas rather than as macroethical issues that examine larger societal issues.

By focusing on microethics, we may neglect the social nature of engineering practice[2,14,15] which allows codes to be successfully applied across communities of practice. Harnessing the power of peer pressure in an engineering setting can be done in classrooms through pedagogical approaches that incorporate active and collaborative learning. There are a range of potential pedagogical approaches faculty can use, such as small group discussions with reporting out to the larger class, role playing,[16] academic controversy (a form of debate where participants switch sides about 2/3 through the session),[17] other social instruction strategies like collaborative learning,[18] and legitimization of differences which take into account minority viewpoints.[19] These approaches can allow for students to experience consensus-based decision making as well as situations where consensus cannot be made and decisions must come by fiat. Techniques like "micro-insertion" allow for more practice addressing ethical issues for students throughout their technical courses, with little reduction in time spent on technical content.[20]

A framework used at multiple institutions and previously presented at the ASEE National Conference & Expo in 2013 by Bates & Loui[21] starts with identifying stakeholders, gathering information and considering alternative actions and consequences. These actions are then evaluated with a series of tests related to basic ethical values:

Harm test: Do the benefits outweigh the harms, short term and long term?
Reversibility test: Would this choice still look good if I traded places?
Common practice test: What if everyone behaved in this way?
Legality test: Would this choice violate a law or a policy of my employer?
Colleague test: What would professional colleagues say?
Wise relative test: What would my wise old aunt or uncle do?
Mirror test: Would I feel proud of myself when I look into the mirror?
Publicity test: How would this choice look on the front page of a newspaper?

While these questions give a concrete process for students (and faculty) to follow, students could also be given the option to review the dilemma with in terms of values such as honesty, fairness, civility, respect, kindness, etc.

Framework Implementation

This framework can be used to support activities such as in class discussion, reflective written assignments, or a combination of the two. Because identifying stakeholders is part of the task, students can be assigned roles as particular stakeholders to do preparatory written analysis before coming to a class discussion. A variety of class sizes can use this framework, particularly when small group discussions are incorporated. Small groups allow for intimate detailed discussion and reporting out to the larger group allows for dissemination of ideas and comparison of approaches. Group sizes of four are suggested in order to both allow for input from each participant and create potential for diverse experiences to be brought into the discussion. It can be beneficial to lay ground rules that ensure that each group member participates. In smaller classes, faculty may know student names. In larger classes, collecting an index card with the name of each group's "reporter" will allow the professor to call on groups by name and reach as many groups as possible.

Each group should be given the question framework, or alternately a value or values to evaluate a case study, dilemma description, or local, current issue that affects the students and/or their communities. A good example source of case studies is http://ethics.tamu.edu which contains dilemmas including conflicts of interest, acknowledging mistakes, dissent, whistleblowing, environmental and safety concerns, honesty and truthfulness, organizational communication, ownership, quality control and product liability, public service, responsibility, and gender issues.[22] Each group can be asked to identify stakeholders, consider possible actions, and evaluate consequences of actions. After discussing for a specified amount of time which depends on what is available to the class, and possibly ranging from 3-10 minutes or longer depending on the complexity of the case, teams report out to the larger group with the leader highlighting key issues as the group reports.

If writing assignments are used, they can be quickly graded using rubrics assessing quality of writing as shown in critical thinking (clearly stated meaning, accurate details, relevant and sufficient details, addresses complexity of issue, considers other points of view, internally consistent without contradictions) and ethical literacy (e.g., referencing professional codes, addressing human impact, addressing environmental impact, recognizing agents of change).[23]

Course Examples

While this framework is one approach and has been used in multiple courses of varying size, level, topic and focus (major related and multidisciplinary), there are many other types of assignments that can be used to incorporate ethical learning in classes. Working with the professional codes of the primary society for your students is one way. One suggestion presented by Rachelle Hollander[24] is to examine codes of ethics and how they have changed over time, looking at influential cases and societal changes that are reflected in the codes. Another is to look at case studies over time (whether over the length of a term or a student's academic program), where available information changes, as may student technical knowledge and sophistication in ethical thinking. Reflecting on changes in their own thinking can allow

students to observe their own learning and support the development of skills for lifelong learning in the future.

