

Curriculum Innovation: Professional Responsibility

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Abstract: This paper describes course and curriculum development for integration of topics of professional responsibility at the undergraduate level of the Department of Mechanical Engineering at the University of Texas at Austin. The paper discusses the development of a two-hour credit (semester) course in engineering professional responsibility and the development of course material and curricula for topics of professional responsibility in a required writing course. The paper focuses on strategies for introducing Professional Responsibility as an academic topic of study early in an undergraduate student's academic career.

Keywords: ABET, professional responsibility, ethics, legal aspects, curriculum

1. Introduction

Engineering faculty across the world struggle with the integration of topics of professional responsibility into engineering undergraduate curricula. Since the 1950's, the curricula of study for engineering have become increasingly based in science and engineering science. This increase in analytical training has provided engineers necessary tools to address the technology needs for the 21st Century, but it has also had at least one undesirable effect. As the science and engineering science content of undergraduate programs have increased, engineering curricula have generally decreased the emphasis on engineering design and engineering professional responsibility (topics of safety, engineering ethics, engineering liability, intellectual property, etc.). The Accreditation Board for Engineering and Technology (ABET) and others have noted with concern the decrease in engineering design and professional responsibility in the curriculum. As an indication of that concern, the criteria by which ABET evaluates engineering programs in the United States require the integration of design and of topics of professional responsibility¹ into the curriculum.²

At the same time that engineering programs are considering how to introduce (and to integrate) these topics into a course of study, many programs are under increased pressure to reduce the number of hours necessary for completion of a B.S. degree in engineering. Universities are also under significant financial constraints that can make difficult the introduction of new material in any curriculum.

The Department of Mechanical Engineering at The University of Texas at Austin (UT-Austin) has increased student undergraduate exposure to topics of professional responsibility over the last decade. A central focus in our capstone design course is the "inherent (and unavoidable) impact" the practice of engineering has on society. The integration of topics of professional responsibility into the capstone design course has been successful for several reasons: design issues and dilemmas are inevitably intertwined with issues of professional responsibility; students in their last year of undergraduate study are better suited to a discussion of difficult issues than they are at any prior time in their education; and the course work is enriched rather than increased by the addition of this focus.

The Department strengthened undergraduate exposure to professional responsibility by taking advantage of the capstone design experiences in their senior year.³ Faculty recognized a need, however, to introduce the topics earlier in the curriculum, to integrate these topics into more courses, and give students who are really interested more opportunities for exploration of the many issues involved. This paper discusses the Department of Mechanical Engineering's efforts over the past few years to increase the exposure undergraduates receive prior to their senior year and describes the evolution of a two-hour credit (semester) course in engineering professional responsibility. The course, referenced as ME 204, was first offered in the 1998-99 Academic Year. The faculty significantly redesigned ME 204 after the first year (1998-1999 Academic Year) of teaching the course in order to take advantage of the lessons learned during the first year. The paper further discusses the revisions planned in

ME 333T (the department's required writing course). Those revisions, which will be implemented in the fall of 2000, will incorporate a discussion of Professional Responsibility into the writing curriculum.

2. The First Year: The Origins of ME 204, Professional Responsibility

In the Fall of 1997, the ME faculty voted to increase the exposure to topics of Professional Responsibility earlier in the undergraduate curriculum by adding a required two semester hour credit course in the freshman year. The course was organized with a 1-hour lecture consisting of 100 students and a one-hour workshop consisting of 25 students each. A textbook in engineering ethics was the required text for the class, and reading assignments were chosen primarily from that text. The goals of the course were ambitious. The Department wanted students to understand the demands, limitations, and potential obligations of their future profession. In addition the faculty expected students to sharpen their analytical skills with regard to the issues presented in the lectures and in the reading. The course, as originally organized, presented several challenges.

