Reimagining Ethics Education for Peace Engineering

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***Abstract*—Recent disasters, including the Flint water crisis, the Volkswagen emissions scandal, and the post-hurricane scandal in Puerto Rico, reflect a moral failure to respond to the social dimensions of engineering. We employ three jumping-off points: ideological foundations in the culture of engineering education, dominant imaginaries of "community-engaged" research and practice, and the instruction of engineering ethics. We share the belief that these deficiencies are interconnected and mutually reinforcing, and more importantly that they render engineers vulnerable to causing or perpetuating injustice inside and outside the walls of the profession, and blind to recognizing such injustice when it occurs. In response, we propose how a focus on peace engineering can put engineers in dialogue with the publics they serve.**

Keywords—community engagement; ethics; social justice

I. INTRODUCTION

Large-scale moral failures like the recent Volkswagen emissions scandal, Flint water crisis, Facebook data crisis, and post-hurricane crisis in Puerto Rico call for urgent reexamination of engineers' professional and ethical obligations to society. Intending to provoke reflection on a reconceptualization of engineering ethics education, this paper employs three jumping-off points pertaining to the engineering profession's relationship to "the public": ideological foundations in the culture of engineering education, dominant imaginaries of "community-engaged" research and practice, and instruction in engineering ethics. The paper posits that these are interconnected and mutually reinforcing forces, which promote a technical/social dualism, a de-politicization of the technical, and an ideology of "successful" meritocracy in which existing societal structures are considered just, while simultaneously excluding questions of socially constructed hierarchies of knowledge; of power asymmetries on local, national, and global scales; of equity; and of justice. The result is a professional culture that fosters in engineers a sense of duty to develop technologies and interventions *separately* from "the public," exercise the power of their expertise *over* "the public," and view their work as socially "beneficial"—if not "miraculous" or "heroic"—*regardless* of the public's experiences and views. Such a culture would tend to promote a colonial imposition of an engineered peace, rather than peace engineering.

We suggest that this culture attaches to engineers an awe-inspiring aura of omniscience that is fed by perfect objectivity -- what we name "the flaw of the awe." This aura, in turn, tends to seep into the public sphere, often delegitimizing or discounting local knowledge, agency, and voice. This can widen power asymmetries between engineers and the communities they aim to serve by convincing the latter that they have either nothing to offer to the former, or that they need not take precautions against the possibility of engineering harm. We argue that, as well-intentioned as the development of the engineer's "hero" persona might be, it is fundamentally flawed because it renders engineers vulnerable to causing or perpetuating public harm. Moreover, it tends to leave engineers unequipped to a) foresee such harm, b) work to prevent it through adjustable implementation of their expertise that responds to local conditions, voices, and needs, and c) recognize it when it occurs or hear the voices of affected publics attesting to it. We close with a call for a new engineering ethics, one *with representation*, that disrupts patterns of systemic paternalism in engineering practice. We envision this ethic as fitting in with, and in fact central to, peace engineering.

II. CURRENT CULTURE OF ENGINEERING EDUCATION

Engineering has been criticized for its technical/social dualism [1], in which "real" engineering consists of technical calculations. Social considerations are considered "extras" that don't count as engineering. This culture is manifested in several different ways. One of the more obvious is the distinction between "hard" and "soft" skills. Hard skills form the technical core of engineering, while soft skills comprise all the "extra" stuff: ethics, communication, teamwork, societal impact, etc. In this formulation, soft skills are "easy", and perhaps don't require formal education, while hard skills are "difficult" and must be continually reinforced in multiple classes. Riley and Lambrinidou describe "the profession's tendency to marginalize, ignore, silence, and/or atrophy the…central elements of ethical engineering practice…" [1, p. 3]. These elements include the non-technical dimensions of engineering, local knowledge, agency of all persons, and the public as the profession's primary client. In their place we find beliefs in meritocracy, the primacy of technical knowledge, and the "flaw of the awe", i.e., a culture which positions engineers as the ultimate authority, purely objective, and even savior of the public.

Engineering education creates these mindsets through its separation of the technical "important" topics from the non-technical "unimportant" topics. Focus on the technical content results in students learning that they can be objective and that they have specialized knowledge that gives them some measure of authority over engineering decisions. Within the engineering education curriculum, social considerations primarily occur only in stand-alone engineering ethics courses. However, these courses typically have no prerequisites and are not prerequisites for any other courses, placing them in isolation from the rest of the curriculum. Even in capstone design, where it would seem natural to include social considerations, it is often missing when projects focus exclusively on the technical design of, for example, a chemical reactor. Important social considerations for such a project include: Where should the reactor be sited so as not to disproportionally impact marginalized communities? Who are the communities and what are their responses to the reactor? What is the impact of the reactor on the environment? What are the engineering alternatives to building the reactor? What moral obligations are implied by the design and use of the reactor? These considerations are absent in the consideration of reaction rates, materials specification, and product throughput that would be standard for this capstone design project.

Cech shows clearly the results of these mindsets in creating what she calls a culture of disengagement [2]. Her data shows that beliefs in engineering as a means to support the welfare of the public decrease over the course of their education. She identifies the source of this decrease through data showing that students perceive that their programs emphasize the technical aspects of engineering over the social aspects.

