Ethics in Science & Engineering: REDEFINING TOOLS & Resources

A Workshop Report

Prepared by
Michelle S. Gonçalves
Jane E. Fountain
Jessica Adamick
Marilyn Billings

Ethics in Science Engineering: Redefining Tools & Resources

The Ethics in Science and Engineering National Clearinghouse (ESENCe) Beta Site is a project of the National Center for Digital Government (NCDG); Science, Technology and Society (STS) Initiative; Center for Public Policy and Administration; and University Libraries at the University of Massachusetts (UMass) Amherst.

Workshop Planning Committee:

- Jane E. Fountain, Professor of Political Science and Public Policy
- Marilyn Billings, Scholarly Communications and Special Initiatives Librarian
- Jessica Adamick, ESENCe Librarian
- Michelle S, Gonçalves, NCDG and STS Initiative Program Manager

Acknowledgements

INTRODUCTION

Digital information and communications technologies and rapid globalization has created an expanding and more diverse workforce and has challenged the dominance of US scientists and industry. These developments, combined with increasing global interdependence in research and development, have led to complex, new ethics challenges for scientists and engineers. In 2007, the National Academies of Science, Engineering, and Medicine published *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. The report, produced by a 20-person committee of "CEOs, university presidents, Nobel laureates, and former presidential appointees," (Augustine, 2010) established in 2005, issued a call to action: "without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, [the US] economy will suffer and our people will face a lower standard of living."

In response, the US Congress passed the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act.[1] The Act sought to improve scientific and technological innovation and create a well-educated and thoroughly prepared scientific workforce for the 21st century.

Section 7009 of the America COMPETES Act required each institution applying for funding from NSF to describe within proposals to the Foundation "a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduate students, graduate students, and postdoctoral researchers participating in the proposed research project."

On August 20, 2009, NSF issued an Implementation Plan, which was published in the *Federal Register,* requiring Authorized Organizational Representatives of research entities to "certify" that appropriate responsible conduct of research (RCR) plans were in place at the time of proposal submission. Moreover, NSF made a commitment to "support the development of an on-line RCR resource containing research findings, pedagogical materials, and promising practices regarding RCR in science and engineering." The Implementation Plan stipulated that "development and evolution of the ongoing online RCR resource [would] be informed by the research communities that NSF supports and [would] serve as a living resource of multimedia materials that may be used to train current and future generations of scientists and engineers in RCR."

Two beta projects were designed and developed with support from NSF to advance national capacity for online ethics in science and engineering. At the University of Massachusetts (UMass) Amherst, researchers and experts at the National Center for Digital Government; the Science, Technology and Society Initiative; and the university libraries developed ESENCe, the Ethics in Science and Engineering National Clearinghouse beta site. A second beta site—based at the National Academy of Engineering's Center for Ethics, Engineering, and Society and developed in collaboration with the Ethics Education Library at the Center for the Study of Ethics in the Professions at the Illinois Institute of Technology— enhanced the well-known Online Ethics Center.[2]

The ESENCe beta site project sought to examine and test the potential of information science to provide effective tools to coordinate materials from across disciplines and to develop a web-based portal that would connect faculty and researchers to the best available materials to promote ethics in research, training, and practice. The strength of a research university in the development of such a beta site lies in its ability to push the boundaries of research and practice. Contemporary science and technology are characterized by dramatic changes driven by globalization and the Internet revolution. The web and related advances in digital tools have transformed the ability to organize

---

[1] See the America COMPETES Act, PL NO. 110-69, Sections 7008 and 7009.

[2] See www.onlineethics.org

and communicate information. Web-based collaboration and networking tools—social media—increasingly used in science and engineering research, development, and education have transformed knowledge acquisition and sharing. Yet ethics and RCR research has not fully exploited their potential to increase innovative capacity.

The developers of ESENCe sought to advance knowledge and practice in four principal ways:

1. Introduce and beta test the use of several promising next-generation web-based tools and applications;

2. Pay explicit attention to the increasingly transnational and global production and conduct of science and technology and its implications for ethics and RCR;

3. Deepen understanding of the behavioral and social foundations of ethical behavior in science and engineering by extending ethics and RCR to include relevant social science theory and research;

4. Leverage the power of information and library sciences, and the capacity of university libraries, to improve dissemination, description, organization, harvesting, and documentation of ethics and RCR materials, processes, and best practices.

Thus, the enactment of Section 7009 in the America COMPETES Act and the development of ESENCe served as catalysts to reassess the traditional boundaries and definitions of ethics and RCR in light of contemporary science and engineering institutions and practices.

The leaders of the ESENCe beta site project organized a national workshop, "Ethics in Science and Engineering: Redefining Tools and Resources," that was held on October 22-23, 2009 at UMass Amherst. The workshop objectives, broadly speaking, were twofold: first, to explore the potential for leveraging the university's role as a locus of education and mentoring for ethics and RCR in science and engineering and, second, to explore the potential and limitations of digital tools, including social media, for supporting such growth. The workshop initiated a dialogue between university faculty involved in ethics research and education and library and information scientists. Discussions centered on the potential use of cyberinfrastructure and digital tools to advance ethics education and RCR.

Workshop discussions were focused on the following questions:

1. What feasible courses of action might be crafted for institutions that will be required to certify themselves in ethics and responsible conduct of research?

2. To what extent might the new NSF requirements be used to encourage broader approaches in ethics training and socially responsible conduct of research?

3. What do we know about how researchers and others are actually using digital tools to promote knowledge sharing in ethics and RCR?

4. What empirical studies might provide guidance in this domain? What types of studies should be undertaken?

5. Among the wide range of tools and applications that come under the web 2.0 heading, which have the greatest potential to promote learning and knowledge sharing in the domain of ethics in science and engineering?

6. In what way should we broaden the definitions of ethics in science and engineering to encompass greater need for diversity, social justice, globalization, and recognition of changes in the organization and conduct of research?

This report captures central themes from the workshop and is intended to contribute to development of the research agenda for ethics education and RCR.