- A. How to engage students with the material? This was particularly challenging considering that this was the first engineering class for many of the students. Students at this level frequently have not yet chosen to be fully engaged in their own education. Moreover, engaging students in a large lecture section is always an interesting challenge, and it can be even more difficult during a student's first semester in a university environment.
- B. How to make students accountable? The second challenge was to induce freshmen, first-year engineering students to involve themselves in the reading and the lectures, and to think critically about the subject matter in a class in which content mastery is not the yardstick used to measure student performance. The initial approach was a writing-intensive class that called upon students to exercise their creative, analytical, and communication skills in a weekly essay based upon lectures and reading from the text.
- C. How to make the grading manageable? A writing-intensive curriculum has enormous merit in terms of potential benefit to students, but measuring student performance in such a class creates a significant burden for grading.

3. The Second Year: Re-Design of ME 204

The Department faced significant difficulties in teaching 100 freshman the techniques of analysis and inquiry in Professional Responsibility. Faculty took advantage of the lessons learned from the first year of teaching the course to significantly re-design the learning experience. As part of the re-design, faculty developed the following objectives for the revised course.

_ Develop an understanding of the Professional Responsibility of Engineers

- Develop analytical skills for identifying and evaluating issues of Professional Responsibility
- Develop an understanding of the differences between moral and professional responsibility
- Develop an appreciation of ancillary workplace tasks (health and safety, regulatory and code compliance, and hazardous material responsibility) as crucial engineering functions and duties.

To achieve these objectives faculty made changes in the pedagogical and the administrative approach to the course.⁴ (See Table 1.) The Department moved the course from the Freshman year to the Sophomore year in order to give students in ME 204 the benefit of engineering courses in their freshman year and to increase their analytical maturity. Instead of an existing textbook, faculty compiled and edited a course pack containing required reading.⁵ The material in the pack included discussions on the history of technology, engineering, design, creativity, the anatomy of a failure, ethics and engineering, intellectual property, etc. Readings were selected to supplement the topics and include selections from work by prominent authors on the history of technology and engineering, design and creativity, the anatomy of failure, ethics and engineering, engineering and public policy, and intellectual property and the law. It is useful to note that the lecture topics and workshop activities address the following ABET Criteria 2000:

- An ability to function on multi-disciplinary teams
- An understanding of professional and ethical responsibility

- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global/societal context
- A recognition of the need for and an ability to engage in life-long learning
- A knowledge of contemporary issues

Table 1: ME 204 Course Schedule (Spring Semester 2000)

<i>Week</i>	<i>Date</i>	<i>Lecture</i>	<i>Lab</i>
1	1/17/00	[none]	Introduction, Administrative
2	1/24/00	<u>Introductory Lecture</u> Assign QA1	QA1 Due --Present/Discuss in class Case Study preferences and discussion
3	1/31/00	<u>Intellectual Property</u> Assign WA1	<i>Derek' s Case</i>
4	2/7/00	<u>Engineering Code of Ethics</u> WA1 Due	<i>Fencing over Fences</i> Assign WA2/OA1 Case Study teams; Specifications
5	2/14/00	<u>Regulatory Compliance</u>	<i>Gilbane Gold 1</i> Assign WA3
6	2/21/00	<u>Guest Lecture: Environmental Law</u> Assign WA4	<i>Gilbane Gold 2</i> WA3 Due —Present in class
7	2/28/00	<u>Toward a Student Code of Ethics</u> WA4 Due	<i>Writing Tutorial</i> Mid-Semester Grade Summary
8	3/6/00	<u>Guest Lecture: Teams in Manufacturing</u>	<i>Academic Honesty</i> Discuss Semester Research Project Assign WA5/OA2
9	3/13/00	[no lecture]	[no workshops]
10	3/20/00	<u>Design Codes and Standards</u> Assign QA2 WA2 Due	<i>Case Study Presentations</i> OA1 Due (by schedule)
11	3/27/00	<u>Safety</u> Assign QA3 QA2 Due	<i>Case Study Presentations</i> OA1 Due (by schedule)
12	4/3/00	<u>Guest Lecture: Engineer and Society</u> Assign QA4 QA3 Due	<i>Case Study Presentations</i> OA1 Due (by schedule)
13	4/10/00	<u>Guest Lecture: Codes and Standards</u> QA4 Due	<i>Tweaking Data</i>
14	4/17/00	<u>Tour 1</u>	Oral Presentation tutorial
15	4/24/00	<u>Tour 2</u> WA5 Due Assign QA5	<i>Semester Project Presentations</i> OA2 Due (by schedule)
16	5/1/00	<u>Wrap-Up Lecture</u> QA5 Due Course Evaluation	<i>Semester Project Presentations</i> OA2 Due (by schedule)
17	5/8/00	[final exams]	

