Overcoming Challenges to Infusing Ethics into the Development of Engineers: Proceedings of a Workshop

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Overcoming Challenges to Infusing Ethics into the Development of Engineers

Proceedings of a Workshop

Carl Anderson, *Rapporteur*

Center for Engineering Ethics and Society

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the views expressed in the proceedings, nor did they see the final draft before its release. The review of this publication was overseen by **Robert Nerem,** Institute Professor and Parker H. Petit Distinguished Chair for Engineering in Medicine Emeritus at the Woodruff School of Mechanical Engineering at Georgia Institute of Technology. He was responsible for making certain that an independent examination of this manuscript was carried out in

accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this publication rests entirely with the rapporteur and the National Academy of Engineering.

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Introduction

On January 11–12, 2017, the National Academy of Engineering's Center for Engineering Ethics and Society (CEES) held a workshop designed to help the engineering community identify institutional and cultural challenges to instilling ethics in engineering programs and to develop approaches, programs, strategies, and collaborations to overcome those challenges. The workshop was a follow-on activity to the 2016 CEES report *Infusing Ethics into the Development of Engineers: Exemplary Education Activities and Programs*.

This proceedings of the workshop presentations and discussions reflects only the opinions of those who spoke at the workshop. It has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop; it offers no conclusions or recommendations. The planning committee's role was limited to planning and convening the workshop. The views presented in these pages are those of individual workshop participants and do not necessarily represent the views of all workshop participants, the Center for Engineering Ethics and Society, or the National Academy of Engineering.

This proceedings is divided into three major sections. The first, **Background and Context, Attendees, and Organization of the Workshop**, details the impact of the 2016 report, the planning and development of the workshop, and the selection of teams to attend the workshop. The second section, **The Challenges**, describes the challenges to infusing ethics into the development of engineers, from the perspective of workshop participants. The third section, **Responses, Opportunities, and Possible Next Steps**, reports promising approaches described by workshop participants for overcoming the institutional challenges presented in the previous sec-

tion, as well as some of the opportunities available for funding of research on the formation of engineers.

The workshop agenda is in **Appendix A**, the dinner topics selected by the teams are in **Appendix B**, a list of participants is in **Appendix C**, and **Appendix D** presents biographical sketches of the panelists.

Background and Context, Attendees, and Organization of the Workshop

BACKGROUND AND CONTEXT

To help the engineering community tackle challenges to infusing ethics in engineering programs, the NAE Center for Engineering Ethics and Society (CEES) held a follow-on workshop on January 11-12, 2017 to its 2016 report, *Infusing Ethics into the Development of Engineers: Exemplary Education Activities and Programs*. This workshop convened current and emerging leaders in ethics and engineering who are working to improve the ethical development of engineering students at a workshop to (1) share their work, experiences, and lessons learned; (2) discuss strategies for overcoming institutional and cultural challenges; and (3) develop plans and collaborations for advancing efforts to infuse ethics into the development of engineers.

Recent research on instructional and cultural challenges for infusing ethics in engineering instruction has begun to identify issues, suggest strategies, and test approaches to changing institutional culture. In addition, scholars who have worked to infuse ethics have invaluable lessons to share from their experiences. Practicing engineers, engineering educators, and engineering ethics scholars had both informal and guided opportunities to strategize and develop plans for incorporating ethics in engineering curricula. Information, expertise, mentoring, and facilitated discussions and collaboration at the workshop aimed to help attendees advance their work and develop effective plans for their own institutions. Ultimately, these attendees will form the basis for a cohort of leaders and agents of change across the United States.

WORKSHOP ATTENDEES

The CEES advisory group invited and reviewed applications from teams of 2–4 individuals—faculty, administrators, and professors of practice—actively working on strategies and plans for incorporating ethics into the curriculum and culture of engineering education. The teams were asked to describe their innovative activities, approaches, and strategies—current or planned—for overcoming institutional or cultural challenges to infusing ethics in the development of engineers. Representation was sought in attendees' range of engineering disciplines, teaching levels (bachelor's and graduate), and institutions (from liberal arts colleges to large public universities as well as minority-serving institutions).

Attendees were selected for both the innovativeness and the potential impact of their activity. Evidence of their participation in faculty development relevant to teaching and learning was also considered. Of 43 teams that applied, 16 interdisciplinary teams from 15 universities were invited to attend.

In addition, speakers with a range of expertise were asked to present and discuss work relevant to incorporating ethics into the engineering curriculum, including speakers with insights from sociology and anthropology, professional engineers, representatives from professional societies, program directors, among others.

ORGANIZATION OF THE WORKSHOP

The workshop was organized by the CEES advisory group based on a model created by the NAE Frontiers of Engineering Education program. Workshop activities, some running concurrently, included the development and refinement of team plans, a poster session, panel sessions of invited speakers, affinity group discussions, a working dinner with focused topics of discussion, and opportunities for feedback during and after the workshop.

The workshop began with two panel sessions to identify effective practices and scholarship on two connected topics: making engineering ethics relevant to students and supporting faculty in integrating ethics into engineering education. Each of these panels began with a set of presentations detailing the relevant work of the panelist, followed by a moderated question and answer session, allowing attendees to more deeply engage. Afterward, an informal poster session encouraged participants to network and begin to make connections to their own projects and efforts.

Attendees then divided into nine elective affinity groups for discussions moderated by members of the CEES advisory group. The groups'

themes, listed below, were based on input from teams during the application process:

- Influencing the Engineering Mindset and Culture;
- Handling Ethics in the Classroom;
- Approaches for Building Institutional Buy-in and Support;
- Approaches for Building and Developing Faculty Capacity;
- Addressing the False Division between Technical and Nontechnical;
- Strategies and Approaches for Evaluating Ethics Education;
- Curricular Approaches and Issues of Scaling Up and Across Institutions;
- Placing Ethics within Existing Engineering Tools and Practices; and
- Teaching Ethics to an International and Multicultural Group.