Research Trends & Background

Multi-disciplinary research spanning library and information sciences, social sciences, and ethics education is in its infancy. Research in library and information sciences indicates that universities have been inefficient at
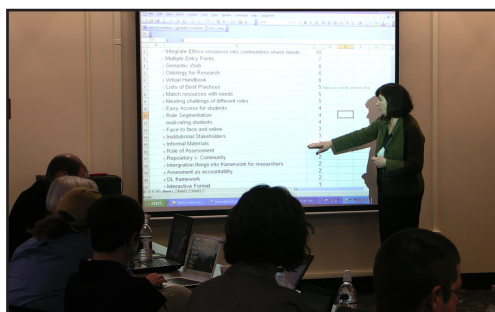
knowledge preservation and sharing. Like other complex institutions, as university libraries enact new technologies, they experience "information friction" seeking to balance the clean, functional divisions of bureaucratic systems with the growing importance of networked collaborative and interdisciplinary research and practice (Fountain, 2001; Unsworth, 2008). University institutions have an important opportunity—some might say, an obligation—to exploit the potential of the Internet and web 2.0 technologies to create environments in which students, staff, and faculty can visualize information, interact in knowledge networks, and share information across boundaries and media in order to enhance innovation. Yet the bureaucratic nature of university campuses makes it difficult to develop cross-boundary capacity.

Internet-enabled collaboration allows sharing within and across universities globally and direct information delivery to users. These trends are in distinction to the development of proprietary, localized networked sharing methods (Fountain, 1998; Unsworth, 2008). Universities have the potential to transcend limits of geographic location and to "[meet] the public in the information commons," a standard for many other innovative sectors (Unsworth, 2009). The library is reinventing itself from a traditional model in which patrons seek out library services on the library's terms to one that delivers services directly to patrons (Leggott, 2001). Physical proximity becomes less important as libraries begin to employ, for example, Internet "chat" reference services and provide remote access to electronic resources (Leggott, 2001). However, most university libraries are not yet campus-

wide information managers. Best practices for campus-wide sharing and management of institutionally-produced information such as inter-departmental communications, faculty research output, course offerings, and syllabi remain emergent. To return to the specific purpose of this report: university libraries might coordinate the information services related to ethics education and RCR. They have the potential to enable decision makers to evaluate current training materials and systems at the campus level thereby breaking through departmental and college functional divisions. But such enterprise-level efforts are limited if legacy computer systems and "siloed" processes keep departments and colleges in relative isolation.

The current model of restricted access to institutional scholarly output also poses an obstacle to effective cross-disciplinary teaming for research and teaching. Libraries might develop institutional capacity to act as a catalyst for change by adopting open access repositories (Leggott, 2005; 2009). Such repositories make scholarly information, including faculty research and writing, freely available to the public thus facilitating knowledge sharing and weakening proprietary access to knowledge that publishers increasingly exercise over authors and university libraries. Moreover, repositories effectively disseminate grey literature such as syllabi and instructional tools, which are not typically indexed and searchable using standard web-based search engines. Libraries, especially those at liberal arts colleges, have a history of curriculum-based collection development, but these efforts are not typically available beyond the confines of the respective college. In sum, the relationship between a repository's

online resources and services and institutional teaching and learning merits further empirical examination in light of transformative changes in knowledge sharing and communication infrastructure.

Researchers and practitioners in the field of education might accelerate and deepen adoption of new technologies that would provide platforms and tools to enable innovation in teaching. Distance learning and "blended" learning, combining classroom and distance modalities, for instance, have proven successful at many institutions and continue to develop. Yet university systems and practices typically lag these developments and tend to reinforce traditional models of classroom teaching (Unsworth, 2009).

In the area of ethics education, online programs that leverage emerging web-based technologies remain in early stages of adoption despite widespread use of online, "click-through" RCR training modules such as those available through the Collaborative Institutional Training Initiative (CITI). The efficiency with which off-the-shelf training packages may be inserted into tight faculty and researcher schedules and large university institutional structures is appealing, but the long-term effectiveness of off-the-shelf tools for enhancing ethics and RCR has been questioned. Some researchers have concluded that off-the-shelf, stand-alone, non-interactive, web-based modules for RCR and ethics training are ineffective by themselves (see Kalichman 2005; NAE 2009; Schrag 2005; Sieber 2005; Smith-Doerr, 2009) and teach "compliance education" instead of ethical reasoning (Schrag, 2005). The point is that moving the status quo online is insufficient. To meet the competitive demands that call for innovative science and technology, ethics and RCR must develop broader and deeper education and mentoring knowledge. Moreover, state-of-the-art information and communication should be used to deepen knowledge and foster innovation and scientific discovery within the bounds of RCR.

Researchers and ethics educators argue that effective ethics training requires institutional transformation and the ongoing engagement of faculty, students, and administrators. Empirical research results indicate that even financial incentives or punishments meant to encourage universities to enact ethics trainings, either online or face-to-face, do not "force" universities and colleges to act. For example, Smith-Doer (2006) examined the reactions of life scientists and their research institutions to ethics requirements initiated by the National Institute of Health. She found that a number of institutions "deflect" their ethics requirements and provide no formal training that allows researchers and graduate students to broadly and rigorously examine the ethical or societal dimensions of scientific research. In other words, the outcome of ethics education should be attitudinal and institutional transformation rather than mere compliance. As Smith-Doerr (2006) notes, "Organizations are difficult to change, and when change occurs it is often only on the surface."

An ongoing debate within the ethics in science and engineering community centers on how to define ethics and how to decide the key issues to be included in core training for researchers and practitioners. Current ethics education is often micro-focused, meaning that the case studies, teaching modules, and topics addressed focus on individual decision making and group- or laboratory-level conflicts. It ignores macro issues of social responsibility and societal implications of research and development, as well as a host of inter-organizational and systems-level ethics and RCR dilemmas. An increasing number of ethics researchers have recommended further research and development of macro ethics (see, for example, Colby & Sullivan, 2008; Conlon & Zandvoort, 2009; Herkert, 2005, 2004; Herkert, Wetmore, Canary, & Ellison, 2009). But the field of ethics in science and engineering is slow to change.