4. The Third Year: New Applications--Professional Responsibility in a “Technical Writing” Course

As part of our efforts of continual improvement, faculty are also developing an integration of the topics of Professional Responsibility into ME 333T, the required course in Professional Communications (previously titled as Technical Writing). The required writing course is a fitting arena for discussion and analysis of these topics. Because university writing courses have never been primarily concerned with content mastery, issues of a deliberative philosophic nature have often been the fodder for written and oral discussion. By changing the writing course to incorporate an exploration of ethics and professionalism in engineering, we will be using writing

instruction for a similar purpose: students will write and make presentations about the generative issues that arise in any discussion of controversial, multi-faceted questions. One of the many benefits of this strategy is that it incorporates ethics into the existing curriculum. The revised course in Professional Communication, when implemented should provide a cost-effective and efficient method to better integrate these topics into existing curricula without increasing course loads for engineering undergraduates.

Another benefit is that the integrity of the existing course will not be compromised by the revisions. In fact, we believe the course will be improved. One logical concern is that either students will be overburdened with more work or important material will necessarily be cut from the existing curriculum. There is no reason for either outcome to occur. In the 1999 syllabus, student assignments in ME 333T, Engineering Writing, are shown in the following excerpt from the policy statement:

“The major communications assignments in this course are

- instructions (a collaborative assignment);
- a memo requesting approval of your research topic (this assignment will include an annotated bibliography and a resume);
- proposal to perform a literature review (this assignment will include a revised resume and an executive summary of an article pertinent to your research);
- formal report;
- formal presentation; and
- an editorial pertaining to an ethical issue in engineering.”

In addition to these assignments, you will also work on several minor assignments. These will include a collaborative presentation on one chapter from the text, a definition of a technical term, and several peer critiques. These assignments will be graded on a credit/no credit basis.”

In the fall of 2000 the policy statement will change to reflect the incorporation of topics on professional responsibility and ethics, but those changes will be minor. Students’ reading assignments will be increased by the introduction of a course packet that will consist of 12 to 15 articles on engineering ethics and professional responsibility. These articles are chosen from contemporary literature on pertinent issues. Authors include leading thinkers in the field such as Henry Petroski, Samuel Florman, Edward Tufte, Deborah Johnson, Mike Martin, and Roland Schinzinger. All of the communication assignments currently listed on the policy statement will remain although some of them will be changed slightly. For instance, the executive summary, which is listed as an attachment to the proposal, will become a separate assignment in which students will summarize and analyze an article pertaining to engineering ethics and/or professionalism that they locate outside of class. The chapter presentation, which is mentioned briefly in the section on minor assignments, will also change. Instead of working in groups to present a chapter from the text, students will work in groups to present an analysis of one of the articles in the reading packet. In addition, students will be required to emphasize the ethical and social significance of their research topics even more than they have in the past, and in general there will be more emphasis on rhetorical strategies and argumentation. The requirements on some other assignments will be adjusted, but none of the changes significantly increase the workload for the students or undermine the purpose of the writing course.

The goals of the course are stated in the 1999 policy statement:

“Mechanical Engineering 333T is an upper division communications course that focuses on professional modes and styles of discourse in the field of engineering. As a required course for all Mechanical Engineering students, it fulfills part of the University's substantial writing component requirement and is a prerequisite for ME 366J. The primary goal of this course is to give students the opportunity to develop confidence and skills as writers and speakers in a professional setting. To accomplish this we will explore ways of developing analytical, organizational, and writing skills.”

All of the revisions to 333T can be made without compromising any of these goals. In the Fall 2000 policy statement, the goals will be expanded to indicate that ethics and professional responsibility will be primary topics of discussion in the class. We believe that expansion will improve our methods of encouraging analysis, allow our students to explore the importance of ethics and professional responsibility in their careers, and give the College of Engineering a significant opportunity to meet the ABET 2000 Criteria.

