

Feminisms in Engineering Education: Transformative Possibilities

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The goal of this paper is to examine the possibilities for explicitly feminist work in engineering and engineering education. What does it mean in engineering contexts to take a feminist perspective, and how might this influence the profession and society? We seek to establish an understanding of feminist perspectives in the engineering community broadly to recognize the connectedness of all forms of social injustice. Thus feminist visions of engineering might address a broad set of concerns such as militarism, racism, and global economic inequality as well as sexism and heterosexism. Our exploration of three feminist frameworks within engineering generates a set of questions for future research and institutional transformation.

Keywords: liberative pedagogies / social justice / ethic of care / engineering / feminist technology studies.

Introduction

We are a group of engineering educators who have come together in several overlapping contexts to consider the relationships among engineering, social justice, and peace, and to ask what feminisms have to offer engineering education and practice (see, *Frontiers in Education* 2009). In this paper, we describe theoretical frameworks, examples from our research and teaching, and thought questions to help further a discussion about what engineering education and practice might be like if they were done from explicitly feminist perspectives, and with social justice and peace as central goals.

This work is informed by feminist theory, which brings specific questions that employ gender as a category of analysis (Scott 1986), as well as feminist activism, which offers experiential knowledge and tools for change. It builds on the previous work of scholars who have analyzed gender in the profession of engineering in historical and contemporary contexts, taking up a variety of issues from workplace culture to professional ethics (Adam 2001; Dryburgh 1999; Oldenzel 2000; Frehill 2004; Trescott 1983). Some scholars have focused their analysis specifically on the context of engineering education, considering topics including cultural

identity formation and gendered discourses (Foor, Walden, and Trytten 2007; Hacker 1989; Stonyer 2002; Tonso 2007). Despite this growing body of literature, it remains unusual among engineering educators to explicitly identify approaches as feminist.

This paper draws on three feminist traditions that we find particularly relevant to engineering. By extrapolating from the intersection of feminist science and technology studies, the ethic of care, and anti-racist and liberatory pedagogies to engineering education and engineering practice, we make visible new directions for robust research in engineering and engineering education that reflect multiple feminist perspectives and that generate new questions for analysis and strategies for change. Intending to be neither comprehensive nor representative, we use these traditions as places to start thinking about engineering and engineering education in a way that is grounded in feminist thought, and may be productive for generating multiple visions and strategies for transforming engineering education.

Forming the Questions: Feminist Frameworks

The application of gender as a lens of analysis within engineering education and practice has been strikingly narrow compared to the perspectives laid out in feminist theory and practice as a whole, and even compared to feminist critiques of science. Most discussions of women or gender in the sciences and engineering begin and end with a simple focus on women's underrepresentation, asking questions such as "Where are the women?" (Howard Hughes Medical Institute 2005) "Why so few?" (National Research Council 1994), or "Why so slow?" (Valian 1998). We believe the problem of women's underrepresentation in engineering (defined in terms of percentage counts of participation based on sex) indicates deeper, more fundamental problems about the nature of the profession and of the engineering education enterprise. When we define the underrepresentation of women narrowly as a problem unto itself, we develop equally narrow solutions, ones that do not even adequately address underrepresentation (Schiebinger 1997).

What would taking a feminist perspective in engineering contexts look like, and how might this perspective influence the profession and society? One of our shared career goals is to establish an understanding of feminist perspectives in the engineering community that recognizes the connectedness of all forms of social injustice. We seek to converse with modern feminist movements in the United States and globally. This would constitute a broad collection of people—women and men—concerned with a wide range of issues that affect women's welfare, including women's economic or political power, how families are recognized and function in different

societies, how different kinds of “work” are understood and valued, war and violence (particularly against women), sexuality and women’s health, representation of women through art and music, and so on.