Materials used to teach ethics in science and engineering tend to be geographically bounded. Although business schools and the field of business ethics have explored ethics in transnational and global corporations and the ethical dilemmas that results from competing regulatory guidelines, ethics in engineering and science is just beginning to recognize the centrality of these issues. The prevalence of international partnerships in the science and engineering professions, growing international student and researcher exchanges, and the ease with which information can be shared around the globe point to the

critical need for research and education on the ethical dilemmas scientists and engineers face in a globalized, web-based environment. Among the most important topics to be addressed regarding the international dimensions of ethics are: ethics in transnational contexts, international accountability, the diffusion of ideas across borders, international regulatory processes, the impact of conflicts between nations, and social equity (IDEESE, 2007). In short, research on ethics and RCR and the education and mentoring of scientists and engineers should be aligned more strongly with contemporary organizational practices.

WORKSHOP PARTICIPANTS AND STRUCTURE

To address the issues just reviewed, the ESENCe research group organized a national workshop called "Ethics in Science and Engineering: Redefining Tools and Resources." A carefully selected group of invited participants included experts with interdisciplinary knowledge in the social sciences; public policy; science, technology, and society; information sciences; library sciences; human-computer interaction; and ethics. A complete list of participants is presented in Appendix A.

Library and information science graduate school administrators and instructors offered a broad perspective on the state-of-the-art in information science research related to information sharing and dissemination. This group included Alpha DeLap, Director of Research Services at the University of Washington Information School; Terry Plum, Assistant Dean at the Simmons College Graduate School of Library and Information Science; and John Unsworth, Dean of the Graduate School of Library and Information Science and Director of the Illinois Informatics Institute at the University of Illinois, Urbana-Champaign. These researchers stressed the need to mine research findings—both within library science and beyond—to benchmark development of a national online resource against best practices and the state-of-the-art in information science. In an invited presentation to the workshop participants, Unsworth presented examples of 1.0 and 2.0 clearinghouses and described ongoing research in data and text mining with the potential to strengthen libraries and clearinghouses. He advocated for developers to use research findings concerning the strengths and weaknesses of online versus face-to-face interactions.

Library, information, and computer scientists including Jessica Adamick, ESENCe Librarian; James Allan, Professor of Computer Science and co-Director Center for Intelligent Information Retrieval at UMass Amherst; JG Bankier, President of Berkeley Electronic Press; Marilyn Billings, Scholarly Communication Librarian at UMass Amherst; Julia Blixrud, Assistant Executive Director of Scholarly Communication of the Association of Research Libraries; Leslie Button, Associate Director of Collection Services at UMass Amherst; Ann Caldwell, Metadata Specialist at Brown University Library; Mark Leggott, University Librarian at the University of Prince Edward Island and an expert on Internet research and repository software; Thinh Nguyen, Counsel at Science Commons; Susan Perry, Director of Library, Information and Technology Services at Mount Holyoke College; and Rebecca Reznik-Zellen, Science Librarian for the Center for Hierarchical Manufacturing, a National Science and Engineering Center, and InterNano Project Manager at UMass Amherst provided expertise in digital libraries and scholarly communication. Reznik-Zellen is building InterNano, a nanotechnology subject repository and online resource site that reflects in one domain of research the much broader development opportunities for a national digital ethics library.

Workshop organizers invited a select group of ethics educators with expertise ranging from philosophy to science, technology and society. Anthony Beavers, Professor of Philosophy and Director of the Cognitive Science program at the University of Evansville is the editor of Noesis, a philosophy search engine, and an affiliate of the Indiana Philosophy Ontology Project (InPhO); he is director of the Digital Humanities Library and Executive Director of the International Association for Computing and Philosophy. Michael Bowler, Assistant Professor of Philosophy at Michigan Technological University, is

the principal investigator of an NSF Ethics Education in Science and Engineering (EESE) project researching "moral motivation and ethical sensitivity in multi-national graduate students." Gary Comstock, Professor of Philosophy at North Carolina State University and developer of the Open Seminar in Research Ethics, has examined extensively the America COMPETES Act RCR requirements. Matthew Keefer is Associate Professor of Educational Psychology, Research and Evaluation at the University of Missouri and a specialist in professional ethics and moral development. Lisa Newton, Professor of Philosophy at Fairfield University is an expert on workplace, environmental, and business ethics.

Social science and science, technology and society researchers included Douglas Anderton, Professor of Sociology, Associate Dean for Research, and Director of the Social and Demographic Research Institute at UMass Amherst; Jane Fountain, Professor of Political Science and Public Policy and Director of the Science, Technology and Society Initiative at UMass Amherst; Joseph Herkert, Associate Professor of Ethics and Technology at Arizona State University, who has developed a macro ethics approach to examining ethical dilemmas and teaching ethics education; Deborah Johnson, Chair of the Science, Technology and Society Program and Professor of Applied Ethics at the University of Virginia and a national leader in ethics education at the intersection of ethics, gender, and technology. Maren Klawiter of Yale Law School and Katie Shilton, a researcher at the Center for Embedded Network Sensing at UCLA brought expertise concerning emerging ethical and legal challenges raised by new scientific developments and ubiquitous sensing technologies.

The workshop was structured to allow for interdisciplinary plenary sessions and discipline-focused small group sessions. (Appendix B shows the detailed workshop schedule). During the first plenary session, Professors Joseph Herkert, John Unsworth, and Deborah Johnson, and Librarian Mark Leggott provided presentations on the state of ethics and RCR research and trainings in library and information sciences; ethics education; and science, technology and society. Break-out sessions followed in which small groups brainstormed and discussed methods

by which institutions might broaden and deepen ethics and RCR and the potential and limitations of digital environments for improving access to ethics activities or materials. (Appendix C lists the specific break out questions asked to each group.) Groups debriefed in a plenary session designed to discuss and broaden ideas generated in the break-out sessions. A group of rapporteurs documented the key suggestions and findings. After presentation and discussion of the group reports, a set of ranking and prioritization activities were used to elicit the most promising themes and issues. Participants were asked to vote for those issues they considered most important for improving ethics and RCR training and research. Appendix D organizes participant input by topic to suggest the breadth of discussions. Voting results are shown in Appendix E.

Workshop Themes

The workshop contributed to building a multi-disciplinary network of scholars and administrators interested in deepening and broadening ethics and RCR research and education. To our knowledge, this event was the first time library scientists had engaged in sustained discussion with experts in ethics in science and engineering. It provided for cross-fertilization of ideas through deliberation among experts from the social sciences; public policy; science, technology and society; information sciences; library sciences; and ethics.