The group discussions began with attendees' reflections on ideas to be explored during the session, followed by a guided discussion of prepared questions developed by the CEES advisory group in advance of the workshop, based on suggestions from attendees. Representatives of each affinity group reported on the group discussions the following morning.

A panel discussion then summarized the workshop discussions, identifying opportunities and potential next steps, before the final plenary session.

The Challenges

DEFINING THE PROBLEM

The first panel, moderated by Paul B. Thompson, W.K. Kellogg Chair in Agricultural, Food, and Community Ethics at Michigan State University, addressed the need to make engineering ethics relevant to students both during their education and throughout their careers.

Erin Cech, assistant professor of sociology at the University of Michigan, opened the panel discussion by highlighting the importance of ethical engagement for professional engineers and identified the responsibility for ethical engagement and concern for social well-being as rooted in what she described as "engineering's social and legal monopoly on an entire area of life." She made the case that because formal engineering education may be the only institutionalized training where future engineers learn ethics and the responsibilities of their profession, it is crucial to ensure that engineering programs instill in students a concern for ethics and public welfare.

Cech described a sociological study she conducted[1] into the question of whether undergraduate engineers become more concerned with their ethical and social responsibilities throughout their academic tenure and into their professional careers. The study assessed responses to three questions: (1) Do views of engineering students change during their education? (2) Do programs embed and emphasize engagement with ethical and public welfare? (3) Do program emphases affect student views? The research

[1] Cech EA. 2014. "Culture of Disengagement in Engineering Education?" Science, Technology & Human Values 39(1):42–72.

involved a longitudinal sample of 326 undergraduate engineers from four academic institutions—the Massachusetts Institute of Technology, Smith College, Olin College of Engineering, and the University of Massachusetts, Amherst—from the time they entered as freshman to 18 months after graduation. Cech noted that "this is not a representative sample of all US undergraduates, but it does represent a wide spectrum of approaches to engineering education in the United States."

Cech focused on four aspects of ethical and social welfare considerations in terms of their importance to students in understanding what makes a successful career: (1) professional and ethical responsibilities, (2) understanding the consequences of technology, (3) understanding how people use machines, and (4) a composite social consciousness scale of the importance to students of improving society, being active in their community, promoting racial understanding, and helping others in need.

The research showed that students' concern for ethical and public welfare issues in all four categories decline significantly from the time they enter as freshmen to their senior year, controlling for gender, race/ethnicity, class background, and school. Cech cited this decline as a fundamental issue for the workshop participants to tackle. Once students enter the workforce, she went on, concern for each of the four categories "stagnates, if not declines further." Furthermore, the engineering programs in which students were enrolled placed significantly less emphasis on engagement-related issues like ethical responsibilities than on traditionally technical issues. She explained that her study showed a statistical relationship between the extent of a program's emphasis on ethical and social issues and students' concern for their ethical and social responsibilities as engineers.

According to Cech, the results suggest "a culture of disengagement, a constellation of beliefs, meanings, and practices that frame ethical and public welfare concerns as tangential to 'real' engineering." This culture, she said, has consequences for what it means to "think like an engineer," in determining what counts as legitimate or important information when defining and solving engineering problems, and what successful engineering actually looks like. She identified three concepts underlying the culture of disengagement: (1) depoliticization, which "frames nontechnical concerns, like ethics, as irrelevant to real or pure engineering work"; (2) technical/social dualism, "the idea that there is a separation between technical skills and social skills and that technical skills are much more valued than social skills"; and (3) meritocratic ideology, which "frames the existing social structures that engineers are working in as fair and just and not in need of change."

Cech urged the workshop participants to validate ethics and public welfare in the context of engineering "not just in the curriculum or in exams, but also in things like tenure decisions." She also highlighted the impor-

tance of incorporating ethical considerations into what would otherwise be purely technical spaces, noting that "it's often common to bracket these things off into their own courses, but that only reproduces the technical/social dualism and depoliticization." She pointed out that there is often a relationship between what is valued in undergraduate engineering programs and what the students value. "If we can change what's going on in the culture of these institutions, it will change the way students understand their social and ethical responsibilities," she said.

The affinity group on Addressing the False Division between the Technical and Nontechnical extended Cech's analysis and cited the need to expose the fact that the opposition between these concepts is socially constructed. The group called for educators to articulate to students what engineers do by "unearthing the sociocultural aspects of engineering practice" and to make the implicit nontechnical underpinnings of engineering explicit in their teaching of engineering. Primarily, the group noted, it is critical to think about developing an "ethos" of excellence in engineering that includes ethics as part of the definition of excellence rather than "infusing ethics into engineering," which, they said, supported the technical/nontechnical dichotomy that reproduce the culture of disengagement that Cech described.

The affinity group on Influencing the Engineering Mindset and Culture addressed questions about changing engineering culture in institutions of higher education, especially because of institutional and cultural resistance to change and perceived risks of change. The group proposed recognizing that practitioners and educators communicate engineering culture and mindset, even in technical courses; revising language used in classroom, office, and external communications; avoiding negative stereotypes of engineers; giving specific examples of ways that engineers contribute to society; practicing and encouraging epistemic humility (willingness to acknowledge one's ignorance or limitations of knowledge); portraying ethical engineering work as "doing more good in the world"; and recognizing that ethics are always part of good engineering practice.

MAKING ENGINEERING ETHICS RELEVANT TO STUDENTS AND THEIR FUTURE CAREERS

Engineering for Social Justice

Jered Dean, Associate Professor and director of Capstone Design at Colorado School of Mines, gave examples from his experience in directing this program to lay out some of the challenges involved in integrating ethics and social responsibility for engineers into the curriculum in a way

that demonstrably affects student outcomes. The program asks students to use tools and checklists on health, safety, and welfare, which are tied to the code of ethics.

Dean reported that the program is moving toward new avenues to engage students in thinking about ethics and social responsibility. For example, the school is attempting to develop a course on Engineering for Social Justice, which will involve listening contextually, identifying structural conditions, acknowledging political agency, increasing opportunities and resources, reducing risk to users and community, and increasing human capabilities. He reported that student responses to an announcement of the course were very positive, but conveyed uncertainty: "in exit interviews, students basically said, 'we love this idea, yes! We want to engineer for social justice, but we have no clue how to do that. . . .'" The new course "didn't pan out."

