Board 72: Why Engineering Ethics? How Do Educators and Administrators Justify Teaching Engineering Ethics?

Dr. Soheil Fatehiboroujeni, Indiana-Purdue University

Soheil FatehiBoroujeni received his Ph.D. in Mechanical Engineering from the University of California, Merced in 2018. As a postdoctoral researcher at Purdue University, School of Engineering Education, Soheil is working on a multi-institutional project characterizing governance processes related to change in engineering education, and pursuing other research interests in epistemology and design, among other philosophical topics in engineering education.

Dr. Atsushi Akera, Rensselaer Polytechnic Institute

Atsushi Akera is Associate Professor and Graduate Program Director in the Department of Science and Technology Studies at Rensselaer Polytechnic Institute (Troy, NY). He received his M.A. and Ph.D. in the History and Sociology of Science, University of Pennsylvania. His current research is on the history of engineering education reform in the United States (1945-present). He is the immediate past chair of the ASEE Ad Hoc Committee on Interdivisional Cooperation; Chair of the International Network for Engineering Studies (INES); past chair of the ASEE Liberal Education / Engineering and Society Division; and a former member of the Society for the History of Technology's (SHOT) Executive Council. Publications include /Calculating a Natural World: Scientists, Engineers and Computers during the Rise of U.S. Cold War Research/ (MIT Press, 2006).

Dr. Donna M Riley, Purdue University-Main Campus, West Lafayette (College of Engineering)

Donna Riley is Kamyar Haghighi Head of the School of Engineering Education and Professor of Engineering Education at Purdue University.

Dr. Alan Cheville, Bucknell University

Alan Cheville studied optoelectronics and ultrafast optics at Rice University, followed by 14 years as a faculty member at Oklahoma State University working on terahertz frequencies and engineering education. While at Oklahoma State, he developed courses in photonics and engineering design. After serving for two and a half years as a program director in engineering education at the National Science Foundation, he took a chair position in electrical engineering at Bucknell University. He is currently interested in engineering design education, engineering education policy, and the philosophy of engineering education.

Dr. Jennifer Karlin, Minnesota State University, Mankato

Jennifer Karlin spent the first half of her career at the South Dakota School of Mines and Technology, where she was a professor of industrial engineering and held the Pietz professorship for entrepreneurship and economic development. She is now a research professor of integrated engineering at Minnesota State University, Mankato, and the managing partner of Kaizen Academic.

Sarah Appelhans, University at Albany

Sarah Appelhans is a PhD candidate in Cultural Anthropology. Her dissertation research, "Steel Toes and Ponytails: Gender and Belonging in Engineering", investigates the boundaries of membership in engineering in the Capital District of New York. She is honored to be a research assistant on the NSF-sponsored study on engineering education reform entitled "The Distributed System of Governance in Engineering Education." In addition to her academic experience, she is a former mechanical engineer with several years of experience in the aviation and construction industries.

Thomas De Pree, Rensselaer Polytechnic Institute

Thomas De Pree is a PhD student and HASS Fellow of Science and Technology Studies in the School of Humanities, Arts, and Social Sciences at Rensselaer Polytechnic Institute in Troy, New York. Trained in sociocultural anthropology, he received a BA in Anthropology and Psychology from the University of New Mexico in 2010, and a MA in Anthropology and Education from Teachers College, Columbia University in 2015.

Why Engineering Ethics? How Do Educators and Administrators Justify The Development of Engineering Ethics?

Abstract

This work-in-progress paper presents preliminary findings on how the education of engineering ethics is justified by academic administrators and policymakers drawing from the data collected in a multi-institutional project called "The Distributed System of Governance in Engineering Education". The project seeks to understand the practice of engineering education reform using ethnomethodological data collected from oral interviews at a variety of academic institutions and other organizations in engineering education.