Such a conversation might entail learning from history and applying our awareness of that history to current contexts in engineering. For example, to learn from the history of womanists and women of color who challenged second wave white feminists to recognize the limitations of gender as a sole category of analysis early in the history of the feminist movement (Crenshaw 1994; Essed 2001; hooks 1984; McCall 2005) means to struggle today to make room for intersectionality in engineering education. Foor, Walden, and Trytten’s (2007) ethnography of one working-class bi-racial woman studying engineering, and Chinn’s (2002) consideration of narratives from female Asian and Pacific Islander scientists and engineers, are two excellent examples of how race, class, and gender can be considered together to tell a more complete story of engineers and engineering. Such work continues to face challenges in the engineering education community, where work is often categorized as being about “women in engineering” or about “minorities in engineering,” leaving little room for intersectionality.

Along similar lines, we know that a feminist movement sensitive to the concerns of women of color, of poor women, of queer women, of women living in the global South, and of women with disabilities, would need to confront racism, imperialism, militarism, homophobia, and other social justice issues (Lugones 2003; Mohanty 2003; Pharr 1988). A movement concerned with the liberation of women must address the reality that women are affected by multiple forms of oppression, not only gender-based oppression.

Ecofeminist thinkers such as Warren (2000) and Mies and Shiva (1993) argue that the same conceptual frameworks that support gender oppression (hierarchical thinking, value dualisms, conceptualizations of power that privilege some, and a logic of domination that justifies such oppression) also support the domination of nonhuman nature, as well as other forms of categorical oppression. Warren (2000) critiques feminisms that retain nature-culture dualisms. She notes that socialist feminism, while challenging many dualisms, does not challenge human/nonhuman dualisms. In contrast, she has developed an approach she labels “transformative feminism,” and Mies and Shiva (1993) have worked to further integrate Warren’s thinking with socialist feminism to create a socialist-transformative approach. Together, these approaches seek to do away with the conceptual frameworks that underlie multiple forms of oppression, and integrate feminist concerns with concerns for social and ecological justice (Tong 1998).

Taking a transformative feminist perspective in engineering, therefore, might mean fighting for representation of all women, as well as men, of

color and other under-represented groups in engineering, but it might also entail raising concerns about engineering's links to militarism, ecological sustainability, and global economic inequality. In fact, engineering's strong role in the military-industrial complex and in globalization ought to draw many of these concerns front and center.

Where can a broader approach to feminism in engineering education and practice take us? We work across our disciplinary backgrounds and experiences to develop new questions and frameworks for investigation that work toward the wider transformation of the field. We offer three frameworks: a feminist technology studies framework, an ethic of care framework, and an anti-racist/liberative feminist framework. These frameworks were chosen based on our own interests, and each framework draws on the gender studies literature with some initial theorizing at the intersection of engineering that can serve as a foundation for future exploration. Each represents a distinct path for generating possibilities in feminist engineering education and practice, though as we will see, there are also many opportunities for synergy.

Learning from Feminist Technology Studies

Theoretical Foundations

The field of feminist science and technology studies has recently turned its analytic gaze upon the profession and practice of engineers. This intensely interdisciplinary field, growing since the 1960s and 1970s, acknowledges that gender is a fundamental way of signifying power relationships in Western/Northern societies, and analyzes the impact of gender as a social construction on the theory, practice, and development of science and technology.

Scholars employ critical theory focused through the analytical lenses of gender, race, and class to look at the practice of science, hidden assumptions in science, and the content of science (see, for example, Harding 1986, 1991; Haraway 1988; Longino 1996). Such work calls for questioning whether science as practiced in mainstream environments is as objective as it claims itself to be, and whether such claims are, in fact, harmful to the practice of "good science." The artificial dichotomies (male-female, science-non science, civilization-nature, work-home) and metaphors (for example, Martin 1991; Spanier 1995; Upchurch and Fojtova, this volume 2009) we construct to describe and explain the world around us can be harmfully misleading, especially in "border" cases where a dichotomous outcome is unclear or inappropriate (for example, Fausto-Sterling 1992, 2000; Kessler 2001). What constructions might be more caring and more just, while simultaneously more scientifically appropriate?