Out of this experience, Dean and his colleagues developed an "Engineering for Social Justice" checklist, with steps to map existing design best practices and accessible tools for students to integrate into the design process as part of their capstone projects. The checklist includes six categories of assessment, including Listen Contextually, Identify Structural Conditions, Acknowledge Political Agency, Increase Opportunities and Available Resources, Reduce Risk to Users/Community, and Increase Human Capabilities. Yet despite very positive initial student reactions, "the vast majority of students explicitly avoided using the checklist in its entirety." Others used only one or two tools from the checklist in developing their projects, rather than the entire checklist. However, the one team that used the social justice checklist in its entirety modified their design in order to achieve a higher score on the checklist. The team did, however, change the name of the checklist from 'social justice' to 'social license', as the client for the project responded negatively to the original name of the checklist.

Dean presented the lessons learned from this effort: "It needs work. We're not there yet. Last semester was our first semester trying it out. We'll try it again this semester with some minor tweaks. . . . We found out that we need to provide more support to our students around this activity and . . . a few of our faculty . . . sent me notes with negative responses to [the idea of] engineers engaging in engineering for social justice, so we need to work on our faculty—train the trainers as well."

Dean concluded by urging workshop participants to go beyond ethics basics—the code of ethics, legal basics, licensure—and to think about other lenses that might get students to think about ethics as *part of* the work of engineering, rather than a separate concept.

Service Learning and Integrating Ethical Considerations into Curricula

Carla B. Zoltowski, former codirector of Purdue University's Engineering Projects in Community Service program (EPICS)[2], described the program's "engineering-centered, multidisciplinary, vertically integrated, and student-led" learning design courses that "meet human, community, and environmental needs," with projects often spanning multiple semesters. EPICS was established in 1995 and has been adopted by a number of universities across the United States. The program involves more than 500 students each semester and has more than 3,000 alumni.

Zoltowski also described her work as part of a team developing a tool for assessing engineering ethics. The Engineering Ethical Reasoning Instrument (EERI) is based on a neo-Kohlbergian developmental schema and very similar in structure to the Defining Issues Test-2 (DIT2). She made it clear that the dilemmas included in the EERI are similar to what students might encounter on a student design project, even drawing some scenarios from actual EPICS projects. Students complete the tool before a lecture and then, during the lecture, identify ethical issues from the scenario, first individually and then in a class discussion.

Another aspect of EPICS that Zoltowski described is reflection through guided questions. Every week, EPICS students are asked to reflect on one aspect of their work: What did I learn? How did I learn it? Why does the learning matter? What will/could I or others do in light of this learning?

The Role of Professional Engineering Societies

Tara Hoke, representing the American Society of Civil Engineers (ASCE) and focusing on its specific efforts, addressed the role of societies in promoting ethics and concern for public welfare among engineers.

ASCE is the largest professional society for civil engineers, with approximately 150,000 members; only about 28,900 of them are under the age of 30 and about 23,700 are students. ASCE provides ethics webinars and presentations, hosts ethics publications (including a monthly column of professional ethics case studies) and videos, awards the Daniel W. Mead prize to students who submit essays on an ethics topic, and maintains an ethics hotline.

Hoke noted that ASCE also enforces its code of ethics against its members. The society's Committee on Professional Conduct, in effect since the 1950s, is empowered to investigate concerns and then take informal actions or recommend formal actions to ASCE leadership. Formal actions may

[2] For more information about EPICS, see http://www.purdue.edu/catalogs/engineering/college/epics.html.

include admonition, suspension, or expulsion. The most common infractions committed by younger members, Hoke said, concern billing practices, employment, academic misconduct, and public statements.

Hoke acknowledged some significant challenges in ASCE's enforcement activities: low numbers of reported cases (about three calls a month related to ethics issues), cases focused largely on more senior engineers, minimal use or awareness of the society's ethics hotline, and a lack of ethics resources specifically tailored to the needs of younger members. But looking forward, she said that ASCE is excited about the possibility of working with "other societies to produce video ethics training for younger members" and plans to encourage student members and younger members to become more involved in ethics committees.

ENCOURAGING AND SUPPORTING FACULTY IN TEACHING ETHICS

Norman Fortenberry defined the problems involved in supporting faculty in teaching ethics to engineering students succinctly at the end of the workshop. According to him, "An overcrowded engineering curriculum makes separate, standalone engineering ethics courses difficult; Moreover individual ethics courses risk marginalization, while modules within existing courses risk dilution and necessitate negotiation with faculty peers and other institutional constituencies. There is low faculty knowledge, comfort, and facility with teaching ethics. Coteaching—linking engineers with people in philosophy and other disciplines—is time and labor intensive, and particularly in the context of public universities, can be quite expensive. Facilitating learning at scale—both larger classes and across classes—is a challenge." This articulation of the challenges was addressed by the second panel session of the workshop.

Building Faculty Capacity

The second panel, moderated by Sharon Jones, opened with a recognition that "this session is devoted to ideas related to supporting and encouraging and helping faculty to bring enthusiasm and lessons learned here into the classroom."

Thomas Litzinger described some of the work at Pennsylvania State University in supporting engineering faculty in teaching ethics. He identified two main issues: first, that most faculty members feel that they lack knowledge of ethics required to teach it effective and, second, that teaching and assessment methods used in ethics education are not commonly used in engineering education.

Litzinger highlighted his experiences with one method of addressing these issues: through a one week summary workshop for faculty. The workshop includes ethical theory and frameworks, application of theory to case studies, ethics resources and assessment methods, and instructional design. Faculty members design new ethics instruction and assessment tools, he said, and ultimately share their designs and assessments and receive feedback from other participants. Litzinger described these workshops as very positive, and noted that faculty outcomes varied: "we have seen faculty adopt the slides that our philosophy colleague use, talk to their students about them, have the students use moral theories and others who are not comfortable with that and choose to use the codes of ethics as a way to instruct their students."

