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The Environment for Science and Engineering

This chapter provides a summary of material from the presentations, responses, and discussion related to the first session, *Needs and Issues for Ethics Education in Scientific and Engineering Research*. In preparing their remarks, panelists were asked to consider the following questions:

> Investigators and students exist in complex research and learning environments that include academic and other organizations, such as professional societies, commercial research laboratories, government funding agencies, and peer-reviewed journals. What do these individuals and groups identify as the main impediments to developing effective responsible research programs? Are there conflicting ideas about what these impediments are and what to do about them?

The panel was chaired by Francisco Ayala, a member of the NAS and of the project's advisory committee, and University Professor and Donald Bien Professor of Biological Sciences, Ecology and Evolutionary Biology at University of California, Irvine . The speakers were Joseph Helble, dean, Thayer School of Engineering, Dartmouth College; Deborah Johnson, chair, Department of Science, Technology and Society, University of Virginia Charlottesville; Michael Mumford, professor, Psychology Department, University of Oklahoma Norman; and Wendy Williams, director, Research Education, The Children's Hospital of Philadelphia. The respondents were NAE member Paul Citron, chief technology officer (retired), Medtronic; Hugh Gusterson, professor, Department of Sociology and Anthropology, George Mason University; and Susan

Silbey, Leon and Anne Goldberg Professor of Humanities, Massachusetts Institute of Technology (MIT).

At the beginning of the meeting, when attendees attempted to explain why ethics education is important, they proposed a variety of answers. Some described well-known instances of research misconduct. Others referred to less well known, but equally deleterious research practices that undermine both public trust in science and engineering and the integrity of research, for example, honesty in recording data and acknowledging research contributions. Still others noted that the responsibilities of academic institutions and research faculty include training and education that promotes the understanding and application of the ethical standards of academia and specific fields. Some referred to former students, who had told them that only when they were faced with difficult ethical questions on the job did they recognized the value of the time spent on those and other ethical issues during their education. And some noted that sometimes the brightest and most socially aware students turn away from research programs and careers that do not live up to their ideals.

> A lot of research investigators are alienated by an incentive structure that makes their community nasty, individualistic, and competitive. . . a lot of graduate students, especially female graduate students, but I have also heard it from male graduate students, . . . quit. They say, “I don’t want to become that kind of person, so I’m going to find some other way to spend my life.”
> *Caroline Whitbeck, Online Ethics Center*

Many participants noted that ongoing changes in American culture influence ethically responsible behavior. To develop ethics and mentoring activities and assess the results, program leaders and staff must be aware, for instance, of the internationalization of U.S. graduate programs, the nature and priorities of current undergraduate culture or mores, and the disparate pathways into graduate education, furious competition for federal grants, and the growing number of university-industry partnerships. Program leaders must recognize that new technologies promote globalization and change faculty-student interactions. In discussions throughout the meeting, some workshop participants noted that increasing pressures for tenure and increasing competition for grants have led to a variety of problems, including instances of competitive mentoring—the same project being assigned to more than one graduate student, only one of whom receives credit for the work.

Panelist Susan Silbey of MIT reminded participants that these "structural forces … tend to produce unethical behavior."[1] Other attendees agreed on the need for new, creative responses that include attention to ethics. Many pointed out past efforts by leaders in scientific and engineering fields, as well as leaders of professional societies and academic organizations, to strengthen codes, issue reports, cooperate in government efforts to devise and implement policies, and initiate new educational activities. These responses are reflected, as Deborah Johnson of the University of Virginia said in her remarks, not only in ABET[2] criteria requiring student competencies in ethics and an understanding of the social context of engineering, but also in new NSF requirements that

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[1] See for instance Vaughan, D. *"The Dark Side of Organizations: Mistake, Misconduct and Disaster"*, Annual Review of Sociology, 25 (1999): 271-305. Also, Anderson, M. S., Ronning, E. A., De Vries, R., and Martinson, B. C. (2007). ***The perverse effects of competition on scientists' work and relationships. Science and Engineering Ethics***, 13(4), 437-461.