Feminist science and technology studies scholars, whether coming from historical (for example, Bix 2004; Frehill 2004), philosophical (for example, Harding 1986; Longino 1996), sociological (for example, Fujimura 1996), or scientific (for example, Fausto-Sterling 1992; Spanier 1995; Subramaniam 2009) backgrounds, interrogate the power relations in Western/Northern cultures that influence how science is practiced. Feminist scholars interested in studying technology and engineering as different from science need to address additional sets of questions: How do different groups define what technology is? How does this definition function amidst ideas of "natural" and "unnatural"? How do the construction and development of different types of technology benefit or disadvantage certain populations inscribed by race, class, gender, and nationality? (Cowan 1983; Kolko 2000; Lerman, Oldenzil, and Mohun 2003; Rana 2009; Wajcman 1991).

A small but enthusiastic group of engineering researchers have started to extend feminist science and technology studies to the study and practice of engineering and engineering education (Faulkner 2000; Tonso 2007). Some of them gathering yearly at the Frontiers in Education Conference (see, Frontiers in Education 2009), and embracing in particular the qualitative methods developed and employed by feminists in the social sciences, these researchers explore issues of engineering identity, historical boundary work of engineering, and new visions of engineering

One of the authors of this paper has written about what a feminist engineering classroom might look like, and has more recent and developing work about how feminist theories on boundary work applied to work and technology make visible how the discipline of engineering can be interpreted as itself gendered (Pawley 2004). Based on interviews with engineering faculty at a large research institution, Pawley (2007, forthcoming) has argued that there are three common universalized narratives that engineering educators use to define engineering within educational contexts: Engineering as applied science and mathematics, as solving problems, and as making things. These narratives are termed "universalized" because participants used them without consideration of local inconsistencies or variability. Localizing the definitions using the contextualizing boundary dimensions of "space," "time," and "actors" makes visible how the narratives act to define engineering in unintended yet gendered ways. Thinking about space articulates how dominant approaches to engineering in educational contexts are large-scale, oriented around industrial, commercial, or military domains. Time demonstrates how engineering education relies on the past to direct its future. Consideration of actors suggests who is excluded from these universalized narratives as shared with students: who construct engineering problems, who benefit from engineering solutions, and who actually make the "things" (Pawley 2009). The combination of these localizing dimensions in the context of engineering education makes visible engineering's gendered boundaries,

as engineering's problem-definitions and solutions have overlooked the contexts and spaces where women have worked over time, and where women still do the majority of the work. In addition, low-tech but high-impact solutions (for example, inexpensive water filtration systems for third-world countries), are dismissed by academic gatekeepers as simply "do-gooder" engineering and therefore outside of the scope of "acceptable" engineering. The ultimate argument is that, through these forms of academic boundary work, engineering educators strengthen for their students the image and reality of engineering as a discipline that focuses on the so-called "first world," and on high-tech solutions, rather than on solving the problems experienced by women and people in poverty (Pawley 2009).

Framing Questions

It is becoming clear that a "gender" analytic lens can be particularly illuminative in analyzing engineering both inside and outside of the discursive domain of women's underrepresentation in engineering and engineering education (for example, Frehill 2004; Tonso 2007). This research suggests that the educators of engineers and other science or technology professionals should learn to doubt the simplicity of widely accepted and disseminated definitions of engineering of "solving problems" (Downey 2005) and "applying science," and instead start working with their students to ask such questions as:

- For whom do engineers work? How do these work relations reinforce or resist classed, gendered, or raced power relations?
- What is the place of science in engineering's application? Where is the place in engineering for sociology, anthropology, and other such social sciences? What is the nature of power relations between science and engineering, how have they changed over time, and how do cultural stereotypes compare scientists and engineers while still valuing the hegemonic classed masculinity?
- What problems do engineers in practice actually solve? What kind of problems seem not worth investigating by engineers?
- What populations benefit from engineers' solutions, and what populations are overlooked? Why are these populations are overlooked, and what populations bear unintended consequences or penalties of engineering solutions?
- Why are certain problems or forms of knowledge considered outside the scope of engineering in educational contexts? Where does knowledge about domestic work, caring work, and peace work fall in relation to engineering knowledge?