Larry Shuman recognized many of the barriers to building faculty capacity for teaching ethics: a lack of competent, qualified instructors; variations in pedagogy and cultural circumstance; large class sizes; faculty and administrator buy-in, especially at the department chair level; assessment and evaluation.

However, Shuman argued that engineering educators could expect institutional support for ethics education in engineering based on the direction of recent proposed changes to ABET accreditation. Specifically, Shuman identified changes from current ABET Criterion 3 to the proposed Criterion 3 (Box 1-1). Shuman said that these changes would encourage programs to support educators in instilling the ability to "recognize a potential ethical dilemma, evaluate risk, and resolve the situation."

BOX 1-1
ABET Criterion 3

Current ABET Criterion 3:

(f) an understanding of professional and ethical responsibility Plus:

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(j) a knowledge of contemporary issues

Proposed ABET Criterion 3:

(5) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal context

SOURCE: ABET 2016-2017 Criteria for Accrediting Engineering Programs – Proposed Changes, available at www.abet.org.

Shuman reviewed several ways to integrate ethics into engineering courses, such as case studies, discussion, written reflections, and combinations of these activities. Educators can also take advantage of seminars and guest speakers, modules within engineering courses, philosophy courses dealing with ethics, or courses dedicated specifically to engineering ethics. He also noted the possibility of using "model-eliciting activities," which create "realistic problems with a client, solved by a team," and "put[ting] an ethical dilemma into these activities." These activities are designed to encourage students to develop models in order to solve complex and realistic problems. The ABET changes, he said, might provide significant institutional support for these alternatives.

The affinity group on Approaches for Building and Developing Faculty Capacity concurred that faculty may need motivation and/or lack confidence in teaching engineering ethics, especially if they lack expertise. The group noted the need for strategies for capacity building among faculty to build confidence and skills in initiating and facilitating conversations about complex ethical questions with no clear right or wrong answers. The group identified three approaches to support faculty in teaching ethics:

- Develop an online community of practice to get ideas and support from faculty at other institutions who teach engineering ethics.
- Engage local industry, which might lead to funding for research, faculty stipends, and prizes for ethics integration in classrooms or student projects and greater ability to relate to real-world experiences.
- Establish ethics fellows programs offering specialized training and recognition for faculty.

Institutional Change

Jaime Lester, associate professor of higher education at George Mason University, described her experience and expertise in organizational changes in higher education institutions and proposed that interdisciplinary collaborations might be key to organizational change in academic settings. Observing that "change happens on multiple levels of a higher education institution, and often it can and does occur on the local level," she presented a model of organizational diffusion, the notion that "individuals who have a passion or an interest who undergo some form of training—innovators or change agents—diffuse their knowledge and interest through an organization." Lester noted that much of the focus of traditional efforts at institutional change is often misdirected at policy change, "but rarely do we talk about what happens in terms of the relational pieces."

Elliot Douglas, NSF program director for Engineering Education, highlighted the difficulty in propagating change from initial change agents throughout an academic institution: "How do we change the culture of those who aren't here and who wouldn't be here? How do we get those faculty to rethink how they think about what engineering education actually is so that all of these things—ethics, communication, all of those things that get lumped into professional skills—become an actual part of engineering education?"

Lester agreed that the barriers to faculty pedagogy changes extend beyond policy and institutional barriers to include individual barriers (i.e., teaching socialization, time, competing priorities, an increase in contingent faculty) and interorganizational barriers (i.e., accreditation standards and disciplinary norms) as well.

Affinity group members considering approaches for building institutional buy-in and support noted key barriers to positive organizational change: the (de)valuation of ethics at all levels, limited infrastructure and resources, competing priorities, defensiveness, lack of and distorted reward structures, and the need for sustained efforts. They also noted a number of challenges to organizational change at all levels, such as failure to anticipate push-back from peers and administrators, overanticipation of push-back leading to self-defeat, failure to identify and enlist allies, attempts to do too much too fast, and dilution or cooptation.

They identified three strategies for encouraging institutional change, recognizing that different strategies will apply to and be more effective at different institutions. (1) Identify and leverage powerful movers at an institution (e.g., advisory committees, students, accreditation bodies, legislatures, funding agencies, peer institutions). (2) Build relationships across boundaries, through awards, recognition, tenure, and promotion. (3) Connect ethics to existing programs and priorities, grounding communication about engineering ethics in concrete, familiar topics.

Responses, Opportunities, and Possible Next Steps

Elliot Douglas opened the final panel session, devoted to responses, opportunities, and possible action, by describing many of the funding opportunities for research into engineering ethics education available from NSF. He described the Professional Formation of Engineers (PFE), the overarching framework for many NSF programs that address "the formal and informal processes and value systems by which people become engineers." These include introductions to the profession at any age, the development of technical skills, professional skills, ways of thinking, knowing, and doing, and identity as an engineer, and acculturation to the profession and its norms. "I think ethics really comes into many of these areas," he said.

Douglas presented three PFE programs: Research in the Formation of Engineers, Research Initiation in Engineering Formation, and Improving Undergraduate STEM Education: Education and Human Resources. In addition to the PFE topics of interest, the first program comprises at least five other areas of interest: advancing holistic engineering formation; diversifying pathways to and through engineering; exploring citizen engineering, credentialing, and expertise; developing engineering-specific theories of how engineers are formed; and understanding how change in engineering formation processes travels, translates, diffuses, and/or scales. The program is largely focused on "small, exploratory, and speculative projects" that are primarily research projects; projects on designing modules or evaluating curricula likely do not fit, he said.

Research Initiation in Engineering Formation is similar to Research in the Formation of Engineers, except that it is designed to support researchers

who are new to engineering education research. Under this program, a co-PI with experience in engineering education serves as a mentor.

Improving Undergraduate STEM Education: Education and Human Resources has two tracks, Engaged Student Learning, which focuses on design, development, and implementation of and research on STEM learning materials, approaches, and tools; and Institutional and Community Transformation, which focuses on approaches to increase the propagation of highly effective methods of STEM teaching and learning.

