Work in Progress – Ethics Integrated Into Engineering Courses

David A. Rogers¹ and Paulo F. Ribeiro²

Abstract - The very nature of engineering implies a commitment to ethics. Ethics education can occur in a wide variety of engineering courses. Beginning with first-year courses and continuing through the curriculum, students are taught to sort through the facts and constraints of engineering projects and search for solutions that best serve the user. Many students experience a philosophical, historical, and professional approach to the general topic of engineering ethics and social responsibility by taking a formal course in engineering ethics. Professional ethics can be integrated into course or capstone projects. In graduate courses, students receive explicit instruction in research ethics. The graduate who has been through a variety of ethics education experiences will be in a better position to leave the university and accept the very serious demands of the vocation.

Index Terms – Curriculum, Engineering ethics, Research ethics, Social responsibility.

INTRODUCTION

The very nature of engineering analysis and design implies a commitment to truth, which involves finding the best or optimal solutions for the customer. Teachers of engineering ethics often deal with questions about the fundamental philosophical underpinnings of moral decisions. Ethical standards are rooted in human understanding of the meaning of life. In Abolition of Man [1], C. S. Lewis advocates the existence of an objective moral code that transcends time and culture. Those who are part of historic religious communities believe that ethics is rooted in a moral code that is discernible in human experience and consistent with and enlightened by religious experience. There are dangers inherent in denying the validity or possibility of objective moral judgments. For example, without the concept of objective truth and a moral code there is no firm basis for the constraints on what social and political and cultural elites might do to control and reshape society. The engineer’s code of ethics would be rooted only in what contemporary society permits. Moral decisions could be the objects of legal or political power struggles. In a public institution supported by a pluralistic society, the instructor can appeal to the common human experience of behaviors that promote the common good in a civilized society. In a private institution engineering ethics can be rooted in the concept of objective truth and the moral code that is commonly shared by the community that the institution serves.

The engineering profession in the United States has focused on ethics since its legal foundation [2]. Those committed to the idea of engineering as a profession have long emphasized the responsibility the engineer has to the public [2]-[3]. Reflection on the range of professional ethics instruction that occurs both implicitly and explicitly in the educational experience of engineering students leads to a positive appraisal of this activity.

ETHICS IN THE CURRICULUM

The importance of ethical performance of the profession can be studied in any engineering classroom. For example, in laboratory courses students learn respect for honest data collection and interpretation. In course projects, students work under constraints and responsibilities that closely model the demands that they will face after graduation. At North Dakota State University (NDSU), ethics education segments have been created for use in the “Impact of Technology on Society” (ENGR 312) and in “Advanced Research Methods in Engineering” (ENGR 789). Ethics and social responsibility is a principal concern of ENGR 312. Following Barbour [3], a broad foundation for practicing engineering in a way that is consistent with global environmental and human problems is approached from a historical and philosophical perspective. ENGR 789 is devoted to developing the research capabilities of the Ph.D. student. The instructor introduces the students to institutional expectations in the areas of academic integrity and research ethics. Students experience a philosophical, historical, and professional approach to the general study of engineering ethics by taking ENGR 402 (“Engineering Ethics and Social Responsibility”) during their career at NDSU. Throughout their studies students learn from engineering faculty the importance of performing that profession at the highest possible level of service to society.

Engineering ethics is rooted in a commitment to the truths of science and their use to improve life in this world. To paraphrase Steve Covey [4], the focus of the ethical practice of engineering should be the practice of engineering in an environment of trust and competence by engineers who know the limits of their competence and are trustworthy in the use of

¹ David A. Rogers, Dept. of Electrical and Computer Engineering, North Dakota State University, Fargo, ND 58105, David.Rogers@ndsu.nodak.edu.
² Paulo F. Ribeiro, Dept. of Engineering, Calvin College, Grand Rapids, MI 49456, p ribeiro@calvin.edu.

© 2004 IEEE
their craft. As suggested earlier, in formal engineering ethics courses these practical ethical concerns can be approached as applications of principles learned in the human struggle to develop a civilized, just, and sustainable society [5].

**THE CHALLENGES OF ETHICS**

Intense study of science and mathematics along with the development of specialized knowledge in a particular branch of engineering gives the student the technical development necessary to meet the challenges that life will present in making a profit, obeying the law, serving society, and providing products that are safe, durable, and suitable.

Throughout the curriculum faculty can foster student development of an awareness of ethical responsibility. The professor can promote a consciousness and commitment to a process of lifelong study of ethics, which might be outlined as follows:

1. Recognition of factors or influences that guide my life.
2. Identification of virtues that should be central in my life.
3. Recognition of the impact of these virtues on others.
4. Acceptance of the consequences of (2) and (3).
5. Apply myself to ethical dilemmas of the workplace.
6. Commit myself to lifetime learning in ethical issues.

In a program that demands a high level of technical understanding, the importance of personal and professional ethical performance can be ever present in the classroom.

**PROFESSIONAL ETHICS**

A formal engineering ethics course and the capstone design experience help students to learn traditional engineering boundaries in product or process development as suggested by the following checklist (which can be introduced in a variety of engineering courses):

1. Unusually or unnecessarily high cost to purchaser.
2. Hidden or future danger in the product.
3. Product that has a use or potential use the engineer finds objectionable (produced under unprincipled leadership).
4. Product that is hazardous to manufacturing employees.
5. Product using a stolen design.
6. Manufacturing or working in an environment that discriminates against people because of race, religion, gender, national origin, disability, etc.
7. Producing a product or service that has an overall damaging effect on the culture(s) where it is produced or used.

This checklist assumes that engineering design includes an ethical foundation.

**CONCLUSION**

Engineers who are committed to moral reasoning and a lifetime committed to a high road of human conduct find that an essential asset in this pathway is a solid education in the technical methods of their field. The technical knowledge must be guided by the conscience of an engineer that is clearly informed about the full range of consequences of personal and professional activities. Professors and practicing engineers need to realize that ethics is at the foundation of sound engineering practice. Lewis argued in essence that if the practitioner doesn’t start with a commitment to ethical practice, he or she has no chance of achieving ethical outcomes [6]. Technology without ethics is a disaster waiting to happen. Ethically informed engineering is a positive contribution to human civilization.

**ACKNOWLEDGMENT**

This is to acknowledge our debt to Dr. Donald L. Stuehm (Professor Emeritus, NDSU) and Dr. Jenny L. McLaughlin (formerly at NDSU) for valuable discussions when this paper was in its formative stages [7].

**REFERENCES**