The source of the technical/social duality of engineering is a deterministic Newtonian view of the universe [3], a belief that nature can be described through a set of mathematical equations that can be solved to describe all behavior. Engineering is thus a profession that seeks to master the universe through application of these equations. Riley argues that "engineering has largely reflected the values of mainstream society and of neoliberal, military, and corporate interests. This is due in part to, and continually justified by, engineers' commitment to considering themselves value-neutral or objective. This set of values has been inculcated in engineers through the engineering education process" [4. p. 107].

III. Imaginaries

If you ask elementary students what an engineer does, many might say they work on engines [5]. Often the stereotype of an engineer has little to do with *who* engineers are, *what* they do, *what* their professional, ethical, and personal commitments to society are, and *how* they differ from non-engineers. The imaginary of who is an engineer and what they do informs the public's perceptions of and predisposition toward engineers. Potentially, these imaginaries may influence how communities interact with engineers and engineers' potential impact (technological, social, political, physical, and psychological) on the community.

We hypothesize, based on personal experience of one of the authors, that community members might at times find themselves in "awe" of engineers as agents of omniscience and perfect objectivity as well as masters of all relevant technical knowledge. They might also view engineers as power brokers who have the skills and expertise not only to fix the problem at hand but also to speak on their behalf to other experts, as well as to elected officials and policymakers in positions to make decisions for the community. An individual's "awe" of engineers can at times also manifest itself as "community awe." Community awe happens when activists within a community collectively embrace the engineer as one who understands all aspects of the issue in question, is more effective than they themselves can be in articulating the problem and possible solutions, and who thus can speak on their behalf to those who have not or will not hear them. In instances where community voices have not been heard or have been consistently ignored and dismissed, activists may in fact seek out engineers to be their spokespeople, with the expectation that the engineers' expertise will open for them doors that are traditionally closed and, as a result, provide them a platform to be heard.

Community awe can align powerfully with engineers' own conceptions about their role in society. Predominant themes in the engineering profession's imaginaries of the public are that engineers benefit the public, solve societal problems and, in their interactions with non-engineers, build and sustain their professional image [6]. Community perceptions and self-perceptions of engineers as technological guardians of the public good can in turn encourage engineers to accept a community's recognition, adopt a superiority mindset, and begin to speak on behalf of the community without continued engagement with the community, possibly even ignoring or contradicting widely-held community perspectives.

This shift in the relationship from a partnership that supports community agency and leadership, to an asymmetrical dynamic that turns engineers into leaders and communities into followers illustrates what we call the "flaw of the awe." The flaw of the awe involves interpretation of the public's (real or perceived) acceptance of, reliance on, and respect for engineers as permission for engineers to transition into a paternalistic and dominating role that involves working *over* communities rather than *with* them. As publics gain a voice that extends into the national and global social media, they are continuing to challenge engineers and scientists in new arenas beyond the judicial system and local communities. This changing dialogue becomes contentious when the engineers' voices are given credence over the communities' voices. When this occurs, community activists tend to quickly recognize that they have been discounted and often begin to speak on their own behalf while, once again, looking for ways to be heard. If the expert's voice overpowers the citizens, they can feel completely disempowered. At this point, the flaw of the awe has become a “fatal flaw,” which is characterized by the total breakdown of trust between communities in crisis and engineers. At this point, communication has broken down, any possible working relationship is undermined, and any agreement may be exceedingly difficult to reach.

IV. Teaching Engineering Ethics

Perhaps the strongest driver behind engineering ethics education in the United States is the need for engineering programs to attain or maintain Accreditation Board for Engineering and Technology (ABET) accreditation and meet the requirement that students gain an understanding of their professional and ethical responsibilities as engineers. To receive ABET accreditation, engineering programs must show that they work to instill this understanding in their students. ABET does not prescribe exactly how this understanding must be instilled, and various programs take various approaches. But one of the most common approaches is to offer a stand-alone course in Engineering Ethics that is required for engineering students to graduate.

We often understand engineering ethics in terms of the codes of ethics of various professional engineering societies, most of which have their own code [3]. Since engineering ethics courses are meant to satisfy the ABET requirement, and given our common understanding of engineering ethics as contained in ethics codes, courses are often designed to address the professional and ethical responsibilities of engineers. A potential flaw in this approach is that the ethical responsibilities of engineers might be understood as coextensive with the professional responsibilities of engineers.

Conflating professional and ethical responsibilities in this way narrows our understanding of engineering ethics, so that an engineer’s ethical responsibilities are conceived to be met as long as they behave as good professionals. Herkert is an interesting waypoint on our journey to recover and broaden our understanding of the ethical responsibilities of engineers [7]. Our own conception is that the ethical responsibilities of engineers extend far beyond their narrow professional responsibilities to include concerns for knowledge hierarchies, power asymmetries, equity, and social justice. Broadening our understanding of engineering ethics in this way has several implications for how engineering ethics should be taught.