Wenda Bauchspies, NSF program director for Science, Technology, and Society/Cultivating Cultures for Ethical STEM (CCE STEM), discussed this collaborative program that spans seven NSF directorates and primarily funds research projects to identify factors that are efficacious in the formation of ethical STEM researchers. The program solicits proposals for research that explores what constitutes ethical STEM research and practices, whether certain labs/communities/workplaces have a "culture of integrity," and what practices contribute to the establishment and maintenance of ethical cultures. This research is intended, Bauchspies said, to feed universities programs of responsible conduct of research training.

Bauchspies noted several ideas for CCE STEM research projects from the discussion at the workshop:

- What are the values embedded in design practices, processes, and decision making and what is their impact on ethical choices, decisions, dilemmas, and challenges?
- What are the everyday ethics of a community/lab/workplace? What supports, challenges, reinforces, or erodes them?
- What are the ethics needs of younger engineers, professionals, practitioners, and scientists?
- What is the role of managers of STEM in the culture of ethics or the ethical values of a community/lab/workplace?

Norman Fortenberry summarized many of the theoretical and practical conclusions of the workshop and identified many lingering questions. He reiterated the importance of viewing ethics not as something separate from engineering to be integrated but as a necessary and always included part of engineering excellence and professional practice. He also noted that other skills involved in engineering that are often labeled "professional" and less important than "hard" knowledges and skills are also critical to producing successful engineers.

"I think we're spending too much time tinkering around the edges, when what we need is a movement toward much more radical change," Fortenberry said. "We need to move engineering departments to a team concept, no longer requiring each individual faculty member to be expert

at an ever-expanding number of expectations. . . . We need to more broadly hire engineering faculty for their specialized knowledge of ethics and communication and other professional skills."

Addressing requests and suggestions of several affinity groups, Frazier Benya described an existing resource run by the National Academy of Engineering that could directly and immediately support the work of the invited teams: the Online Ethics Center for Engineering and Science (OEC, www.onlineethics.org), which shares resources on ethics in engineering and science. The OEC posts descriptions of approaches for incorporating ethics into engineering so that they can be shared in the ethics education community. In addition, Benya noted, the OEC hosts subject aids that provide bibliographies and short introductions to major topics in science and engineering ethics. These resources, she explained, were created to help instructors with less experience teaching ethics become more familiar with ethics topics.

Appendix A

Workshop Agenda

Workshop on
Overcoming Challenges to Infusing Ethics
into the Development of Engineers

January 10–12, 2017

National Academy of Sciences Building
2101 Constitution Avenue NW, Washington, DC

AGENDA

Tuesday, January 10, 2017
State Plaza Hotel

5:00 pm **Welcome and Introductions Dinner**
Gerry Galloway, *Center for Engineering Ethics and Society Chair*

8:00 pm **Adjourn**

Wednesday, January 11, 2017
National Academy of Sciences Building
Lecture Room

8:00 am **Welcome** (breakfast available)
Proctor Reid, *National Academy of Engineering*

8:30 am **Panel 1: Making Engineering Ethics Relevant to Students and their Future Careers**
This panel will focus on addressing the challenges with making engineering ethics relevant to students both during their time in school and in their future careers.
Moderator: **Paul B. Thompson,** *Michigan State University*
Panelists: **Erin Cech,** *University of Michigan*
Jered Dean, *Colorado School of Mines*
Carla Zoltowski, *Purdue University*
Tara Hoke, *American Society of Civil Engineers*

10:00 am **Break**

10:30 am **Panel 2: Encouraging and Supporting Faculty in Teaching Ethics**
This panel will focus on addressing the challenges with encouraging and supporting faculty in infusing ethics into engineering education.
Moderator: **Sharon Jones,** *University of Portland*
Panelists: **Larry Shuman,** *University of Pittsburgh*
Thomas Litzinger, *Pennsylvania State University*
Jamie Lester, *George Mason University*
Ann Ferren, *Association of American Colleges and Universities*

12:00 pm **Brief explanation of poster session logistics and desired outcomes**

12:15 pm **Lunch and informal networking**

1:00 pm **Attendees set up posters**

1:15 pm **Poster Session**
All attendees, mentors, and invited guests will walk around the posters with a pad of Post-it notes to add suggestions to

the posters. As the attendees read the posters they should look for connections to their own project. During this time one member of each team will stand by their posters and team members will switch off doing this during this time so that everyone can see the posters. The schedule and a map of where the posters are will be provided ahead of time.

2:30 pm **Affinity Group Discussions**
Attendees will split up during this time, each attendee will pick an affinity group from a list of potential topics. Each affinity group should have 6-7 people at most.

4:30 pm **Break**

5:00 pm **Informal networking session/cocktail hour/socialize (Great Hall)**

6:00 pm **Dinner & Discussion (Great Hall)**
The dinner is an opportunity to discuss some broad topics in engineering ethics education that interest attendees and to hopefully lead to further collaborations. Attendees will be able to suggest topics and vote for dinner topics during the day. An initial list of potential table topics will be available at the reception on Tuesday evening and posted in the meeting space on Wednesday, along with a spot for writing in suggested topics. NAE staff will select the most popular topics on Wednesday while attendees are in the affinity group discussions. Attendees will then pick their table/topic on a first-come first-served basis.

8:00 pm **Adjourn**

Thursday, January 12, 2017
National Academy of Sciences Building
Lecture Room

8:00 am **Breakfast with Affinity Group to put together presentations**

9:30 am **Affinity Group Presentations**
Moderator: **Joe Herkert,** *North Carolina State University*

10:30 am **Break**

10:45 am **Affinity Group Presentations**
Moderator: **Joe Herkert**, *North Carolina State University*

11:45 am **Lunch and Team Discussion**
Teams will share and discuss ideas from Affinity Groups and develop enhancements to plans.