Investigations of effective strategies for ethical formation of engineering students have been continuously pursued in the engineering education community. Review of the literature on this topic results in not only identifying diverse approaches and conceptions of engineering ethics, but also a set of diverse rationales and contexts of justification for development and implementation of programs on engineering ethics. The students' attitude towards ethical development is shaped by how the subject is delivered, e.g., use of "best practices" or conceptual clarity in the notion of ethics offered to them, as well as why it is taught. Institutions send a signal to students, even if they do not intend to, about the importance of ethics in the engineering profession by how and why they address this matter.

The initial analysis of interview data from over a hundred subjects from more than twenty universities demonstrates diverse ways of justifying ethics education such as satisfying ABET accreditation requirements or complying with recommendations of the disciplinary professional association (e.g., ASME or ASCE). Identifying a resistance to notions such as judgment, and in general, a disregard for engineering ethics in conversations on governance and educational decision-making are other preliminary findings of this work.

Keywords: Engineering Ethics, Rationale, Governance, Engineering Education

1 Introduction

Throughout the historical evolution of engineering as a profession, the practice and the discourse of responsible and ethical conduct have been crucial elements from an educational as well as a political perspective. Comprehensive surveys of this history[1,2] demonstrate how factors such as a struggle for professional independence and authority, a loyalty to the special interests of the business and capital, and–more immanent to our discussion–rationale of serving, developing, and advancing the well-being of society are formative to what engineering is and, hence, what constitutes engineering ethics. All major professional disciplinary societies, such as ASME, ASCE,

and IEEE today articulate and periodically update codes of ethics entailing canons and rules of practice. This continuous activity, in part is driven by both emergent and long-lasting challenges in regulating and maintaining a practically and socially responsive system of engineering ethics. For example, adherence to, and observance of professional disciplinary codes of ethics are often expressed in preambles as an obligation to the membership, however, enforcement mechanisms are not as clearly defined as the codes themselves[3]. In addition, practical situations in which fulfilling a subset of two or more rules becomes contradictory, i.e. practical cases that render elements of a deontological (duty based) ethics irreconcilable, amount to further issues demanding scholarly attention beyond the scope of this paper.

Systematic surveys of literature on engineering ethics interventions[4,5] compile various frameworks and pedagogical approaches adopted by educators to promote the ethical formation of engineering students. Efforts and initiative of this kind are justified by (i) the requirements and guidelines of accreditation boards or professional societies[6,7,8,9], or (ii) unprecedented ethical concerns with regard to new technologies that challenge or transcend existing ethical frameworks[10,11,12], or (iii) the essential role of engineering in societal progress and improvement[5,13,14]. Although the unifying theme in the majority of efforts and initiatives is to develop and nurture the *ethical reasoning* of engineering students, the rationale, the context in which programs are conceived, and the scale of efforts are diverse.

The students' attitude towards ethical responsibility is shaped not only by *how* the subject is delivered, e.i., how ethics is interpreted and implemented which is often investigated under the rubric of effective and coherent instructional frameworks[15,16,17,18], but also by *why* it is taught. Institutions send a signal to students, even if they do not intend to, about the nature of ethics and responsibility in engineering profession by how and why they pay attention to it in the curriculum.

In this paper, to understand how the education of engineering ethics is negotiated, justified, or rationalized in action we use the data collected form a study on the practices of engineering education reform as they unfold within the fragmented professional structure and complex institutional ecology of U.S. higher education. Although some insights exist into "why engineering ethics?"[19,20], the ethnomethodological outlook of our approach focused on "method" and practice of governance and decision-making is well-positioned to arrive at a more nuanced, fine-grained, multiple-standpoint understanding of the matter through oral interviews and limited fieldwork. The project as a whole is based on a multi-site, multi-scale research design, employing mixed mode analyses (primarily historical research, semi-structured interviews, and content analysis). We use grounded theory method[21], as suited to the study of complex institutions and organizational discourse. The grounded theory provides basic analytic tools, i.e., strategies to interpret the data and to develop novel conceptualizations without providing rigid directives or formulaic research methodology antithetical to analysis of social phenomena.