[2] ABET Inc., the recognized accrediting agency for college and university programs in applied science, computing, engineering, and technology, is a federation of 29 professional and technical societies representing these fields. See ***www.abet.org***.

proposals for research projects must include a description of their societal relevance (NSF evaluation criterion 2).[3]

In a general discussion, NAS member W. Carl Lineberger, University of Colorado, Boulder, commented that "…we really do have a wonderful opportunity. … I've been going around, talking to various groups of chemists about … how can they do a better job on broader impacts [NSF criterion 2] … I believe you have a very large number of receptive people to pay attention to ethics via this broader impacts mechanism, because it's going to affect them in a very serious way."

Throughout the discussions, meeting participants noted that organizations that fund research and employ scientists and engineers encourage interdisciplinary work and teamwork. However, they also noted that academic incentives for advancement favor individual work. Thus, these incentives should be revised to acknowledge and reward collaborative and cooperative efforts. Professional societies, government funding organizations, and universities can cooperate on workshops to promote ethics, prizes for outstanding ethical leadership, and changes to the tenure process that reward outstanding mentors, for example.

Several workshop participants described substantial barriers to the development of new incentives and suggested that change would be more likely in the long run if faculty achievements in professional ethics activities were incorporated into tenure decisions. In the meantime, recognition for collaborative and cooperative work could be reinforced by prizes given by organizations for outstanding ethical leadership or graduate and

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[3] The NSF *Grant Proposal Guide* provides the NSF review criteria concerning societal relevance; see particularly *http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.* For recent notification of intention to address ethics, see also *http://www.nsf.gov/oirm/bocomm/bo/bfa_updates_handout2final_27may08.pdf.*

postdoctoral workshops in science and engineering ethics sponsored by the National Academies and other professional societies.

Overall, the workshop participants indicated that ethics mentoring and education should include interactions between scientists and engineers and the larger environment in which they work, and should include discussions of how the environment affects, and sometimes changes, research and professional practices. As an example of these interactions, Mark Frankel, AAAS, noted how conflicts of interest can pose challenges to issues of authorship. Some time ago, he said, only researchers and professional organizations paid attention to authorship issues. However, with today's complex funding arrangements for research, the issue of authorship has taken on a much broader relevance.

Many attendees agreed that values, such as shared standards and transparency, can promote public trust in the work and intentions of scientists and engineers. These values, they said, should be topics of discussion in science and engineering ethics programs. These values provide an overall coherent focus for these activities. However, they also pointed out that differences between science and engineering, as well as field-specific differences within them, should also be taken into account in research ethics activities. This is especially important because many scientific and engineering research projects today involve researchers from different disciplines and subfields, which might have different standards. The differences and similarities should be identified and, if necessary, justified. As one participant indicated, these differences may reflect ethically acceptable differences, with similar underlying ethical values that require discussion to resolve. Standards for authorship credit provide an example. Numerous participants commented that these particularities can limit the utility of generic communications, or rules meant to cover numerous fields. They also noted that ethics education in electronic or lecture formats, which are limited to one-way communication, are less effective because they do not allow for the kinds of deliberation and discussion of ethical problems and practices that can create shared standards and transparency.

Attendees discussed how research on interactions between science, engineering and the larger social context, whether approached from the point of view of science and technology studies, social and behavioral sciences, history, philosophy, or social ethics, can shed light on the ethical implications of the organization of scientific and engineering work and how ethical considerations arise in the everyday work of scientists and engineers. They also noted the importance of leadership from the science and engineering communities (e.g., the National Academies, AAAS, and scientific and engineering societies in specific fields) in raising the visibility of these issues.

Some discussants pointed out that research on the interactions between science and engineering and the larger social environment can not only help to identify ethical considerations relevant to conducting research; but it can also identify other aspects of professional conduct that can influence whether junior scientists and engineers continue in career paths that include research and teaching or decide to pursue other career goals. For instance, acknowledging and ameliorating factors that result in hyper-competition in a department may raise retention rates; a seminar led by a faculty member from a small college may demonstrate the desirability of an alternative pathway.