1:00 pm **Panel 3: Responses and Opportunities**
This panel will discuss opportunities for supporting the plans developed at the workshop. All panelists will summarize their thoughts on the workshop discussion and discuss the vision they see going forward (what challenges and opportunities remain and what next steps can be taken by the group, individuals, and organizations to overcome the challenges).
Moderator: **Bill Kelly**, *George Mason University*
Panelists: **Elliot Douglas**, *National Science Foundation*
Wenda Bauchspies, *National Science Foundation*
Norman Fortenberry, *American Society for Engineering Education*

2:30 pm **Wrap-up discussion**

3:00 pm **Adjourn**

Appendix B

Dinner Topics

Social Justice

Research Ethics

Community Engagement of Service Learning

Including Public and non-Technical Perspectives in Engineering Work and Practice

Including Liberal Arts and Humanities in Engineering Education

Sustainability

Engineers Social Responsibility

Engineering and Privacy

Appendix C

Participants List

James Abbas
Arizona State University

Carl Anderson
National Academies of Sciences, Engineering, and Medicine

Lida Anestidou
National Academies of Sciences, Engineering, and Medicine

Tom Arrison
National Academies of Sciences, Engineering, and Medicine

Solon Barocas
New York City Lab of Microsoft Research

Wenda Bauchspies
National Science Foundation

Ashley Bear
National Academies of Sciences, Engineering, and Medicine

Frazier Benya
National Academies of Sciences, Engineering, and Medicine

Stephanie Bird
Science and Engineering Ethics

Jenifer Blacklock
Colorado School of Mines

Eric Brey
Illinois Institute of Technology

Andrew Brightman
Purdue University

Matthew Brown
University of Texas at Dallas

Sarah Brownell
Rochester Institute of Technology

Carol Buckton
Siemens Corporation

Thomas Budinger
University of California, Berkeley

Beth Cady
National Academies of Sciences, Engineering, and Medicine

Jeffrey Catchmark
Pennsylvania State University

Erin Cech
University of Michigan

Stephanie Claussen
Colorado School of Mines

Jerry Coursen
Arizona State University

Karen Crosby
National Science Foundation

Glen Daigger
One Water Solutions, LLC

Vibhuti Dave
Colorado School of Mines

Steven Day
Rochester Institute of Technology

Jered Dean
Colorado School of Mines

Burton Dicht
IEEE

Nick Doty
University of California, Berkeley

Elliot Douglas
National Science Foundation

Emily Dringenberg
Kansas State University

Ann Ferren
Association of American Colleges and Universities

Norman Fortenberry
American Society for Engineering Education

Emma Frow
Arizona State University

Katherine Fu
Georgia Institute of Technology

Gerald Galloway
University of Maryland, College Park

Nicholas Gans
University of Texas at Dallas

Kyle Gipson
James Madison University

Craig Hanks
Texas State University, San Marcos

Stephen Helms Tillery
Arizona State University

Justin Henriques
James Madison University

Joseph Herkert
North Carolina State University

Elisabeth Hildt
Illinois Institute of Technology

Sarah Hitt
Colorado School of Mines

Anna Lauren Hoffmann
University of California, Berkeley

Tara Hoke
American Society of Civil Engineers

Rachelle Hollander
National Academies of Sciences, Engineering, and Medicine

Cortney Holles
Colorado School of Mines

Jo Husbands
National Academies of Sciences, Engineering, and Medicine

Abiodun Ilumoka
National Science Foundation

Brent Jesiek
Purdue University

Sharon Jones
University of Portland

Erick Jones
National Science Foundation

Andrew Katz
Virginia Tech

William Kelly
American Society for Engineering Education (ret.)

Robert Kirkman
Georgia Institute of Technology

Robert Kukta
Stony Brook University

Stacey Kulesza
Kansas State University

Kelly Laas
Illinois Institute of Technology

Jay Labov
National Academies of Sciences, Engineering, and Medicine

Yanna Lambrinidou
Virginia Tech

Toni Lefton
Colorado School of Mines

Jaime Lester
George Mason University

Felice Levine
American Educational Research Association

Karen Levy
Cornell University

Thomas Litzinger
Pennsylvania State University

Michael Loui
Purdue University

Joe Manous
US Army Corps of Engineers

Matthew Marshall
Rochester Institute of Technology

Anne-Marie Mazza
National Academies of Sciences, Engineering, and Medicine

Eduardo Mendieta
Pennsylvania State University

Don Millard
National Science Foundation

James Moore
National Science Foundation

Deirdre Mulligan
University of California, Berkeley

Junko Munakata Marr
Colorado School of Mines

Indira Nair
Carnegie Mellon University

Kurt Paterson
James Madison University

Olga Pierrakos
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Dena Plemmons
University of California, Riverside

Colin Potts
Georgia Institute of Technology

Marko Princevac
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Simil Raghavan
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Donna Riley
Virginia Tech

Wade Robison
Rochester Institute of Technology

Lucas Rodriguez
University of Texas at Dallas

Tom Rudin
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Victoria Sams
National Endowment for the Humanities