Four themes recurred throughout the workshop discussions:

1. Broaden the ethics and RCR community to include greater multi-disciplinarity as a means to foster knowledge creation and dissemination.

2. Social science research must be incorporated into the ethics research agenda and university curricula if United States universities are to strengthen the knowledge base and leverage evidence-based, or empirical, research methods and results.

3. The broad community engaged in ethics and RCR must bridge the current gap between knowledge of social media, web 2.0 and 3.0 tools and applications, and their implementation in the design of web-based resources in ethics and RCR.

4. Open access and easily accessible materials are critical for progress toward the America COMPETES Act vision of an ethically aware and socially responsible workforce and academic community in science and engineering.

Develop a Networked, Multi-disciplinary Community of Practice

A recurring theme throughout the workshop was a call to build an ethics and RCR "community," or robust network, that would extend across the disciplines of science and engineering. Although many individual disciplines have vibrant professional societies with well-developed codes of conduct and other professional standards in place, few linkages currently exist to promote interdisciplinary developments. A multi-disciplinary community for ethics and RCR also is difficult to develop because researchers who extend their research programs and professional activities to include ethics and RCR are typically rewarded and recognized within a discipline. Thus, expertise, materials, and research findings remain fragmented across disciplines and difficult to find.

No map exists to identify the emergent cross-disciplinary network of researchers with interests in ethics and RCR; this limits cross-fertilization and innovation and contributes to the proliferation of partially redundant ethics education and ethics clearinghouses. The absence of a single, centralized resource to outline and define the growing community has encouraged production of inward-looking websites and programming.

A permanent, centralized, online resource center must resonate with an identifiable community. It should make disparate resources indexable and easily searchable. This description and organization of information will be most effective if it extends beyond merely collecting

the results of online searching capabilities. An effective resource should reach out to institutions and programs to encourage collaboration and enable institutions to build from each other's strengths.

If an online resource center is to answer the call for improved ethics and RCR training, it must be a destination as well as a living community. It should be aesthetically pleasing, easy to navigate, and designed to use a number of information sharing tools so that all target demographics perceive the site to address their needs. Authors who submit work should be able to make updates to items under review. Researchers should be able to share records easily with colleagues and to give input and feedback on resources. Success requires an institutional framework and buy in from key stakeholders.

Include Social Science Research in Ethics and RCR

Ethics and RCR will benefit from incorporating social science research expertise into existing theory and practice. A broader base of theory, research, and practice will reflect actual challenges faced by scientists, engineers, and their institutions in the public, private, and non-profit sectors. Two areas for growth were emphasized by workshop participants. First, there is a critical need to extend the boundaries of ethics and RCR in science and engineering to include relevant social and behavioral science research. Second, the field requires greater inclusion of library and

information science research concerning search, retrieval, and knowledge discovery.

Enduring theory and research at the levels of individual, social, and institutional behavior provide illuminating frameworks and insights into, for example, the conditions under which individuals or groups tend to deviate from professional norms; how norms are developed and sustained; and how institutions such as government agencies and universities encode and enforce norms. Research on innovation in groups, on stress and its effects on performance, on cross-cultural understanding and socialization, on the relationship of management structures and practices to performance and much more offer an empirical knowledge base to bring ethics and RCR into alignment with current institutions and practice. While normative theories are central, a range of behavioral research has been missing from ethics and RCR. This gap in knowledge is unacceptable and detrimental to national competitiveness. Within the social and behavioral sciences, a rich trove of empirical research on subjects central to the conduct and organization of science and engineering holds promise to broaden how ethics and RCR are defined, understood, taught, and measured.

This extension of the ethics and RCR knowledge base will complement and extend knowledge and conceptual frameworks currently in use. Integrating social and behavioral science research into the ethics and RCR community—and extending the community to encompass more social scientists—will extend the materials to be captured or developed for an online resource center. For example, social science research that explores the conditions under which decisions are made and the underlying behavioral tendencies of researchers who fabricate data should not be separated from articles, case studies, and other materials that outline examples of data fabrication. National and institutional statistics about ethics violations will become more useful if they are supported by research that explores the conditions under which ethical violations are likely to occur. Current ethics education lacks a macro ethics perspective, thereby ignoring important cultural, institutional, and international dimensions of science and engineering—even as globalization of science and the

global movement of scientists and engineers proceed rapidly. Thus, an integrated framework for ethics education must be created.

Social and behavioral science integration will encourage a broadening of the definition of "ethics" in science and engineering. For example, the challenges of diversity in science and engineering form central questions of ethics, such as why is participation of women and under-represented minorities so weak in many areas of science and engineering? There has been growth in recognition of social justice and its role in science and engineering education, but this is rarely connected explicitly to ethics. Yet the unequal benefits of science and engineering in societies and an array of social justice issues are of obvious significance to ethics. The international dimensions of ethics and RCR demand much greater research as science and engineering have globalized and as flows of scientists and engineers increasingly cross national borders and cultures. The transformative effects of cyberinfrastructure on the conduct of scientific investigation and engineering research require systematic inquiry in order to understand and exploit potential to increase innovation, scientific discovery and downstream benefits of science and engineering. All of the above are examples of significant developments that call out for a more expansive definition of ethics and RCR. To address all these 21st century dimensions of the scientific enterprise, a new definition of ethics must draw upon the full range of knowledge and research available.

The role of library and information science also was made clear at the workshop, specifically with respect to information search, retrieval, classification, and organization—the critical elements for an online resource. Participants noted that the central role played
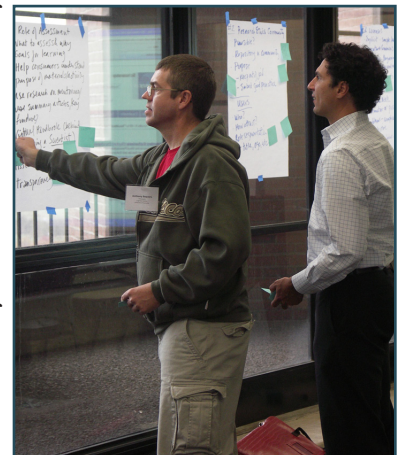
by university libraries, which serve all disciplines, makes them a potentially powerful locus for cross-disciplinary knowledge platforms and systems. Information and library science have been at the forefront of use, display, and organization of multiple media including interactive, visual, and other creative approaches. For example, videos, simulations, graphical, and mapping resources emphasize visual display of information and invite interaction and exploration. By drawing ethics examples from contemporary culture using current media, information might be made more engaging to students.