Data in this paper are reported only in general terms, without attribution, with the exception of some data related to the engineering accreditation organization, ABET, still without individual attribution or identifiers, which will be published only following their review and consent.

2 Engineering Ethics Rationalized: In Literature

In this section we review the types of justification or rationale reported for promoting engineering ethics in the literature. An important category of the engineering ethics literature that lies beyond the scope of present paper contains theoretical works which engage, often philosophically with the question of *what is engineering ethics* as it relates to pressing contemporary matters such as social justice[22], environmental protection[23], or technology and design[24]. Such theoretical engagements play a crucial role in providing a historically and philosophically conscious map to the relationship between *engineering* and *ethics*. Nonetheless, due to the empirical focus of our project on the practice and the discourse of change and reform in engineering education, in this paper we focus on the existing literature that report on initiatives implementing or evaluating instructions on engineering ethics. These efforts demand allocation of resources and commitment of educators within a degree program, if not administrators from without.

A recent systematic survey of literature on engineering ethics interventions from 2000 to 2015 has identified the following categories for "justification or identification of the need for the ethical intervention"[5].

1. ABET Accreditation
2. University, School, or Departmental Efforts
3. National Organizational Efforts
4. Societal Improvement

The first category corresponds to the cases in which fulfillment of ABET accreditation requirements–outlined in student outcomes–is expressed as the rationale for ethics education. Second category, entails cases in the literature where institutions, or degree granting programs lead an initiative to promote ethical development of engineering students. We would like to comment that this category is sufficient only as a *post hoc* rationale from the perspective of educators designing and implementing specific interventions, but not applicable as a *propter hoc* rationale for agents (educators or administrators) who need to materialize and establish such initiatives in the first place. In the next section we try to make explicit the rationalizations from the perspective of both educators and administrators in addition to the perspective of the individuals directly involved in creation of ABET EC 2000 framework of outcome-based assessment.

The third category above is identified as "National efforts (not including ABET) calling for ethics education in engineering"[5]. Finally, the forth category includes cases that cite societal benefits of engineering ethics education as a justification. In the following section we discuss the articulations of rationale for engineering ethics in our data. We also comment on how these data help explicate the structures and practices corresponding to discursive reasoning of our subjects.

3 Engineering Ethics Rationalized: In Practice

In this section we present our initial findings form the semi-structured interview data collected in an ongoing study of the practices of engineering education reform within a diverse set of nationally

representative institutions of U.S. higher education. The data is collected, since September 2017 till October 2018, from twenty three degree-granting programs in twelve states culminating into n=156 number of interviews. Our site selection strategy entailed criteria to maintain diverse representation of public and private institutions, general universities, engineering colleges, land-grant institutions, and liberal arts colleges; women and minority serving institutions, PhD and non-PhD institutions, and institutions of different rank (three tiers) and geographic areas (four zones). In addition, we have interviewed individuals directly involved in the creation of ABET EC 2000 regime and plan to complement the data set by including the voices of professional associations such as ASEE, ASME, ASCE, IEEE which are currently absent in our data. The following is a list of research questions guiding our study.

Structure: What is the basic structure of the engineering education in the U.S. and how it enables and frustrates reform efforts?

Reform Practice: Is there an ethnomethodologically accountable (describable) body of practice for engineering education reform? What are the origins of this body of practice, and how has it changed over time?

Epistemic Habits: What epistemic habits do engineers have that influences their approach to engineering education reform?

Articulations of Context: To what extent, and in what manner do engineering educators and their leadership contribute to articulations of the social context, for example, national agendas such as "engineering manpower crisis" or "national competitiveness" to which they direct their reforms?

Coordination: How are changes in engineering education coordinated across the distributed field of organizations that have responsibilities for, or else have substantial input with regards to new directions in engineering education?

