# Engineering ethics as part of the core course in professional ethics

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## Abstract

Professional ethics is taught as a required general education (core) course in many undergraduate programs. We describe a model for collaborative teaching of professional ethics by a team that consists of (1) philosophers and (2) science and technology professionals. The model requires the application of philosophical principles of ethics to concrete ethical problems in the professions. Both consequentialist and non-consequentialist ethical theories are discussed, and students are encouraged to analyze ethical issues using both perspectives. I (1) describe the method of philosophical discourse that students learn in arriving at and justifying their ethical conclusions, (2) list the ethical questions in the practice of engineering that are examined in this course, and (3) report averages of student achievement scores on seven performance criteria relevant to this course.

## Introduction

The ABET accreditation criteria for engineering programs specifies[1], among other things, that the programs demonstrate that their students attain "… an ability to design a system, component, or process to meet desired needs within realistic constraints such as …ethical (*responsibility*)…", and "…an understanding of professional and ethical responsibilities". Similar accreditation criteria exist for the other undergraduate programs in engineering technology, computer science and applied science. Texas A&M University-Corpus Christi, which offers a B.S. program in engineering technology, requires all students to complete a junior level capstone core course in Professional Ethics. The origin of this course can be traced back to the Challenger explosion in 1986, when faculty discussion began regarding the inclusion of such a course in the curriculum. The novel feature of this course, unlike any other core course at this university, is that the instruction team consists of (1) faculty members from the philosophy program, and (2) faculty members from every other college who are knowledgeable about ethical issues in the professions that many of their students enter on graduation. The author is a physicist and a faculty member of the Department of Physical and Life Sciences. He has been team teaching this course for the past seven years, representing the professions in science and

technology. During 1995-96 the university organized a one year long training program in professional ethics, led by a visiting philosopher, for faculty interested in teaching this course on a regular basis. The author participated in this training. It was felt that a course that encompassed both theoretical and practical issues in ethics related to the professions was better suited to the overall educational objectives than a more specialized course such as engineering or medical ethics. The former would point to the many similarities in ethical issues in the professions, though each profession has its own ethical issues owing to the special roles and responsibilities that different professionals have to shoulder. Such similarities lend themselves to considering various professional ethical issues in a unified framework.

## Structure and content of the course

This 3 credit hour course is split every week equally between a lecture section taught by a philosopher, and a discussion section led by a faculty member from the college pertinent to the student's major. The Science and Technology discussion section is composed of students majoring in biology, biomedical sciences, nursing, chemistry, geology, geographic information science, mathematics, control systems engineering technology, and mechanical engineering technology. The course objective[1] is to " acquire some level of understanding of a variety of issues in moral theory and various moral problems that arise in professional practice and life. " The philosopher presents, in lectures, moral theories from two broad perspectives, consequentialist moral theories such as utilitarianism, and non-consequentialist theories such as those of Kant. The author presents, in the discussion section, the application of these theories in the professions of medicine, engineering, scientific research, and military science and technology. The overall skills expected as outcomes are " … a degree of proficiency in recognizing, evaluating and constructing moral arguments on more than one side of a moral issue."

The material for the lectures are drawn from the following topics[2]: morality as a normative system and its differences from professional code, law and religion; standards for ethical judgements, consequentialist ethical theories, non-consequentialist theories of Kant and Ross, rights and duties, the inappropriateness of the divine command and natural law theories, contractarianism and constructivism, possible differences between ordinary and occupational morality, characteristics of an occupation that qualify it as a profession, and relationships between professionals and clients[3]. The science and technology discussion section begins by clarifying to the smaller group of students in the section, how ethics is not synonymous with law, religion, and professional codes. Formal logic, through which students are encouraged to draw valid conclusions from premises on ethical questions, is presented using a variety of examples, clarifying the connection between logic and ethics. The distinction between valid and sound arguments, and why philosophers differ though they all use valid forms of the argument, is brought out through in-class exercises. This theme of clearly stating all required premises to support a conclusion is emphasized in every component of student assignments on ethical issues for this section. Other topics discussed in the section relate to issues of informed consent in medicine, ethical tests in engineering, ethics in biomedical sciences, including the use of

animals in experimentation, and conducting military research for a state that does not always subscribe to ethical norms[4].

No texts are used for either the discussion section or the lecture. All the course contents are made available through the web[2]. A significant part of the student's assignment is to post analyses on ethics at the course web site, for critique and response by other students. Each post is moderated by the faculty team for content and appropriateness, and graded on a 6 point scale. The posts are organized by threads, which are often begun by the faculty team. In their posts the students need to "focus on making a point (or points) and then giving reasons for the point(s) (they) have made … (They) may …make positive claims (in favor of policies, behaviors, views, etc.) or critical ones (disagreeing with policies, behaviors, views, etc.), but in either case it is essential to back up (their) claims by giving reasons"[3].