Current engineering ethics textbooks often focus on professional microethics, covering topics such as codes of ethics, standards, risk and liability, and the roles of engineers in organizations. They also often provide tools for solving ethical problems, such as "line drawing" to weigh options, creating flow charts, and using cost-benefit analyses. These tools suggest that ethical problems can be solved much like technical engineering problems: by applying a set of heuristics it is possible to come to the “right” decision.

In attempt to advance engineering ethics education, the National Academy of Engineering (NAE) issued a call for exemplary practices that were initially published in a report [8]. The NAE subsequently created the Online Ethics Center (http://www.onlineethics.org/) as a dynamic resource for engineering ethics education.

A review of the exemplars in the NAE report show some common threads:

- Extensive use of cases
- Extensive discussion of professionalism
- Most examples talk about social responsibility, but what that means is not always defined. In some cases it seems to be based on the paramountcy clause (e.g., design so people aren’t harmed).

Although these exemplars may illustrate novel pedagogical practices, for the most part they do not push against the narrow conception of engineering ethics we seek to move beyond.

Apart from the conceptual conflation of "professional-and-ethical" responsibilities, current approaches to *assessing* ethics education also drive us in the direction of teaching content or skills that can be more easily assessed. On the other hand, training engineers to be successful in working within a dynamic sociotechnical situation within a community facing or responding to an engineering-based crisis is a messy process fraught with potential missteps and misunderstandings. Even if we could develop a method engineers could use – and be taught – to help them navigate such situations, judging whether actual attempts at engagement satisfy the demand for social justice resists easy answers. These factors complicate the task of assessing the effectiveness of engineering ethics education approaches that attempt to improve engineers’ understandings of their ethical responsibilities in this broad sense.

One potential direction for ethics education aimed at equity and social justice is to enhance engineers’ sensitivity to cases of *in*justice. Identifying that injustice has happened and finding ways to avoid injustice might be open to both education and assessment in ways that seeking *just* engagement is not. Such an approach rests in part on the intuition that a miscarriage of justice is often more obvious than whether justice has been served.

Imagine a person, Edward, who has committed and been charged with murder. Now imagine two alternative scenarios. In the first, the jury finds Edward guilty and recommends the death penalty, and the judge sentences Edward to face death by lethal injection. In the second, the jury finds Edward not guilty, prompting Edward to jump to his feet and confess that he actually committed the murder; yet the judge has no choice but to put Edward back on the streets. That the second scenario represents a miscarriage of justice seems *prima facie* obvious. However, the first scenario is less clear. Executing Edward will not bring his victim back to life. Perhaps the State should not have the power to execute prisoners (even if capital punishment is legal). Even if we feel Edward deserves the death penalty, perhaps there is a more humane way to carry out the sentence than by means of lethal injection. Although the jury’s verdict is correct, whether justice is served by the sentence remains somewhat controversial.

Of course, actual cases may not be so obvious. We may not have all the relevant information. But our intuition suggests that, given the relevant information, a determination that justice has *not* been served is easier to make than a determination that justice *has* been served. This approach would also avoid repeating the colonialist mistake. Rather than coming in as the ethics expert who knows all about justice and simply expects students to conform, the instructor engages students in listening for signals of injustice – a skill that, along with humility, should stand them in good stead when it comes to community engagement.

V. Considerations for the Future of Peace Engineering Education

The field of ethnomathematics illustrates and advocates for understanding the connection between the development of mathematics and the evolution of science and technology as a response to the environment. By exploring the relationship of mathematics to the physical world it highlights the role and responsibilities of mathematicians in the quest for peace and in making just communities [9]. Within engineering education, Riley and Lambrinidou call for social justice as a core value for engineering [1]. Catalano suggests a core question for engineering ethics based on social justice: "Has the suffering and/or injustice in the world been reduced through the completion of the proposed engineering project?" [10, p. 52]. This question makes it clear that it is not sufficient for engineering solutions to be "less bad", e.g. introducing a process that will produce toxic waste, but engineering it so that less toxic waste is produced. Rather, engineering solutions need to propose positive goods that can be articulated and placed in dialogue with the community. Catalano provides examples of engineering ethics cases, contrasting the conclusions obtained using traditional engineering ethics approaches and what he calls a morally deep world-view [11]. If we are to embrace the Anthropocene – an epoch in which human activity is shaping and forming the current socio-ecological systems of the earth -- and find pathways for creating a livable future for all earth inhabitants (not just humans), we also argue for the need to infuse engineering education and practice with social justice, equity and peace that works with the entanglements of multispecies ecosystems.

To begin this process and to create a counter-narrative and counter-culture to the flaw of the awe, we suggest reimagining ethics education for peace engineering to address such issues as:

- Placing public voices at the center of engineering ethics instruction and, ultimately, engineering practice,
- Enhancing the quality of life in ways that people on the ground—and especially the most marginalized—recognize as enhancement,
- Achieving peace with justice, rather than engineering peace through colonialism.

To further these ends, engineering ethics classes should move beyond issues of professionalism to embrace epistemic listening and epistemic humility; navigating contested spaces, places, and expertise; and enhancing sensitivity to injustice. Doing so would start to move engineering towards the ideals of peace engineering.

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