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Why Teach Ethics in Science and Engineering?*

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This presentation will focus on four matters: context, National Science Foundation (NSF) emphases, professional emphases and pedagogy.

In talking about context, the speaker will make the point that Larry Busch and Dale Jamieson brought home to her: that science, engineering and technology change human relationships in space and time and that these changed relationships have ethical implications. Why and what teaching ethics in science and engineering is all about in the grand scheme of things is recognizing the implications. Dishonesty in science and engineering has enormous implications because science and engineering change and are victims of changed relationships in space and time. And no one needs much prodding to think about the implications of ozone holes or global warming. These are all implications and problems that follow from the success of the human species on the planet. These implications and problems require the recognition that legitimate expectations, feasible control and due care all involve individual and social processes of careful negotiation if human well-being and social justice are to be maintained or expanded.

NSF has had a program supporting research and educational activities examining the ethical and value aspects of the interactions of individuals, institutions and science and technology since 1976. Particularly since 1981, it has taken two major orientations towards the subject: ethics and conduct in science and engineering, and ethics and the impacts of science and engineering. While distinct, these subjects overlap. Stephen Unger talks about the two as "getting the job done right" and "getting the right job done." To teach ethics in science and engineering, both aspects should matter. Take a topic like "intellectual property". One concern is for such things as not taking a colleague's credit. Another concern is for rights to

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indigenous knowledge. Emphasis in both research and education in ethics and values studies must be, in part, to enable people to develop an adequate moral vocabulary so that they can negotiate with each other on these issues without the impoverished vision that they must otherwise bring to the discussion. Through the projects, research and educational, that it supports, Ethics and Values Studies at NSF contributes to the what and how of this social discussion.

At the ideal edge in the professions and pedagogy, developing and using this vocabulary in intellectual and social interactions allows scientists, engineers and others to exercise creativity and leadership in using their expertise to identify, illuminate and meet social goals. It allows important social institutions like universities to make important social contributions - well beyond some narrow sense of scientific or technical or engineering expertise - when the faculty can enable the students, who are persons who will need to continue these negotiations into the next generation, to practice developing the conceptual, intellectual, empirical and social skills that they need to do so appropriately.

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Deborah G. Johnson

The rationale for teaching ethics to engineers and computer scientists seems fairly obvious. Their work (developing, designing and implementing technologies) has an enormous impact on the world. It affects our everyday life as well as our larger social, economic and political systems. If their activities are to serve the good of humanity, we need engineers and scientists who are aware of the social implications of their activities and are willing to take some responsibility for them. We need engineers and scientists who collectively and individually will set standards that lead to safe and useful technologies with minimal negative consequences.

I have not found it a problem to convince engineering or computer science faculty of the importance of this topic. In fact, the Accreditation Board for Engineering and Technology (ABET) and the Association for Computing Machinery (ACM) have been pressuring departments to address ethics in their curriculum. What is more problematic is recruiting engineering or computer science faculty to teach ethics courses.

Here is a sketch of what a course on engineering ethics might look like. The course could begin with the codes of conduct of engineering professional societies. These codes embody what members have agreed upon as the basic commitments of the profession. They also often express ideals that engineers aspire to.

The engineering codes of conduct generally express responsibility to three parties: to society, for public welfare and safety; to employers; and to clients. These responsibilities or duties can be the core of a course on engineering ethics and are used as the principle of organization for *Ethical Issues in Engineering* (Prentice Hall, 1991). A set of issues arises under each, as follows:

Responsibility for Public Safety and Welfare - What is the ground of this responsibility? What does it entail? How far must an engineer go to fulfil it? What is the proper role of engineering in society? Should engineers be led by others? Should they act paternalistically on behalf of society?

Responsibilities of Employers - What is loyalty, and does one owe loyalty to an employer? What are the limits of loyalty? When is whistle-blowing justified? What are the limits on demands to maintain trade secrets?

Responsibilities to Clients - How should we understand the ethics of client-professional relationships? How should we handle conflicts of interest? What do professionals owe in the way of confidentiality and candor?

The course can take up other issues before and after this core. Before addressing these issues, one might discuss the history of engineering, develop a theory of what engineering is, discuss the corporate and business world as the context in which many engineers work or discuss the different branches of engineering. After the core, one might take up special topics or cases, such as risk, the environment, changes that might be made in the profession or in engineering education.