Chris Schairbaum
Texas Instruments

Jon Schmidt
Burns & McDonnell

Jen Schneider
Boise State University

Lauren Schultz
Lockheed Martin

Heidi Schweingruber
National Academies of Sciences, Engineering, and Medicine

Larry Shuman
University of Pittsburgh

Susan Sloan
National Academies of Sciences, Engineering, and Medicine

Steve Starrett
Kansas State University

Harold Stern
Texas State University, San Marcos

Alina Sullivan
LRN

Venkatadriagaram Sundararajan
University of California, Riverside

Marco Tacca
University of Texas at Dallas

Kawai Tam
University of California, Riverside

Xiaofeng Tang
Pennsylvania State University

Jitendra Tate
Texas State University, San Marcos

Paul Thompson
Michigan State University

Walt Trybula
Texas State University, San Marcos

Mark Vasquez
Institute of Electrical and Electronics Engineers

Harold Walker
Stony Brook University

Ece Yaprak
National Science Foundation

Carla Zoltowski
Purdue University

Appendix D

Biographical Sketches of Panelists

PANEL 1: MAKING ENGINEERING ETHICS RELEVANT TO STUDENTS AND THEIR FUTURE CAREERS

Moderator

Paul B. Thompson, *Michigan State University*

Paul B. Thompson holds the W.K. Kellogg Chair in Agricultural, Food and Community Ethics at Michigan State University in East Lansing, Michigan. Thompson's research emphasizes emerging technology with a specific focus on agriculture and food systems. His 2015 book *From Field to Fork: Food Ethics for Everyone* was published by Oxford University Press and was selected as the North American Society for Social Philosophy's book of the year. *The Agrarian Vision: Sustainability and Environmental Ethics* (2010) proposed a new framework for addressing questions of sustainability. Two competing paradigms influence current thinking: "sustainable development" had been crafted in response to growing fears of resource scarcity owing to economic expansion and population growth, An older approach to sustainable agriculture had stressed the integrity of agroecosystems and local institutions, providing a connected biological and social orientation to sustainability. This paradigm is now being promoted by researchers who stress "resilience." He has been the recipient of two recent contracts from the National Institute for Standards and Technology (NIST) for work on improving undergraduate education on the roles and processes for developing technical standards. Thompson completed his PhD studies in the philosophy of technology at the State University of New York

at Stony Brook in 1980. He is married, has two grown children, and enjoys nature walks and playing the guitar.

Panelists

Erin Cech, *University of Michigan*

Cech earned her PhD in sociology in 2011 from the University of California, San Diego and undergraduate degrees in electrical engineering and sociology from Montana State University. Her research examines cultural mechanisms of inequality reproduction—specifically, how inequality is reproduced through processes that are not overtly discriminatory or coercive, but rather those that are built into seemingly innocuous cultural beliefs and practices. She investigates this puzzle through three avenues of research. First, she uses quantitative and qualitative approaches to examine inequality in science, technology, engineering and math (STEM) professions—specifically, the recruitment and retention of women, LGBT, and underrepresented racial/ethnic minority students and practitioners and the role of professional cultures in this inequality. Second, Cech examines how cultural definitions of "good work" and "good workers" can anchor inequality in the workforce. For example, she examines the role of the "passion principle" in the reproduction of occupational inequalities: how seemingly voluntary and self-expressive career decisions help reproduce processes like occupational sex segregation. Finally, she studies how cultural understandings of the extent and origin of inequality help to uphold unequal social structures.

Jered Dean, *Colorado School of Mines*

Jered worked for nine years in product development before joining the Mines Faculty. During that time he had the privilege to work on everything from complex weapon systems to children's toys. His specialties include systems engineering, project management for new product development, design of molded components, and dynamic mechanism design and simulation. Jered is Director of the CECS Engineering Design Program and is passionate about teaching students engineering through project based learning. He received both his BS and MS degrees in engineering from Colorado School of Mines. In addition to leading Senior Design, Jered is the faculty adviser for the Mines SAE Baja team, ARB Club, and CSM Racing Club.

Tara Hoke, *ASCE*

Tara Hoke is the Deputy General Counsel at ASCE and a member of the Virginia bar. Her responsibilities for ASCE include legal consultation in the areas of employment, tax, corporate, contract, mergers and acquisitions, antitrust, intellectual property, real estate, and construction law.

Ms. Hoke oversees ASCE's professional conduct committee, and writes a monthly column, "A Question of Ethics," published in *Civil Engineering* magazine. Tara serves as a Council member for the Committee on Publication Ethics, a nonprofit organization established to provide guidance to journal editors and publishers on publication ethics.

Carla Zoltowski, *Purdue University*

Carla B. Zoltowski is codirector of the EPICS Program at Purdue University. She holds a BSEE, MSEE, and PhD in Engineering Education, all from Purdue and is responsible for teaching design and developing curriculum and assessment tools for the EPICS program. Carla's academic and research interests include Human-Centered Design, Ethical Reasoning, Leadership, Service Learning, and Assistive Technology and she oversees the research efforts within EPICS. She is vice chair of ASEE's Community Engagement in Engineering Education (CEEE) division.

PANEL 2: ENCOURAGING AND SUPPORTING FACULTY IN TEACHING ETHICS

Moderator

Sharon A. Jones, *University of Portland*

Sharon A. Jones has been dean of the Donald P. Shiley School of Engineering at the University of Portland since 2011. Prior to that she spent nine years at Lafayette College in Pennsylvania, first as a faculty member in the Department of Civil Engineering and chair of the Engineering Studies Program, and then as the director of the Engineering Division. She started her academic career at Rose-Hulman Institute of Technology in Indiana. Jones holds an undergraduate degree from Columbia University, a master's degree from the University of Florida, and a doctorate degree in engineering and public policy from Carnegie Mellon University. She also completed a master's of public administration.

Jones is a licensed professional civil engineer and a board certified environmental engineer. Prior to academia, she worked for a large metropolitan city and a global consulting firm. For several years, she was also the joint owner of a small consulting firm. Her teaching interests include engineering policy, environmental engineering, engineering design, and geographical information systems. Her research interests focus on applying decision-making methods to evaluate sustainability policies with emphases on infrastructure, developing economies, and particular industrial sectors.

Jones has also completed projects related to engineering ethics, diversity in the engineering profession, and opportunities to bridge engineering and the liberal arts. Over a 20-year career she has published over

70 peer-reviewed articles and conference presentations, and has received approximately $3.8 million in external funding as PI, or co-PI. She has served on several national boards in the environmental engineering arena and is actively involved with engineering accreditation issues. She received the Professional Engineers in Higher Education and Sustaining University Program's Engineering Education Excellence Award in 2007 from the National Society of Professional Engineers, and the Indian Health Service's Tribal/Urban Recognition Award in 2003. She has also served as a Fulbright Scholar and received two Clare Boothe Luce awards.