Diversity & Closure: Specifically, is this coordination frustrated because of different goals and perceptions that exist within the different levels of an organization? Across organizations? What practices exist, both formal and informal, for managing diverse constituencies and divergent attitudes about engineering education?

Destabilization: How and under what conditions do prior arrangements become destabilized? To what extent are the recurrent cycles of reform in engineering education driven by external factors and to what extent are they driven by an organizational logic or else through reform impulses that are internal to the epistemic culture of engineering education?

Our semi-structured interviews, last around 60 to 90 minutes per individual and include subjects from at least two degree programs (departments) per university, and a variety of positions (non-tenured, tenured faculty, program chairs, deans, and provosts). In particular, our subjects have direct involvement and experience with planning, implementation, resource allocation, or consensus building in the local and/or national initiatives. This allows us to identify the discourse as well as the structural conditions or consequences of governance in engineering education. Emergence of engineering ethics in various contexts or, by the same merit, its absence in numerous others is of interest to us in this paper.

The interviews were recorded (with proper informed consent and privacy protection protocols),

transcribed, coded and analyzed, first with an exploratory, open coding[25] approach to identify emerging themes. In the exploratory stage, a salient category that we named "why engineering ethics" was observed (a) in situations where interview subjects articulate initiatives entailing engineering ethics intervention and their respective involvement in the process, or (b) in general when subjects remark on engineering and its ethical and societal implications. This umbrella code representing various justifications or rationales of engineering ethics then probed further to identify nuances of "why engineering ethics" in each case. The low level codes, finally were integrated into arguments used to rationalize promotion of engineering ethics education.

3.1 Compliance Argument: Meeting Requirements

ABET Engineering Criteria (EC) 2000, as well as the recent revisions modifying or clarifying requirements, explicitly mention "an ability to recognize ethical and professional responsibilities in engineering situations" among the student outcomes. We observed educators citing "ABET requirements" as a reason to integrate engineering ethics into the curriculum, even though their intended form or scope of instruction often diverged. We label this as the "compliance" argument since it is premised on necessity of meeting accreditation requirements in program-wide assessment mechanisms. Although ABET by introducing EC 2000 has framed engineering ethics as an outstanding educational outcome, in many cases, due to the implementational and procedural flexibility that ABET affords, programs can pass the minimum bar without establishing distinct units or formative courses devoted to the instruction of engineering ethics. Nonetheless, "meeting the ABET requirement" is the most pervasive argument for engineering ethics, mirroring the pervasiveness of ABET accreditation among the engineering programs.

3.2 Reform Arguments: Instituting Change

In our data, we document how curricular reform initiatives driven by either individuals within a program or as part of a larger institutional plan, require articulations of "why engineering ethics". Although such initiatives are conceived locally, the arguments used for promotion of engineering ethics transcends locality, hence we avoid the label "local arguments". Our project in part is focused on explaining how exactly the reform and educational innovation emerge–a complex process which present paper do not engage with–what conditions facilitate or falter it, and what consequences it has to the system. Nonetheless, based on our functioning hypothesis that reform initiatives are the response of the (organizational) agents in engineering education to a dynamic environment ("changing times"), we use the label "instituting change" to characterize a unique category of rationales for engineering ethics.

To clarify this category, we look at the contexts where it is figured predominantly. Compared to universities that prioritize research and graduate education as their top priority, we observe that in non-PhD (undergraduate focused) institutions faculty members invest more time and effort on educational reform and innovation while facing less structural barriers to spearhead initiatives such as infusing ethics in the curriculum. While research focused institutions too actively address educational challenges and seek to maintain competitive undergraduate programs, the structural

differences in faculty tenure and promotion models, or quantity and quality of inter-faculty coordinations (just to name two factors) between PhD and non-PhD programs result in differentials over the discourse and practice of education reform to the extent that educational innovation becomes itself a rationale for specific interventions in some undergraduate focused programs. Nevertheless, the PhD/non-PhD binary demarcation provides only a limited insight into the diverse methods and forms employed by engineering programs to monitor, evaluate, and improve undergraduate education. Our data captures such nuances and further analysis of how multiple factors such as institutional size, regional demands, and cultural norms (or pressures) impact education reform is required to give a better picture of governance processes.

