

# **ENGINEERING AND SOCIETY: AN INTERDISCIPLINARY COURSE IN THE SOCIAL ASPECTS OF ENGINEERING PRACTICE**

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## **I. INTRODUCTION**

Over the past five years the Electrical Engineering Department at the Watson School of Engineering and Applied Science has required a senior-level course for all EE students titled "Engineering and Society". This two credit hour course is designed to address both professional preparation for students who will be entering the technical work force, or continuing with graduate school, and to address concerns regarding the ethical behavior of professionals in the technical workplace. Addressing these issues is vital to the success of our students not only as engineers in their chosen field but as responsible citizens in a technologically complex world.

## **II. GOALS**

It is important that an engineering program meet the needs of students to become familiar with the ethical dilemmas that they will face as employees and employers in the engineering workplace. These dilemmas face all citizens in a society that enjoys and relies upon the benefits of advanced technology but are particularly important to those who will be technological decision makers.

With an increasingly difficult and diverse job market, and the expansion in the numbers of technically educated workers, it is incumbent upon engineering schools to provide their students with the broadest possible education as well as the best technical training. This goal led to the introduction of "Engineering and Society" as a replacement for a senior seminar that had been primarily focused on employment opportunities and job search skills. This new course does not neglect the issues of job search and opportunities but includes them in the form of discussions on job hunting skills, workforce trends, and engineering economic analysis.

As practicing engineering professionals the faculty of the Watson School is also especially aware of the necessity for developing communication skills, both written and

verbal. This concern adds another dimension to the level of support shown for a course which emphasizes writing and the verbal communication of ideas.

The personal interests and goals of the individual instructors who have developed this course are also extremely important in the evolution of the structure and focus of the course. The instructors who have taught this course bring an interesting mix of experience and background to the teaching of a course on the social aspects of engineering practice. Professor Richard Schwartz is a lifelong educator, engineering practitioner, and academic administrator whose experience of the development of modern US technological society provides the students with a broad and comprehensive perspective on which they can draw and against which they can test their own ideas and perceptions. Professor Linda Head, new to engineering practice and education, brings unique perspectives that include concern for non-traditional practice, gender based analysis of current culture, and the consciousness of possibilities for an alternative critique of both technology and technological practice. Professor Theresa Sadeghi is an adjunct professor with a strong background in manufacturing engineering and control systems. She had won department and school awards for excellence in student advising and is considered by her colleagues to be a strong advocate on student related career issues.

It is most important in the presentation of a course such as this one to provide the students with a measure of autonomy in the selection of topics, or different aspects of topics, which will be considered. This gives the students a sense of being individually responsible for making decisions about ethical issues that are important to them rather than learning to accept institutional or corporate dictates regarding appropriate behavior. It is in the manner in which the discussion proceeds, the awareness of which issues were chosen, and why and how the issues are dealt with, that the responsibility of the instructor to provide guidance enters into the classroom interaction.

### III. STRUCTURE

During the five years that this course has been taught the syllabus has changed based on factors that have been determined by the individual instructor having responsibility for the course in the current semester. For example, some semesters the discussion section of the course has been totally project-based with students researching and presenting different topics on their own; other semesters discussion has been based on readings from a single text or from anthologies.

The discussion sessions are, of course, the core of the curriculum. This is the portion of the course where students are introduced to the topics that will be analyzed and introduced to the methods of criticism which they will use to move beyond a superficial consideration of these topics. Initially it is important to communicate to the students that they already possess the skills to form an intelligent opinion about which issues are relevant to the environment in which they live and work. The opinions which they have formed in working, reading, and studying thus far in their lives are valid ones. It is also

important, though, to insist that they will have to perform some research into these issues in order to identify the relevant and problematic aspects which are the most fruitful for consideration and discussion. For these reasons the students are assigned the task of preparing and leading the class during these discussions. It is often difficult for the students to function in a classroom atmosphere where the goal is not necessarily to come to consensus. Even though they have been introduced to the concept of engineering design by this point in their education, they are only beginning to work with the notion of competing ideas and problems that do not have a correct answer. Engineering instructors have schooled their students (and been well schooled themselves) in the process of "answering" questions that can be decided based upon reference to a single set of principles and understandings. Now the students must add a new set of skills to their repertory, gaining confidence in their ability to answer questions that do not appeal to a single world view.

The course usually begins with an introduction to the topics and types of topics which will be addressed. Next discussion among the students takes place about the importance of these topics and what initial perceptions exist individually and are shared by the group. An early writing assignment is given in the form of a response paper on a topic covered in the initial discussion. This early writing assignment is primarily a diagnostic tool for identifying any students who might have more than normal difficulty in writing, either technically with grammar and structure or conceptually in presenting an argument.

The remaining weeks of the semester are spent in the core area of discussion regarding topics in the area of engineering/science, technology, and society. A typical set of topics might be:

- Images of Engineering and Science
- Motivation for the Doing/Studying of Engineering
- Current Opportunities - Current Job Market
- Effects of Science/Engineering on Public Policy (and vice versa)
- Corporate Society and the Practice of Engineering
- "Engineering" Ethics
- Values, Their Influence on Engineering Practice
- Funding and the Social Usefulness of Science/Engineering

The students are required to participate in the decisions regarding the presentation of these topics, how they are addressed, what is emphasized, and the format of the discussion sessions. However, the guidance and participation of the instructor is required (and crucial) to the final format of the sessions.