Panelists

Jaime Lester, *George Mason University*

Jaime Lester, associate professor of higher education, George Mason University, holds a PhD and MEd in higher education from the Rossier School of Education at the University of Southern California. The overarching goal of her research program is to examine organizational change and leadership in higher education. This focus has led to examinations of nonpositional leadership and tactics to promote local and institutional change and the role of individual identity in creating equitable workplaces in colleges and universities. Her more recent research on learning analytics and pedagogy in computer science is funded by the National Science Foundation (#1444789) and Google. The aim of this research is to create and promote new data-driven evidence to promote changes in pedagogy, instructional practice, and leadership decision making.

Larry Shuman, *University of Pittsburgh*

Larry J. Shuman is senior associate dean for academic affairs and Distinguished Service Professor of Industrial Engineering, University of Pittsburgh. His research focuses on improving the engineering educational experience, emphasizing assessment of learning and problem solving abilities, and studying the ethical behavior of engineers and engineering managers. He has led the development of a very successful cooperative engineering education program and an innovative study abroad program. He served as the spring 2002 academic dean for the Semester at Sea Program.

A former senior editor of the *Journal of Engineering Education*, Shuman is the founding editor of *Advances in Engineering Education*. He has published widely in the engineering education literature, and is coauthor of *Engineering Ethics: Balancing Cost, Schedule and Risk—Lessons Learned from the Space Shuttle* (Cambridge University Press). He received his PhD from the Johns Hopkins University in Operations Research and BSEE from the University of Cincinnati.

Thomas Litzinger, *Pennsylvania State University*

Tom Litzinger has been director of the Leonhard Center since July 1997. From 1992 until his appointment as director he was Penn State principal investigator of the Engineering Coalition of Schools for Excellence in Engineering and Leadership (ECSEL). Through his experience with ECSEL, he developed a broad understanding of the changes needed in engineering education and the drivers for change. An award winning teacher and researcher, Litzinger provides leadership on issues related to engineering education in the College. Through ECSEL he was involved not only in the curricular and teaching/learning reform, but also in the faculty and student development programs required to bring about change. Through his applied research for industry, allows him to stay abreast of the skills and knowledge required for students to succeed in the workplace.

Ann Ferren, *Association of American Colleges and Universities*

Ann S. Ferren has more than 30 years of experience as an academic administrator in a variety of roles including director of general education, dean of faculty, and interim provost at American University in Washington DC, vice president for academic affairs at Radford University, and most recently provost at the American University in Bulgaria. She has served on the Board, participated in many institutes, and written for several AAC&U publications. Her work on academic quality, assessment, and reallocation of resources to support learning and curricular improvement is particularly relevant in the new economic environment of higher education.

PANEL 3: RESPONSES AND OPPORTUNITIES

Moderator

William Kelly, *American Society for Engineering Education*

William E. Kelly, PhD, PE, retired as director of external affairs at the American Society for Engineering Education (ASEE) in 2015. At ASEE his responsibilities included the engineering dean's council, ASEE's K–12 activities, and ASEE's ABET activities. Before joining ASEE in September 2007, he was a professor of civil engineering at the Catholic University of America (Washington, DC), where he also served as dean of the school of engineering (1996–2001). While dean, he served on the JETS board and the board of directors for the Washington ACE mentor program. Kelly was on the ABET Engineering Accreditation Commission (EAC; 1993–2003) and was chair in 2001–2002. He is a member of the American Society of Civil Engineers (ASCE) Committee on Sustainability and has taught sustainability as a practitioner adjunct faculty member at George Mason University. Currently, he chairs a task committee for the American Association of

Engineering Societies on global sustainability focused on implementation of the United Nations Sustainability Goals. Kelly received his PhD in civil engineering from the University of Notre Dame and received an engineering honor award from his alma mater in 1999.

Panelists

Elliot Douglas, *National Science Foundation*

Elliot Douglas is the NSF program director for Engineering Education. He is also associate professor of environmental engineering sciences and Distinguished Teaching Fellow at the University of Florida. He is director of the Engineering Education Collaborative, which brings together faculty interested in all aspects of engineering education, from improving their teaching to conducting education research. His research interests lie at the intersection between education research and engineering education practice. His work aims to understand complex thinking processes and learning in students, and to use this information to design effective teaching practices, and includes research in critical thinking, active learning, and problem-solving. He also conducts work on qualitative methodologies in engineering education research. He has published a textbook, Introduction to Materials Science and Engineering: A Guided Inquiry. He has been involved in faculty development activities since 1998, most recently presenting workshops on active learning through the POGIL Project.

Wenda Bauchspies, *National Science Foundation*

Wenda Bauchspies is the Program Director for STS/Cultivating Cultures for Ethical STEM (CCE STEM). She coauthored *Science, Technology, and Society: A Sociological Approach* and has coedited special issues for *Cultural Dynamics*, *Subjectivity*, and *Social Epistemology*. Her interdisciplinary scholarship has been published in journals such as *Journal of Asian and African Studies*, *Science as Culture* and *Knowledge and Society*. She has taught courses on the sociology of science; gender and technology; social theory; and science, technology, and development. Bauchspies has a long and continuing involvement with sociocultural research that addresses the transfer, adoption and development of science and technology.

Norman Fortenberry, *American Society for Engineering Education*

Norman L. Fortenberry is executive director of the American Society for Engineering Education (ASEE), an international society of individual, institutional, and corporate members founded in 1893. ASEE is committed to furthering education in engineering and engineering technology by promoting global excellence in engineering and engineering technology instruction, research, public service, professional practice, and societal

awareness. Fortenberry was the founding director of the Center for the Advancement of Scholarship on Engineering Education (CASEE) at the National Academy of Engineering (NAE). He served in various executive roles at the National Science Foundation (NSF) including as senior advisor to the NSF Assistant Director for Education and Human Resources and as director of the divisions of undergraduate education and human resource development. He has also served as executive director of the National Consortium for Graduate Degrees for Minorities in Engineering and Science (the GEM Consortium) and as a faculty member in the department of mechanical engineering at the Florida A&M University – Florida State University College of Engineering. He was awarded the SB, SM, and ScD degrees (all in mechanical engineering) by the Massachusetts Institute of Technology.