3.2.1 Professional Skills for Real World Problems

ABET EC 2000 has been instrumental in encouraging programs to establish industrial advisory boards. These structures allow the voices of partner industries and employers to be heard in the decision-making and impacting the educational initiatives. Employers have consistently expressed the value of graduates experienced with "real world" challenges, apt in "ethical conduct", and skilled in making professionally "informed judgments". We observe that reformers predicate the inclusion of engineering ethics education in the curriculum on the inputs provide by employers (engineering firms), in particular those channeled through advisory boards.

A knowledge of engineering codes of ethics and developing ethical reasoning skills are also necessary for passing Professional Engineering (PE) licensure exams. Educators seeking to support and enhance student success on tests such as Fundamentals of Engineering (FE) also express the crucial role of ethical literacy and reasoning skills as a rationale for promoting engineering ethics education. Therefore, the system of professional licensing administered by NSPE (National Society of Professional Engineers) and its vital role in the wider ecosystem of engineering profession (for example legal protections and obligations of a PE) reflects concretely in conversations as a rationale to promote education of professional ethics.

3.2.2 Ethical Development of New Technology

One of the most essential and characteristic tasks of engineering is the design of new technologies. As the integration of increasingly complex technologies with numerous aspects of our social and private life expands and intensifies, importance of ethical decision-making in production of novel technologies becomes evermore crucial. We observed arguments of this kind in our data as a rationale for attending to engineering ethics education that enables the engineering students to address social and ethical implications of novel technologies.

The increasing and unprecedented complexity of cyber-physical or biological technologies have also created pressing challenges for the industries seeking to develop or commercialize such technologies. Academia and in particular engineering programs, are viewed as potential platforms where ethical and regulatory framework for new technologies can be researched and developed concurrent or conjoined with the technical research itself. This rationale is reflected in our data, although as an exploratory and initial ideation.

3.3 Resistance Arguments

Interpretation of ethics and its practical manifestation is neither universally unvaried nor certain. Indeed both orthodox and heterodox construals of ethics and responsible conduct are observable in all historical and social contexts. In engineering community, positivistic attitudes such as a quest for conceptual certainty and aversion of ambiguity, in addition to disciplinary divergence of interests result into controversial debates on, and resistance to promotion of ethics education. For example, our project has documented that in the creation of ABET EC 2000 criteria, representatives and engineers from various disciplines involved in the process, contentiously debated whether to include or not the language on "informed judgments" in student outcomes. The arguments for exclusion of this particular outcome revolved around the difficulties of teaching professional judgment and ambiguities of measuring the extent to which students achieve such skills.

4 Conclusions

Faced with the growing social impact of modern technologies in our private and collective life, engineering education is urged to respond to the questions such as what is the ethical responsibility of an engineer, or how to promote ethical formation of engineering students. To induce change, materialize education reform, and negotiate for allocation of resources, educators and administrators have to navigate institutional structures built to address competing priorities, driven by local and non-local demands. In this paper we reviewed some of the preliminary findings on how decision-makers and active reformers rationalize engineering ethics by drawing form the data form a multi-institutional study that seeks to understand the governance in complex institutional ecology of U.S. engineering education. By assessing the rationale and justification of engineering ethics education, i.e., "why engineering ethics", in the practice of education reform, this paper seeks to complement the research on perception of faculty[27] and students[28,29] on what constitutes engineering ethics and what constitutes formative and effective educational experiences in engineering ethics.