Use Information and Library Sciences to Improve Information Discovery

Computational research and tools to enhance visibility into all stages of collaborative scientific research have strong potential to advance research on ethics and RCR because such tools allow researchers to examine behavior in minute detail. Using these tools and research findings to deliver trainings and other materials directly to scientists has the potential to markedly increase their value and usability. For instance, a computational approach would enable designers of a repository to embed ethics education content into the actual flow of research practice by querying or bringing to the fore questions of authorship, sources, human subjects review, intellectual property and a host of other issues that lie behind everyday research activities.

To encourage resource discovery, information from an online resource site should be pushed out to users through a number of methods. Users should not be expected to know about the site, and so it should not be constructed solely as a destination. Instead, it must be designed as a resource that can "find" those who need the information when they need it and in the form that it is needed.

Developers of an online resource should use social media and the power of social networks to build relationships among records, collections, repositories, clearinghouses, and related websites. A consortium of site supporters and contributors is critical to ensure discovery and facilitate use. Creating semantic metadata for resources will allow users to benefit from information that is pushed out to other databases. Currently, users have to visit multiple sites to find and access the data they need, especially when searching for multi-disciplinary scholarly resources. With semantic metadata, specifically Resource Description Framework (RDF), materials from the repository could appear in meaningful and contextualized ways outside of the repository site. All of these efforts will make information discovery easier.

Ensure Open Access to Materials

Research should be available to the public to ensure maximum benefit to society and to increase innovation and knowledge development. Open access to articles and teaching materials will ensure broad dissemination which will enable more institutions and organizations to incorporate high-quality materials into trainings, classrooms, and other meetings. The National Science Foundation has taken a proactive stance in encouraging open access to materials. NSF should require all materials produced through programs like EESE to be deposited into a single, centralized resource for digital, free, and immediate access. Additionally, researchers funded through NSF might be required to keep their copyright when publishing and to grant a non-exclusive right to the single, centralized resource identified by NSF to disseminate their work.

Such standardized dissemination is best accomplished through an open access repository that uses the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). OAI-PMH repositories make their metadata shareable so that it can be harvested and searchable via engines such as Google Scholar, WorldCat.org, and WorldCat Local. These first two institutionalized search engines are free and gaining momentum.

Finally, authors should be encouraged to disseminate "grey literature," such as works-in-progress, reports, syllabi, case studies, presentation slides, videos, teaching modules, and other material types which are not traditionally formally published. These are the very materials that may be built upon and reused in a classroom or lab setting for

ethics and RCR education. Thus, the availability—and searchability—of these types of materials is critical.

Future Directions

An Internet platform that facilitates and supports RCR education introduces a host of issues that are not yet well studied. While online ethics courses and online certification tools exist, the potential for online ethics education and digital dissemination of RCR teaching tools has not fully been realized. An opportunity exists to move beyond cursory certification methods to a more dynamic, embedded ethics and mentoring environment that provides knowledge and information to researchers, students, and administrators when and where they need it.

As one workshop participant remarked, internal review boards are too often viewed as hoops through which researchers must jump to get to their research. Changing how faculty, students, and other researchers view ethics and RCR requirements will require a cultural transformation. Professor Deborah Johnson, Chair of the Department of Science, Technology, and Society and the Anne Shirley Carter Olsson Professor of Applied Ethics at the University of Virginia has advocated for a "normalization of professional ethics" such that RCR requirements are no longer perceived as impositions and regulations but as a foundation for "good" research. Alpha DeLap, the director of Research Services at the University of Washington has suggested as an alternative to the institutional review board, a process similar to an ongoing discussion between researchers and research administration focusing on issues as they arise in research.

The time for research on the most appropriate and effective macro-level ethics education is now, as institutions assess the ethics and RCR programming implemented in response to the America COMPETES Act. Those institutions that quickly adopted base-level online certification tools might consider expansion of "certification" opportunities. If a centralized ethics resource site is designed to support both online and face-to-face instruction, it has the potential to address the goals of ethics education and might be used to develop stronger ethics trainings or interventions. Such developments would support a growing, networked research enterprise oriented toward increasing United States competitiveness while assuring the integrity of research conduct.

Bibliography

Adamick, J. 2009. Literature Review as Call to Action: Addressing the Need for Evaluations of Subject Repositories. White Paper prepared for Ethics in Science and Engineering: Redefining Tools and Resources workshop, October 23, 2009.

Adamick, J., & Reznik-Zellen, R. (2010). Trends in Large-Scale Subject Repositories. D-Lib, 16(11/12).

Adamick, J., & Reznik-Zellen, R. (2010). Representation and Recognition of Subject Repositories. D-Lib, 16(9/10).

Anderson, M. S. et al. 2007. What Do Mentoring and Training in the Responsible Conduct of Research Have To Do with Scientists' Misbehavior? Findings from a National Survey of NIH-Funded Scientists. Academic Medicine 82(9), 853-860.

Augustine, N. R. 2010. A Category 5 Storm … Headed Our Way. AMStat News. 1 Dec 2010. Retrieved December 2, 2010 from http://magazine.amstat.org/blog/2010/12/01/sciencepolicy1210/

Beavers, A., & Miller, J. forthcoming. When Networks Know Us Better than We Know Ourselves: Information Monopolies, Information Brokering and the Need for Public Policy Governance. In K. D. Pimple (Ed.), Ethical Guidance for Emerging Pervasive Information and Communication Technology (PICT): Challenges, Opportunities, and Safeguards (working title).

Bowler, M., Amato-Henderson, S., Drummer, T., Holles, J., Schreiber, J. Lockhart, T., Charlesworth, D., & Ren, J. 2010. Testing for Ethical Sensitivity to Responsible Conduct of Research among Multi-National STEM Researchers. Proceedings of the Annual Meeting of the

American Society for Engineering Education 2010.