5. The Third Year: ME 204 as an Elective Course

During the third year, ME 204 will be offered as an undergraduate upper division *elective* (with changes in depth of coverage). This change allows the material developed for ME 204 to continue to enhance the curriculum without adding an additional requirement to the overall course load and allows students to pursue the topic in one of their engineering electives. ME 204 provides exposure to a broader set of topics than previously offered at the undergraduate level. The faculty designed the course to actively involve students in their own education and in difficult questions of engineering professional responsibility. Moving the course out of the freshman curriculum into the later semesters improved student learning. Students at that level demonstrated better maturity to consider intricacies of the issues involved in the profession. The course organization (one-hour of lecture per week in a large lecture hall and one hour workshop in a group of approximately 20-30 students) provides an opportunity to efficiently teach the material, while at the same time involving students in small discussion sections. Students particularly appreciated the way industrial guest speakers reinforced the topics and analysis developed in the classroom. As a demonstration of student involvement, in the Fall of 1999 student teams proposed implementing and enforcing a student-developed honor code in the Department of Mechanical Engineering. Some of the team members are now pursuing the adoption of the honor code by students in the Department and in the College of Engineering. Additionally, a student team from the course has been invited to make a presentation based on their work to a panel on Industrial Ethics at the ASME 2000 International Mechanical Engineering and Exposition. Faculty are still refining ME 204, and the course will continue to be offered as an upper-division elective beginning in 2001.

6. Applicability to Other Engineering Programs

Other engineering programs can readily adopt either of the two approaches described in this paper. ME 204 represented a significant milestone in improved coverage of professional responsibility into the undergraduate curriculum in the department. The course is straightforward, effective, and engaging. It could be easily adopted into any curriculum, if not as a required course (which would add to the undergraduate requirements for graduation), it could be incorporated as an elective, thereby giving students the opportunity to pursue their interests in professional responsibility. Moreover, the changes to ME 333T (Professional Communications) could be equally useful in other institutions. Any College of Engineering that offers a writing course could incorporate changes similar to the ones proposed here without undermining current curriculum, exhausting students with more work, or overburdening faculty.

7. Conclusion

Engineering Professional Responsibility has never been more important than it is today. The impact of technology, globalization, and electronic communication are changing the world, and engineers are at the forefront of those changes. ABET recognizes that the engineers we educate today will face dilemmas and difficulties that cannot be resolved with a calculator and a formula. Engineering educators must discover new ways to help future engineers face the challenges of their careers. The evolution of the described in this paper is one facet of that pursuit.

References and Footnotes

¹ For the purposes of this paper the term "Professional Responsibility" includes the following topics: Safety and Welfare of the Public, Engineering Professional Ethics, Intellectual Property, Engineering Liability, Quality, Communication, and Environmental Responsibility. (For a discussion of the selection of topics, the authors recommend, Nichols, Steven P., Weldon, William F., Professional Responsibility: The Role of the Engineer in Society, *Science and Engineering Ethics*, Vol. 3, No. 3, 1997.)

² Criteria for Accrediting Engineering Programs Effective for Evaluations During the 1999-2000 Accreditation Cycle, Approved November 1, 1998. Accreditation Board for Engineering and Technology. See also: www.abet.org.

³ Nichols, Steven P., Designing Engineers: An Approach to Integrating "Professional Responsibility" in Engineering into the Capstone Design Experience, *Science and Engineering Ethics*, Volume 6, Issue 3, 2000.

⁴ Moore, C. Aanstoos, T., Nichols, Steven P., Designing Assignments for an Engineering Course in Professional Responsibility: The Challenges and Rewards of Encouraging Analysis, ASEE Gulf Southwest Section Meeting, New Mexico State University, Las Cruces, N.M., April 5-8, 2000.

⁵ Aanstoos, T. (ed.), *Readings in Engineering Ethics and Professionalism*, Required readings in ME 204, The University of Texas at Austin, January 2000.