The findings presented in this paper have implications for practitioners and administrators involved with engineering education reform and decision-making. The diversity of institutional missions and mandates within the U.S. engineering education and its decentralized structure of governance requires each of the units in this system to take local and intentional action in identifying challenges and framing viable paths to instituting effective response to the changing needs and contexts. In other words, engineers as organizational actors have developed a body of practices, norms, and structures to regulate and redefine engineering education in response to socio-historical developments. Hence, sociological insights on the practice of reform in higher education informs the decision-makers to better facilitate responsive action.

Our ongoing multi-institutional study has yet to explore the role of professional disciplinary associations as well as industrial employers to synthesize a fuller picture of the national ecosystem of engineering education. Nonetheless, our continuous analysis and data collection is showing both consistent and contrasting patterns in the discourse and practice of education reform. For example, ABET accreditation has been, and remains to be a preeminent element of the U.S. en-

gineering education system. ABET EC 2000 in part has motivated education reform, for instance by providing a context and a rationale for ethics education and promotion of professional skills. ABET mandates degree programs to establish a systematic assessment process that provides not only achievement checkpoints but also a foundation for program-wide improvement and reform. Nevertheless, enforcement of these requirements in some cases are viewed as time consuming or antithetical to local innovation.

Although our study examines various types of public and private institutions with engineering degree programs, we observe that institutions with exclusive focus on undergraduate engineering education are better positioned to align their reformation efforts with demands and gaps such as promotion of ethical reasoning skills or other professional competencies such as communication, collaboration, and lifelong adaptability skills. The incentives to focus on student development, and faculty promotion structures of institutions focused on undergraduate education allows high levels of time investment by, and coordination among the faculty to materialize education reform and institute continuous improvement. The arguments for and contra engineering ethics discussed in this paper represent a set of preliminary findings of our project which we expect to evolve as we engage with other elements and stakeholders in the ecosystem of engineering education such as professional societies, ASEE, NSF, and National Academy of Engineering.

References

[1] D. Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism*. A Borzoi book, Oxford University Press, 1979.

[2] E. Layton, *The Revolt of the Engineers: Social Responsibility and the American Engineering Profession*. Press of Case Western Reserve Univ., 1971.

[3] C. Fleddermann, *Engineering Ethics*. Pearson Education, 2011.

[4] D. R. Haws, "Ethics instruction in engineering education: A (mini) meta-analysis," *Journal of Engineering Education*, vol. 90, no. 2, pp. 223–229, 2001.

[5] J. L. Hess and G. Fore, "A systematic literature review of us engineering ethics interventions," *Science and Engineering Ethics*, vol. 24, pp. 551–583, Apr 2018.

[6] S. Sheppard, K. Macatangay, A. Colby, W. Sullivan, and L. Shulman, *Educating Engineers: Designing for the Future of the Field*. Jossey-Bass/Carnegie Foundation for the Advancement of Teaching, Wiley, 2008.

[7] B. E. Barry and M. W. Ohland, "Abet criterion 3.f: How much curriculum content is enough?," *Science and Engineering Ethics*, vol. 18, pp. 369–392, Jun 2012.

[8] S. M. Culver, I. K. Puri, R. E. Wokutch, and V. Lohani, "Comparison of engagement with ethics between an engineering and a business program," *Science and Engineering Ethics*, vol. 19, pp. 585–597, Jun 2013.

[9] G. D. Catalano, "Senior capstone design and ethics: A bridge to the professional world," *Science and Engineering Ethics*, vol. 10, pp. 409–415, Jun 2004.

[10] L. Kisselburgh, C. B. Zoltowski, J. Beever, J. L. Hess, A. J. Iliadis, and A. O. Brightman, "Effectively engaging engineers in ethical reasoning about emerging technologies: A cyber-enabled framework of scaffolded, integrated, and reflexive analysis of cases," in *2014 ASEE Annual Conference & Exposition*, (Indianapolis, Indiana), ASEE Conferences, June 2014. https://peer.asee.org/20349.