Bowler, M., & Amato-Henderson, S. 2010. Bringing Empirical Methods to Bear Upon the Study of Ethics and Ethics Education in Science and Engineering. Invited paper presentation at Pacifichem 2010 - The International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, December 2010.

Cervone, F. 2008. Managing digital libraries: The view from 30,000 feet - thinking outside the library box - considerations in contextualizing digital repositories for the local environment. OCLC Systems & Services: International digital library perspectives 24(3), 148-152.

Colby, A. & Sullivan, W. M. 2008. Teaching ethics in undergraduate engineering education, Journal of Engineering Education, July, 327-338. Retrieved April 9, 2010 from http://media.web.britannica.com/ebsco/pdf/34/34435802.pdf

Conlon, E. & Zandvoort, H. 2009. Broadening Ethics Teaching in Engineering: Beyond the Individualistic Approach. Paper presented at SEFI 2009, European Society for Engineering Education Conference, July 1-4, Rotterdam, Netherlands. Retrieved April 9, 2010 from http://www.sefi.be/wp-content/abstracts2009/Conlon.pdf

Committee on Science, Engineering, and Public Policy. 2007. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. National Academies of Sciences.

Fountain, J. E. 2001. Building the Virtual State: Information Technology and Institutional Change. Washington, D.C.: Brookings Institution Press.

Fountain, J. E. 1998. Social Capital: Its Relationship to Innovation in Science and Technology. Science and Public Policy 25, no. 2: 103-115.

Fox, E. 2004. Digital Libraries for Education: Case Studies. Lecture Notes in Computer Science, 51-60.

Gruber, T. 2007. Collective knowledge systems: Where the Social Web meets the Semantic Web. Web Semantics: Science, Services and Agents on the World Wide Web 6, 4–13.

Herkert, J. R., 2004. Microethics, Macroethics, and Professional Engineering Societies. In National Academy of Engineering, (Ed.). Emerging Technologies and Ethical Issues in Engineering (pp. 107-114). Washington, D.C.: The National Academies Press.

Herkert, J. R. 2005. Ways of Thinking about and Teaching Ethical Problem Solving: Microethics and Macroethics in Engineering. Science and Engineering Ethics 11, 373-385.

Herkert, J, Wetmore, J., Canary, H., & Ellison, K. 2009. Integrating Microethics and Macroethics in Graduate Science and Engineering Education: Developing Instructional Models. Paper presented at the American Society for Engineering Education Annual Conference and Exposition. Retrieved April 9, 2010 from http://soa.asee.org/paper/conference/paper-view.cfm?id=11085

Herman, I. 2008. State of the Semantic Web (at least as seen from W3C…). Presentation at the 3rd Chinese Semantic Web Symposium, Nanjing, China, August 30, 2009.

Hollander, R, & Arenberg, C. R., eds. 2009. Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done? Summary of a Workshop. National Academy of Engineering. Retrieved December 10, 2010 from http://www.nap.edu/catalog.php?record_id=12695

International Dimensions of Ethics Education in Science and Engineering [IDEESE] Project. 2007. University of Massachusetts Amherst. Retrieved December 10, 2010 from http://www.umass.edu/sts/ethics

Johnson, D. G., & Wetmore, J. M., eds. 2009. Technology & Society: Engineering our Sociotechnical Future. Cambridge, MA: MIT Press.

Johnson, D. G., & Wetmore, J. M. 2008. STS and Ethics: Implications for Engineering Ethics. In E. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), New Handbook of Science, and Technology Studies. Cambridge, MA: MIT Press.

Johnson, D. G. & Powers, T. M. 2005. Ethics and Technology: A Program for Future Research. In C. Mitcham (Ed.), The Encyclopedia of Science, Technology,

and Ethics (pp. xxvii-xxxv). Farmington Hills, MI: Thompson Gale.

Kolbitsch, J. & Maurer, H. 2006. The Transformation of the Web: How Emerging Communities Shape the Information we Consume. Journal of Universal Computer Science 12(2), 187-213.

Law, D. 2009. Academic Digital Libraries of the Future: An Environment Scan. New Review of Academic Librarianship 15(1), 53-67.

Members of the initiatives, "Model Curriculum for Land Grant Universities in Research Ethics" (LANGURE) and "Extend and Assess Research Ethics Education" (EAREE). 2009. Response to NSF's request for public comment on RCR requirement.

National Science Foundation. 2009, Aug. 20. Responsible Conduct of Research. Federal Register 74(160), 42126.

National Science Foundation. 2009, Feb, 26. Responsible Conduct of Research. Federal Register 74(37), 8818.

Pasanek, B. & Scully, D. 2008. Mining Millions of Metaphors. Literary and Linguistic Computing, 23(3), 345-360.

Schrag, B. 2005. Teaching Research Ethics: Can Web-Based Instruction Satisfy Appropriate Pedagogical Objectives? Science and Engineering Ethics, 11, 347-366.

Sieber, J. E. 2005. Misconceptions and Realities about Teaching Online. Science and Engineering Ethics, 11, 329-340.

Smith-Doer, L. 2006. Learning to Reflect or Deflect? U.S. Policies and Graduate Programs' Ethics Training for Life Scientists. In S. Frickel and K. Moore (Eds.) The New Political Sociology of Science: Institutions, Networks, and Power (pp. 405-431). Madison, WI: University of Wisconsin Press.

Smith-Doerr, L. 2009. Discourses of Dislike: Scientists' Responses to Ethics Education Policies in the United Kingdom, European Union, and the United States. Journal of Empirical Research on Human Research Ethics, 4(2), 49-57.