Whatever the structure of the course, case materials are important. Engineering students especially seem to be "hands-on" oriented and cases allow them to see how the issues play themselves out in real world situations. The cases allow them to identify as engineers and ask themselves what they would/should do.

When the speaker teaches a course on Ethical Issues in Computing, she does much of the above in a section called Professional Ethics. Most of the course is focused on generic ethical issues that widespread use of computers seem to raise. These are property rights in computer software, privacy, liability for malfunctions in computer software, hacking, and autonomy and access.

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Jonathan R. Beckwith
"Teaching social responsibility in genetics"

Historically, progress in genetics has presented a double-edged sword. Genetics has provided and continues to provide beneficial information in the areas of health and agriculture. However, early in this century, the rediscovery of Mendel's laws of inheritance led many geneticists to argue for genetic factors in people's social behavior. Their support for the eugenics movement in the United States and the Racial Hygiene movement in Germany contributed to the severe consequences of these programs. Even when geneticists withdrew their approval of eugenics theories, they did not speak out against the misuses of genetic research.

Today, progress in human genetics, strongly facilitated by the federally funded

Human Genome Project, has been accompanied by a resurgence of scientific arguments for genetic determination of human behavior. These arguments can contribute to discriminatory practices and worse. In their education, geneticists, like other scientists, are not exposed to the history of the social connections of their field, nor to any discussion of social responsibility in science. More systematic integration of the social issues associated with science into "straight" science courses can contribute to a greater social awareness among scientists.

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Betsy Fader
"Ethics education outside of the classroom"

It is widely recognized that science and technology are shaping the world in increasingly profound ways, raising complex questions and often creating new and unintended social and ethical challenges. If we, as a global community, are to avoid the misapplication of technology in the future, it is critical that young people - the future decision makers and managers of technology - be trained to understand and resolve these challenges.

Many professionals consider it the responsibility of academe to teach ethics and to convey a values system to students. However, ethics in science and engineering can be "learned" in innovative, creative and, perhaps, more effective ways outside the classroom and laboratory through hands-on, interactive educational experiences. Likewise, teaching ethics in science and engineering need not wait until the student is advanced in his or her education, ready to embark on graduate study or enter the workforce. Ethics education can begin as soon as the student has learned to think critically, to ask provocative questions and to challenge pre-existing assumptions. It can and should be taught in ways that illuminate the individual as an agent of positive social change, capable of affecting both local and global communities.

Student Pugwash USA, a national, educational, non-profit organization, is dedicated to building a commitment among young people to integrate social and ethical concerns into their academic, professional and personal lives. Our extra-curricular educational activities promote the analysis and resolution of critical global problems through informed decision making and the responsible use of science and technology.

Student Pugwash USA activities currently extend to students at over 150 college, university and selected high school campuses across the country. Our programs, including the campus-based Chapter Program, International Conferences on science, technology and social responsibility, New Careers and Mentorship projects and Professional Pugwash (for "alumni" and nonstudents) are student-motivated and, in many cases, student-run. Through these interactive and interdisciplinary initiatives, Student Pugwash USA educates young people on the relevance of science and

technology to their own lives and on its ability to shape the future of the global community.

Student Pugwash USA stresses individual participation in the creation of a secure and sustainable global community. The organization's educational initiatives, including international, national and regional workshops and the promotion of socially-responsible professional experiences, enable students and professionals to jointly explore meaningful avenues of involvement in the resolution of social and ethical dilemmas, particularly those provoked by scientific and technological advancement. By integrating academic training with experiential, mentor-guided activities outside the classroom, students increase their understanding of the complex challenges awaiting them in the professional world and of their role as the future problem solvers.

The dialogue promoted through Student Pugwash USA's programs is intergenerational, international and interdisciplinary, recognizing that discussions of ethics and values among individuals from different disciplines, nations, cultural backgrounds and ideologies are rare. While a uni-dimensional approach to a problem can sometimes yield valuable information, it is only through careful consideration of a variety of perspectives and opinions that complete understanding and, hence, compassion, caring and moral responsibility can result.

It is clear from students' desire for and interest in Student Pugwash USA's programs that young people seek educational opportunities that will facilitate their entrance into the professional world equipped with the skills and understanding necessary to perform ethically and responsibly, and with the knowledge that they, as individuals, can make a difference. As the pace of technological advancement quickens and the need for an informed and active citizenry intensifies, organizations such as Student Pugwash USA that extend social and ethical education beyond the classroom will become an increasingly valuable supplement to the formal education process.

PRINCIPLE SOURCES

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