Learning from an Ethic of Care

Theoretical Foundations

Feminist educator Nel Noddings (1984), drawing on Gilligan (1982), developed the “ethic of care” as a critique of ethics frameworks that omit basic relational values such as caring or sympathy in favor of a more detached and intellectually abstract approach. Both Noddings and Gilligan have been critiqued for implying that caring is an essentially feminine activity, while other advocates of care-based ethics such as Joan Tronto (1993) or Warren (2000) do not locate the ability to care based on gender or sex. Tronto (1993) lays out four phases of care: *caring about*, which is an attentiveness or sensitivity to opportunities to care for others, as in a social or global need; *taking care of*, which is the assumption of responsibility to care for another; *caregiving*, which is the act of meeting another’s needs; and *care-receiving*, in which a response to care returns to the caregiver (106–08).

The ethic of caring approach draws on standpoint epistemologies in its assertion that knowing, or ways of knowing, are not universal, but depend fundamentally on the knower (Alcoff and Potter 1993; Harding 2004). Therefore, the development of authentic knowledge requires that the “cared for” be an agent of this knowledge and, ultimately, of the changes it inspires. Engineering, like science, is not subjectless; therefore we must “start [. . .] thought from the lives of marginalized peoples” to create and reflect knowledge that is authentic in the context of these peoples (Harding 2004, 128). Similarly, because communities themselves serve as agents of knowledge, an ethic of care standpoint requires an understanding of a community’s norms about what counts as evidence (or science or engineering practice), which can only be provided by the community itself (Alcoff and Potter 1993).

This point is echoed in the work of Patricia Hill Collins (1990), as Afrocentric feminist notions of family and society reinforce *caring* community-based approaches through concepts of bloodmothers, othermothers, and community mothers that are fundamentally empowering. Thus, according to Hill Collins (1990), an ethic of care framework can be fundamentally empowering by allowing for “creative acts of resistance” (223). This community-based framing also allows for a more authentic picture of the relationship of communities to capitalist political economies and bell hooks’ concept of the politics of domination, which the traditional engineering discipline represents (hooks 1995).

Hill Collins’s (1990) work reinforces the idea that it is impossible to translate black feminist thought into the masculinist Eurocentric framework of ascertaining truth (and thus the practice of science). Instead, she points to the power relations inherent in the production of knowledge, and

illustrates that black feminist thought brings truth that exists within—and resists—a context of domination. This framework can similarly be applied to the practice of engineering in a caring way, in that the problems that are “solved” should be authentic in the context of domination, and ring true in communities with subjugated knowledges.

Pantazidou and Nair (1999) argue that the engineering design process can be reconceived according to Tronto’s (1993) phases of care. One definition of engineering design is “a thoughtful process for generating designs [. . .] that attain given objectives while adhering to specified constraints” (Dym and Little 2008, 6). Pantazidou and Nair (1999) draw on a standard design textbook (Dieter 1991) to describe the traditional design process as being initiated by the identification of a need, typically characterized in economic terms. The need is then placed in the context of specific artifacts or processes, both technological and economic. Next, different solutions for addressing the identified need are evaluated as the problem and potential solutions are conceptualized. A feasibility analysis is conducted to determine the ability of the designed approaches to meet the assessed need, and the selected product is produced. This process continues iteratively until the product is deemed acceptable. The design process is traditionally conceived as consisting of several steps that may include need identification, problem conceptualization, feasibility analysis, production, and product acceptance.

Pantazidou and Nair (1999) argue that the natural overlay of the engineering design process and the ethic of care framework can be harnessed to transform engineering design from a capitalistic or militaristic-driven process into one focused on care. Thus, attentiveness (caring about) ought to be present in what is conventionally thought of as need identification: Responsibility (taking care of another’s needs) is required in problem conceptualization; competence (caregiving, meeting needs through action) maps to feasibility analysis, as one ensures the design meets intended needs; and responsiveness (care-receiving), is identified in the production process and iterative improvement. This is but one suggestion of how the ethic of care could be operationalized in engineering design and education.