Steneck, N. 2007. ORI Introduction to the Responsible Conduct of Research. U.S. Department of Health and Human Services

United States Government. 2007. The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act. 121 STAT. 572 PL 110–69. [Sections 7008 and 7009]

***

APPENDIX A

Participant List

- Jessica Adamick, Ethics in Science and Engineering National Clearinghouse Librarian, UMass Amherst
- James Allan, Professor, Computer Science and co-Director Center for Intelligent Information Retrieval, UMass Amherst
- Douglas Anderton, Professor, Sociology; Associate Dean for Research; Director, Social and Demographic Research Institute, UMass Amherst
- JG Bankier, President, Berkeley Electronic Press
- Anthony Beavers, Professor, Philosophy and Director, Cognitive Science, University of Evansville
- Marilyn Billings, Scholarly Communication Librarian, UMass Amherst
- Julia Blixrud, Association of Research Libraries
- Michael Bowler, Assistant Professor, Philosophy, Michigan Technological University
- Leslie Button, Associate Director, Collection Services, UMass Amherst
- Ann Caldwell, Metadata Specialist, Brown University Library
- Gary Comstock, Professor, Philosophy, North Carolina State
- Alpha DeLap, Director, Research Services, University of Washington
- Jane Fountain, Professor, Political Science and Public Policy and Director, National Center for Digital Government and Science, Technology and Society Initiative, UMass Amherst
- Joseph Herkert, Associate Professor, Ethics and Technology, Arizona State University
- Deborah Johnson, Chair, Science, Technology, and Society and Anne Shirley Carter Olsson Professor of Applied Ethics, University of Virginia
- Marin Klawiter, Yale Law School
- Matthew Keefer, Associate Professor, Educational Psychology, Research and evaluation, University of Missouri, St. Louis
- Mark Leggott, University Librarian, University of Prince Edward Island
- Thinh Nguyen, Science Commons
- Lisa Newton, Professor of Philosophy, Fairfield University
- Susan Perry, Director, Library, Information and Technology Services, Mt. Holyoke College
- Terry Plum, Assistant Dean, Graduate School of Library and Information Science, Simmons College
- Rebecca Reznik-Zellen, Internano Librarian, UMass Amherst
- Katie Shilton, University of California Los Angeles
- John Unsworth, Dean and Professor, Graduate School of Library and Information Science and Director, Illinois Informatics Institute, University of Illinois, Urbana-Champaign

APPENDIX B

Workshop Schedule

"Ethics in Science and Engineering: Redefining Tools and Resources"
University of Massachusetts Amherst

October 22, 2010

6:00 PM	Participant Dinner: Introductions and Goals
	Dinner Remarks: Jay Schafer, Director, W.E.B. DuBois Library

October 23, 2010

8:30 AM – 9:00 AM	Continental Breakfast
9:00 AM – 9:30 AM	Welcome and Introductions

- *Jane Fountain, Professor of Political Science and Public Policy; Director of the National Center for Digital Government; and Principal Investigator, ESENCe Project*

9:30 AM – 10:45 AM	Plenary Group Session: Panel Presentations

- *Joseph Herkert, Associate Professor, Ethics and Technology, Arizona State University*
- *John Unsworth, Dean and Professor, Graduate School of Library and Information Science and Director, Illinois Informatics Institute, University of Illinois, Urbana-Champaign*
- *Deborah Johnson, Chair, Science, Technology, and Society and Anne Shirley Carter Olsson Professor of Applied Ethics, University of Virginia*
- *Mark Leggott, University Librarian, University of Prince Edward Island*

10:45 AM – 11:00 AM	Networking Break
11:00 AM – 12:00 PM	Break Out Groups
	Groups 1 & 3: Social Science and Science, Technology and Society
	Groups 2 & 4: Computer, Information and Library Sciences
12:00 PM – 1:15 PM	Working Lunch
1:15 PM - 2:30 PM	Group Reports and Q&A
2:30 PM – 2:45 PM	Break
2:45 PM – 3:15 PM	Plenary Exercise: : Rating, Ranking, Prioritization of Key Themes and Issues
3:15 PM – 4:30 PM	Plenary Session: Priorities and Paths Forward
4:30 PM – 5:00 PM	Discussion and Closing Remarks
6:00 PM	On-your-own Workshop Dinner

APPENDIX C

Break Out Group Questions

Groups 1 & 3

Broadening and Deepening Ethics and the Responsible Conduct of Research

1. What can universities do to broaden and deepen ethics and the responsible conduct of research (RCR) education, training, mentoring, and practice? What strategies are feasible?

2. As universities quickly respond to the new National Science Foundation (NSF) rules, what are incentives or opportunities to go beyond excessive standardization and narrowing of education, training, mentoring, and practice? How can appropriate incentives be designed?

3. What are the opportunities and limitations of digital libraries, clearinghouses, or online resources to help universities or researchers improve ethics and RCR education, training, mentoring and practice?

4. How important are macro ethics, cross cultural research and training, social justice, international dimensions, and other similar areas in terms of ethics and RCR in science and engineering? How could these broader areas of ethics be better represented in science and engineering?

5. What are some of the best examples you know of "good practice" or innovations in ethics and RCR? Please describe them, articulate why they are important and provide URLs if you have them.

6. How can Web 2.0, social web, or Semantic Web features be used to enhance education, training, mentoring and practice of ethics and RCR? Please specify tools and applications with particular promise.

7. Please contribute topics, issues, opportunities and challenges that should be a part of a national conversation on ethics and RCR and that should be offered as advice or input to NSF.

Groups 2 & 4

Understanding the Potential and Limitations of Digital Environments for Ethics and the Responsible Conduct of Research

1. What do we know about how researchers are using digital tools in their work?

2. What are the opportunities and limitations of digital libraries, clearinghouses, or online resources to help universities or researchers improve ethics and the responsible conduct of research (RCR) education, training, mentoring and practice?

3. How can Web 2.0, social web, or Semantic Web features be used to enhance education, training, mentoring and practice of ethics and RCR? Which tools or applications have the greatest potential to promote learning and knowledge sharing? What could be adopted "right now" to make a positive impact?

4. What would be the key benefits of a national digital library? What are the most important design features?

5. How can online clearinghouses or repositories be designed inclusively for all areas of science and engineering, and for the diverse audiences within those areas?

6. What are some ways that a major resource site like a national digital library can stay current, anticipate future needs, and help to foster a deepening in ethics and RCR in science and engineering?

7. Please contribute topics, issues, opportunities and challenges that should be a part of a national conversation on ethics and RCR and that should be offered as advice or input to NSF.

Summary of Participant Input by Topic

Ethics across the institution/ across the curriculum

- A framework for ethics education needs to be created.

- A national digital library is a socio-technical system. It requires an institutional framework (as well as software/ hardware) and the buy in of Institutional stakeholders (Deans) and Researchers/scholars.