Students have to complete a project on professional ethics related to the profession they intend to pursue. The author suggests to engineering technology students that they consult a professional engineer with significant experience in industry or government on concrete ethical problems they encountered in their practice of engineering. Students submit an outline of the problem, which the author studies for suitability for further work. The students then discuss with him possible sources of information to further investigate the issue, the appropriateness of theoretical tools developed in the course that can be used for the project, and the overall structure of the project report.

## Course contents on engineering ethics

The material drawn from engineering ethics relates broadly to the " conflict between (1) the obligations to respect the rights of individuals and (2) the obligation to do what is best for the majority affected by the action. Some examples that are used in the discussions to illustrate this conflict are (1 ) Locating a landfill for the minimal environmental damage versus respecting the rights of those living near the proposed landfill site (city engineers' dilemma), (2) Choosing an energy system with the minimum of green house emissions (Nuclear Plants) versus respecting the rights of those living near the proposed plant who fear a radioactive fallout, and (3) Designing automobiles with moderate safety features to lower prices for customers versus the obligation to protect the lives of those who may be killed in accidents for lack of strong safety features. In the last example the infamous case of Ford's decision to market its model *Pinto* in spite of its knowledge of the exploding fuel tank problem is used to illustrate the injustice objection to utilitarianism[5]. The engineer's professional code specifies that "Engineers must be faithful agents of employers", and "Engineers must protect the health, safety and welfare of the public". The code assumes that corporate entities are moral agents that also subscribe to the professional code, an assumption that is often at variance with facts. Non-consequentialist ethical theories, such as those formulated by Ross and Gert, which prescribe rank ordering one's moral obligations, and allow for supercession of one obligation in favor of another, present a practical approach to resolve such a conflict.

## Assessment of engineering ethics learning and summary

The ethical questions in engineering that are considered for discussion and assessment in the course on *Professional Ethics* are: 1. Are automobile engineers morally permitted or obliged to use human cadavers in automobile testing? 2. Is it ethically permissible for a chemical engineering graduate to join a company manufacturing pesticides against personal beliefs that affirm the wholesomeness of organic farming? 3. Is it ethically permissible for an engineer, searching for a new position, to represent on resume the successes of a project she worked on, mentioning only her own contributions without acknowledging the contributions of others on the project team, and leading a prospective employer to draw false inferences? 4. Does a client own the engineering drawings commissioned and is the engineer obligated to provide that drawing to the client knowing that the client will misuse it? 5. Is it ethically permissible for an engineer to seal plans not prepared by her or checked/reviewed by her in detail, and relying entirely on subordinate engineers without a PE status who prepared it? 6. Is it ethically permissible for an engineer to take recourse to what he considers a convenient and safe procedure to deal with a chemical waste, even though it is in violation of EPA regulations? 7. Was Ford's decision, based on cost-benefit analysis, to put its model *Pinto* on the market ethically defensible, even though it had known fuel tank safety flaws that could have been easily fixed? Was it ethically permissible for engineering personnel at McDonnell-Douglas to be silent about known problems with the company's DC-10 aircraft's cargo-hold door, which resulted in one air crash and a second near crash?

The students' written responses to each of the above questions were graded using the assessment criteria shown below. Student scores for these assignments for the period 1999-2004, for a total of 273 students, were averaged for each criterion assessed.

| **Assessment criteria** | **Student score (%)** |
|---|---|
| Summary of the valid logical argument leading to the conclusion | 65 |
| Clarity of description of facts related to the issue | 92 |
| Articulation of conflicting moral values/principles | 82 |
| Articulation of decision on the case/issue | 91 |
| Justification of decision | 80 |
| Anticipation of and responses to possible criticism of decision | 67 |
| Grammar/Coherence | 73 |

The areas in which the author finds student improvement, based on written assignments and class discussions, include (1) the ability to articulate why professional ethical issues are problematic and not something they learned a long time ago through family or social institutions, (2) the ability to see merit in different perspectives on an ethical issue, and (3) the ability to relate the concrete professional (including engineering) ethical issues to the content in lectures and discussions. There is only a marginal improvement in their application of logic, their biggest hurdle being the compilation of the complete list of premises required to draw their desired ethical conclusions. This calls for even more discussion of examples on logical inference. One big source of disappointment is

students' inability to write clearly in formal standard English without spelling and grammatical errors, and their use of informal conversational language while attempting to make a significant point. This last issue needs addressing throughout the curriculum.

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## References

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