Other ways to incorporate macroethics are to ask students to find ethical issues that may be part of technical projects they are already doing.[25] Thinking about product lifecycles or waste electronics when designing a senior project prototype can provide a broader context beyond the technical implementation details. Engaging examples can also come from extracurricular hobbies, such as reading science fiction stories containing detailed imaginings of the impact of technology on society, or auto racing where alternative fuels and solar-powered cars can potentially motivate developments for daily use vehicles.

Real world ethical situations related to civil engineering, some of which include aspects related to taxpayer funding of public projects, can be found online at http://www.asce.org/Leadership-and-Management/Ethics/A-Question-of-Ethics/. These are published monthly and include discussion questions related to the ASCE code of ethics. This type of article can be used regularly in classes to promote discussion about specific situations and the use of engineering codes of ethics or to encourage students to explore the case more deeply. While civil engineering students might focus on the microethical issues related to their future practice, other engineering students might address the macroethical issues related to the impact of e.g., unethical practices related to federal funding.[26]

Available Resources

The online resources described below are taken from Bates et al., 2012[24] and Bates and Loui, 2013[21] and include the Ethics CORE (Collaborative Online Resource Environment), the National Academy of Engineering's Online Ethics Center, the E^3 project, and a list of other sites with ethics information.

The Ethics CORE (Collaborative Online Resource Environment) project is an Internet portal supporting ethics education in science, social science, engineering and math. It is being developed by the National Center for Professional and Research Ethics at the University of Illinois-Urbana Champaign. The online environment consists of tools such as searching, developing, and contributing resources, collaborative workspaces, discussion areas, wikis and blogs as well as essays on teaching and pedagogy, videos, online courses and links to other online resources. The portal can be found at http://nationalethicscenter.org/. For example, "The Practice of Ethics in Classroom Teaching,"[27] is a video showing ways to support student learning through ethical faculty behavior. All members of the engineering education community are encouraged to participate, whether by contributing resources or feedback, by actively participating in collaborative groups, or by using resources to enhance their teaching.

The Online Ethics Center, http://onlineethics.org, is a product of the National Academy of Engineering. It includes resources for responsible research, case studies, professional codes and guidelines, annotated bibliographies and a community of practitioners. Forums allow space for site users to learn more about the resource or to discuss particular case studies. Along with working through case studies, another way to use this center is to have students examine the various codes of ethics and to look at changes over time within the profession.[28]

The Exploring Ethical Decision Making in Engineering (E^3) project is a multi-institution team exploring issues related to ethical development in engineering students. Results of their work can be used to guide institutional and teaching practice to support ethical development. More information and publications can be found at http://www.engin.umich.edu/research/e3/index.html.

Other online sources for engineering ethics education are also available, primarily in the form of case studies that can be used in classes. Some examples are:

- National Institute for Engineering Ethics, Cases from the National Society of Professional Engineers Board of Ethical Review: http://www.niee.org/cases/
- Texas A&M Engineering Ethics: http://ethics.tamu.edu/
- The Ethics Education Library at the Center for the Study of Ethics in the Professions at IIT: http://ethics.iit.edu/node/62 (with other information at their site http://ethics.iit.edu)
- Penn State's College of Engineering Ethics: http://www.engr.psu.edu/ethics/casestudies.asp
- University of Washington Engineering Education ready-to-go Tools for Teaching: http://www.ee.washington.edu/research/dms/Tools_for_Teaching/Tools_for_Teaching/Home.html
- Case studies associated with 2008 textbook by Harris, Pritchard and Rabins[29]: http://wadsworth.com/philosophy_d/templates/student_resources/0534605796_harris/cases/Cases.htm

The National Institute for Engineering Ethics (http://www.niee.org) offers DVDs of three video cases that dramatize fictional but realistic cases: *Gilbane Gold, Incident at Morales,* and *Henry's Daughters*. Loui et al. (2003)[30] demonstrates how to organize discussion of *Incident at Morales* with small-group collaborative learning techniques.

Summary

There is significant value in incorporating ethics into technical courses as students see faculty, who are their engineering role models, spending time on the topic. It is not then held apart as something "others" (like philosophers) do outside of the context of the work of an engineer. While engineering faculty may be stepping outside of their comfort zones to incorporate ethics into their technical classrooms, the perspective they offer, or are able to bring into the classroom via industry guests, will support the development of contextual skills to address ethical dilemmas for their students. The resources and framework presented here are options for faculty to implement ethical learning in classrooms and student communities in straightforward ways that do not hinder, but can potentially deepen, technical learning by providing broader context for that knowledge.

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