- To understand what strategies are feasible, we must understand the responsibilities of researchers, ethics educators, and the university. How can we balance the need for ethics education and requirements with the need to conduct research? Is a research ethics community even plausible?

- Encourage more engagement between graduate students and principal investigators.

- The writing across the curriculum model is one to copy. It has been proven that writing classes do not work; ethics classes do not either. Incorporating ethics into existing coursework and frameworks is more effective.

- Currently IRB protocols are hoops researchers have to jump through in order to conduct research. Professional ethics has not caught up to the structures in place at a university. Professional ethics needs to become the norm instead of the imposition or regulation.

- Professional ethics is atypical in the sense that it did not develop from organic roots or norms as medicine did. Yet researchers have control over how professional ethics develops. What makes it powerful is that the professionals have authority over the rules and regulations. Mentoring plays a big role in passing on professional ethics, however the mentoring received by science and engineering students is more focused on the lab, and not the professional workplace.

- The reward structure at institutions does not encourage anything beyond a quick training.

Collecting and Identifying Materials for an Online Resource

- A variety of materials should be compiled: publications, chats/blogs, proposals (in progress and ideas), syllabi, cases, commentaries, teaching notes, assessment rubrics, multimedia formats, ethical issues from popular culture, decision-making exercises and simulations, presentation slides.

- It should provide lists of best practices with multiple ranking functions. Features should include Top 10 downloads as well as various experts' rankings of top papers, modules, websites, etc.

- A site must be easy to access and discipline specific. Nursing students and business students will not be seeking the same materials.

- There is a need for empirical ethics research and assessment on ethics trainings and interventions.

- Metadata is key to search and retrieval.

Copyright and Publishing Restrictions

- When incorporating materials into a site, licensing is important. License language should be simple and explicit. Creative Commons licenses are good examples.

- Traditionally researchers hold on to data until publishing. If we could give credit to those releasing raw data, it would enable better and more effective research.

- An online site has the capacity to shape the way materials are used. A site should provide a spectrum of licensing choices, but it should be understood that authors will tend toward the more conservative licenses.

Potential of New or Emerging Technologies to Enhance an Online Resource

- Features of the Semantic Web may play a role in an online resource center. Enriched metadata, for instance, can help

people find your material without them finding your site. Identifying and mapping relationships between various data points is potentially transformative.

- However, the Semantic Web is complicated. It is only understood by computer scientists. It is not clear how important the Semantic Web is for an ethics repository.

- A site may encourage the creation of a virtual handbook on research ethics, where scholars across could contribute findings and results.

- If new tools can be used to determine the usefulness of an item in a repository, it is a big plus. Not having to spend 20 minutes looking at a resource is invaluable.

Encouraging Use of an Online Resource

- Users must be clearly identified.

- There is clear role segmentation across curriculum and institutions. The average 20 year old student does not have the same experience and needs as a 65 year old professor.

- An ideal site will help you to consider what is it that you want to assess and why (researcher); help the educator think about his or her own goals for student learning; help the educator/consumer of ethics curriculum to understand its purpose; and help the educator use research on mentoring/role playing.

- What is the role of professional organizations? How can they be used to attract people to an online resource site?

- Roles can be broken out into administrators concerned with compliance and ethical ecology or atmospheres; researchers and scholars concerned with knowledge, instruments and subjects; educators concerned with teaching and curriculum assessment; and students or professionals who are interested in learning and general know how.

- An online ethics site needs to provide an interactive forum with access to a real person. The personal connection enabled through face to face, or at least a human response, is invaluable.

- Integrate ethical resources into the communities where they are needed (pull, e.g. receive an email) rather than on one site where everyone must go to get the information (push).

- Currently, a repository is passive.

- Breaking materials out by discipline is important.

Key Design Features of a National Digital Library

- An online resource site must be flexible and adaptable to changing needs

- Must provide multiple entry points. You cannot expect users to find you, or to find you in the same way every time. Resources must be pushed out to commonly used resources, groups, etc.

- The site should meet the students where they are.

- Designs must consider sustainability. What is required for a permanent site? Could a site like this realistically be maintained?

- Must incorporate social and knowledge networking

Macro Ethics Models

- Much ethics research and trainings focus at the micro level. Macro ethics by contract examines ethical issues and dilemmas both individually and collectively for broad social policy.

Teaching Ethics

- Who should be responsible for teaching ethics? The ethicist or the discipline-based instructor? Neither thinks the other understands the other's field, yet neither wants to teach ethics and RCR.

- It is not clear that ethics can be effectively taught solely online.

- Must get students and faculty to acknowledge that ethics is a social endeavor.

- Ethics trainings should incorporate new technologies, especially those tools students are using. Examples include Twitter and Facebook. However, if we use Twitter to teach ethics, we must ask at what point the message gets distorted. You can only teach so much in a single tweet.

APPENDIX E

Focusing Issues: Voting Results

Topics listed below represent the key focusing issues raised throughout the workshop. To create recommendations for paths forward, participants voted for those issues they considered most important. Participants could vote for more than one issue.

Votes	Topic	Votes	Topic
10	Integrating ethics into existing communities instead of forcing users to find the site	2	Examining repositories versus communities
7	Ensuring multiple entry points/paths to find materials	2	Creating RCR frameworks for researchers
6	Utilizing the Semantic Web	2	Using assessments as accountability
6	Creating an Ontology for Research	2	Creating a Digital Library framework
6	Creating a Virtual Handbook for RCR and ethics	1	Ensuring interactive formats in ethics trainings or online resources
5	Creating a list of best practices in ethics education and implementation	1	Encouraging engagement between graduate students and principal investigators
5	Matching resources with needs	1	Ensuring ethics and RCR hooks into course content
5	Meeting the challenges associated with multiple user roles	0	Creating a research ethics community
4	Creating easy access for students	0	Defining the purpose of a digital library or online resource
4	Role segmentation	0	Examining the impact of copyright and other licenses
4	Finding ways to motivate students/ encourage interest in ethics and RCR	0	Exposure of content
3	Incorporating face to face and online trainings	0	Examining ethics review triggers
3	Institutional stakeholders	0	Creating taxonomies
3	Collecting informal materials	0	Creating an institutional framework for ethics and RCR
3	Exploring the role of assessment	0	Ensuring adaptability and flexibility of resources