[11] R. M. Berry, J. Borenstein, and R. J. Butera, "Contentious problems in bioscience and biotechnology: A pilot study of an approach to ethics education," *Science and Engineering Ethics*, vol. 19, pp. 653–668, Jun 2013.

[12] A. Ferrari, C. Coenen, and A. Grunwald, "Visions and ethics in current discourse on human enhancement," *NanoEthics*, vol. 6, pp. 215–229, Dec 2012.

[13] M. Pantazidou and I. Nair, "Ethic of care: Guiding principles for engineering teaching & practice," *Journal of Engineering Education*, vol. 88, no. 2, pp. 205–212, 1999.

[14] G. D. Catalano, "Engineering ethics: Peace, justice, and the earth," *Synthesis Lectures on Engineers, Technology, and Society*, vol. 1, no. 1, pp. 1–80, 2006.

[15] J. Li and S. Fu, "A systematic approach to engineering ethics education," *Science and Engineering Ethics*, vol. 18, pp. 339–349, Jun 2012.

[16] M. W. Keefer, S. E. Wilson, H. Dankowicz, and M. C. Loui, "The importance of formative assessment in science and engineering ethics education: Some evidence and practical advice," *Science and Engineering Ethics*, vol. 20, pp. 249–260, Mar 2014.

[17] M. C. Loui, "Ethics and the development of professional identities of engineering students," *Journal of Engineering Education*, vol. 94, no. 4, pp. 383–390, 2005.

[18] M. C. Loui, "Educational technologies and the teaching of ethics in science and engineering," *Science and Engineering Ethics*, vol. 11, pp. 435–446, Sep 2005.

[19] C. E. Harris Jr., M. Davis, M. S. Pritchard, and M. J. Rabins, "Engineering ethics: What? why? how? and when?," *Journal of Engineering Education*, vol. 85, no. 2, pp. 93–96, 1996.

[20] D. Callahan, *Goals in the Teaching of Ethics*, pp. 61–80. Boston, MA: Springer US, 1980.

[21] J. Corbin and A. Strauss, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. SAGE Publications, 2014.

[22] D. Riley, "Hidden in plain view: Feminists doing engineering ethics, engineers doing feminist ethics," *Science and Engineering Ethics*, vol. 19, pp. 189–206, Mar 2013.

[23] P. Vesilind and A. Gunn, *Engineering, Ethics, and the Environment*. Cambridge University Press, 1998.

[24] I. van de Poel and L. Royakkers, *Ethics, Technology, and Engineering: An Introduction*. Wiley, 2011.

[25] R. Emerson, R. Fretz, and L. Shaw, *Writing Ethnographic Fieldnotes, Second Edition*. Chicago Guides to Writing, Editing, and Publishing, University of Chicago Press, 2011.

[26] A. Akera, D. M. Riley, A. Cheville, J. Karlin, and T. A. De Pree, "The distributed system of governance in engineering education: A report on initial findings," in *2018 ASEE Annual Conference & Exposition*, (Salt Lake City, Utah), ASEE Conferences, June 2018. https://peer.asee.org/31086.

[27] A. Katz and D. B. Knight, "Factors related to faculty views toward undergraduate engineering ethics education," in *2017 ASEE Annual Conference & Exposition*, (Columbus, Ohio), ASEE Conferences, June 2017. https://peer.asee.org/28350.

[28] A. R. Bielefeldt, M. Polmear, C. Swan, D. Knight, and N. Canney, "An overview of the microethics and macroethics education of computing students in the united states," in *2017 IEEE Frontiers in Education Conference (FIE)*, vol. 00, pp. 1–9, Oct. 2017.

[29] D. S. Fuentes, G. M. Warnick, B. K. Jesiek, and R. Davies, "A longitudinal study of social and ethical responsibility among undergraduate engineering students: Preliminary results," in *2016 ASEE Annual Conference & Exposition*, no. 10.18260/p.26348, (New Orleans, Louisiana), ASEE Conferences, June 2016. https://peer.asee.org/26348.