Two factors have prompted a reorganization of this course in the past year. The first is that engineering students respond more enthusiastically to a course in which they actively engage topics with field trips, experiments, demonstrations and small group discussion of topical and highly relevant issues. They are much less intrigued by complex

philosophical treatments of even some of the same ideas and issues. Second, there has been increasing encouragement from the administration at Binghamton University to provide interdisciplinary experiences for all students at the university. This has led to an opening of the course to students outside the engineering school. Opening the course to non-engineers means attracting and meeting the needs of students who are more likely to be interested in an ideas-based treatment of the topics.

The reorganization of the course will address the two factors, active engagement and ideas-based learning, mentioned above. Using the technique of reporting on new scientific and technological developments with an accompanying commentary on the social, environmental, and political effects, the engineering students will be encouraged to explore the social-interactive aspects of their profession which are not normally addressed in engineering courses. Field trips to technical workplaces and onto the Internet to grapple with the complexities of modern communications will encourage the non-engineering students to develop their technological curiosity while pursuing the critique of the social implications of science and technology.

#### IV. DISCUSSION

As a technique for encouraging a critical view of the world, the students are required to select either 1) the topics which are most relevant to them or 2) the aspects of assigned topics which they find most compelling for discussion. It is often the case that the complexion and internal dynamics of the class itself will dictate the direction and format which the structure of the class assumes. We have found that, given free reign, engineering students find a voice for the political, moral, and ethical passions which they do not often have the opportunity to express in their technical classes. Students are often somewhat naive in their ability to perform a political or social critique, often they expect the social world in which they will be working to be an extension of their home and school experiences. For the majority of our students, who are nearly all of traditional college age, moral learning has come from home, neighborhood, and religious affiliation. Few of our students have had significant experience of the world outside of their early environment or formal education in rational methods of social criticism. Consequently, these students tend to personalize all aspects of their interactions, seeing moral good as having primarily to do with their individual responsibilities to themselves and their immediate family and friends. A common perspective is that the greatest value is the support of a family and that the possibility of more global perspectives and values such as justice, freedom, or self determination are of secondary importance to them as individuals. Our hope is that rather than provide these students with just another "canned" set of preconceived notions that echo the corporate or "engineering" point of view, we will provide them with the idea that they can question their (or any) existing point of view. It certainly is not going to occur that in a two credit hour class the skills to breakdown, critique, and reconstruct a moral system will be communicated. However, it is entirely possible that some awareness of the possibility of difference can occur. The

students can begin the journey to responsible adult citizenship by learning to question the authority of their own internalized perceptions.

## V. ANALYSIS

Determining effective pedagogical methods for addressing ethical issues with engineering students who have not been extensively schooled in the methodology of social critique remains a concern in a course where class time is limited and potential topics are not. A course of this nature is extremely difficult for an engineering professor to teach - it requires the investment of time and energy, and openness to new ideas, by a person who was probably not formally schooled in the methods and ideas addressed in this course. Through natural processes of self selection the people who choose to develop and teach a course such as this one are at least willing to make some investment in the course and the ideas addressed. The motivation and sophistication of the instructor are important; students are usually quick to detect indifference and/or an attempt at imposing an agenda rather than guiding learning. Since the "work" of the course occurs both in group discussion and in individual response papers that are a conversation between the student and the instructor, it is important that a cooperative environment be created in the classroom and a safe and trusting relationship be created between the individual student and the instructor. This class, to be fully effective, requires intimate learning where both the student and teacher are actively involved in a conversation about issues, ideas, feelings, reactions, responses; all the nuances of an introduction to topics that are outside the stereotypical interaction between an engineering student and engineering professor. This is a risky enterprise for all. The surrender of control over the transmission of facts that is the typical process in a technical classroom is essential both on the part of the student as receiver and the instructor as transmitter. Both must take on the less structured role of mutual "seekers" after understanding and appreciation of questions that are often left unresolved.

## VI. CONCLUSIONS

The success of a course such as "Engineering and Society" depends upon the commitment, good will, and energy of the school administration for allocation of teaching resources as well as the interests and concern of the individual faculty members. Engaging students, motivating them to work productively at social and moral critique during a school semester filled with difficult technical classes, and providing thoughtful and consistent responses to their work is a challenging teaching assignment. And assessing the results of such a project is not easy, straightforward, or even likely in the short term. The results of a consideration of the issues addressed here will be apparent over the long term in the student's work and personal decisions throughout their careers. Since we do not create real moral dilemmas for the students to solve, we can only suggest likely scenarios and hope that the ways of analyzing these will resonate now and in the future as they become workers and leaders in the technological workplace. Beyond the benefits to the students, there is also the purely selfish benefit for the instructors who

have the opportunity to learn from their students, from the process, and from the exposure to new ideas and disciplines that challenge our own preconceptions. Finally, the duty to provide the broadest possible education to our students is primary. In an economy where versatility, flexibility, and a comprehensive perspective are crucial to creating a satisfying career, engineering educators owe their students every possible opportunity to learn all of the necessary skills. The course “Engineering and Society” is one of the many important efforts to achieve this goal made by the Electrical Engineering Department at the Watson School of Engineering.