Furthermore, we argue that this framing of the engineering design process within the ethic of care also can uncover an inherent critique of the design process. An identification of “the” engineering design process implies that there is only a single way to proceed through these stages and leaves little room for creativity. The ethic of care approach illustrates that the engineering design process itself must be flexible and open to critique by the “cared for” whose needs are being addressed. Additionally, the manner in which engineering needs are identified must shift from their grounding in relations of capitalism to relations of caring in order to subvert historical and present day power dynamics.

Framing Questions

The ethic of care challenges the field of engineering to approach problems from a perspective of responding to the needs of traditionally oppressed peoples and communities that is often absent. Furthermore, these communities must serve as agents of knowledge, both in terms of “knowing how” (process) and “knowing that” (content).

One author of this article has explored how an orientation toward social consciousness in the classroom can motivate learning (Tucker and Ferguson 2007). Building on Tucker’s (2007) work, the authors of this paper have additionally explored how an ethic of care can challenge individualist narratives in engineering and engineering ethics (see, *Frontiers in Education* 2009). For example, traditional engineering ethics case studies revolve around a central, often stoic, heroic figure who intervenes to correct, expose, or prevent an ethics violation in spite of potential personal costs, such as loss of income, prestige, or career opportunities (Adam 2001; Martin and Schinzingler 2005). In contrast, an ethic of care framework urges that emotion, connectedness, and community-based perspectives are crucial to engineering decision-making.

One engineering project that reflects an ethic of care is Waste-for-Life, a project in Buenos Aires that is based on using the knowledge of community groups and cooperatives to convert waste into useful products (Waste for Life 2009). Specifically, simple technologies have been and continue to be developed to upgrade cardboard and waste plastic bags into useful composite materials that can be used in domestic products and building materials (Baillie 2008). The practitioners did not approach these communities with a specific technology to implement; rather, the project was conceived in tandem with these community groups after extensive dialogue about community needs, norms, practices, and expertise.

Martha Albertson Fineman’s introduction to Ruth O’Brien’s *Bodies in Revolt* recognizes the potential for engineering of assistive devices to use a care-based approach, because of the ways in which individual differences are taken into account in a caring relationship between designer and user, challenging the idea of doing engineering based on broad assumptions about how bodies should be or act (Fineman 2005). The Program of Rehabilitation Organized by Disabled Youth of Western Mexico (PROJIMO), a grassroots rehabilitation nonprofit run and organized by young people with disabilities in Mexico, incorporates users as co-designers of assistive technologies, tailoring devices to cultural context, physical environment, activities, and interests (Werner and PROJIMO 1998). Here, a careful approach to the power dynamics of who cares for whom and who makes decisions about technology results in a participatory approach to design and to social change, as members also work to prevent violence, create jobs for disabled youth, and change social attitudes toward disability.

Questions that emerge from this work and that of the theorists cited above include:

- If engineers (or society) were to reprioritize engineers' work based on real attentiveness to others' needs, how would engineering be different? Which needs would be priorities? How can one counter market forces or organizational hierarchies to make room for a caring process of needs identification and prioritization?
- How are each of the caring roles reconceived in engineering relationships? Who cares about, takes care of, gives care, and receives care? What is the role of reciprocity in care-based engineering projects? What is the role of underserved populations, who rarely are cast as engineering clients in traditional settings? What would engineering processes look like, and how would a serious consideration of power relations reinvent the involvement of community groups, corporations, governmental organizations, academics, engineers, social scientists, and other stakeholders?
- How are competing needs resolved, for example, among engineers, clients, the public, and the environment?
- What are engineers' capacities for care? How can engineering education develop caring capabilities of engineers, in all four phases of caring? Can engineers receive care in the process of doing their jobs?
- The concern for engineering's professionalization has pushed it toward historically masculinized professions such as law and medicine; how would engineering be different if we drew from historically feminized professions such as nursing, teaching, and librarianship?

Some potential misuses of care may include paternalistic motivations, in which the engineer "bestows" a solution upon those groups receiving their care. This misunderstanding of the ethic of care may derive from the labels of "caregiver" and "care-receiver." A more appropriate understanding of care requires full integration among the engineers and those whose problems are to be addressed; everyone involved collaborates to reach an appropriate solution. Tronto (1993) notes that when practicing care, one should not "put oneself in the other's shoes." Instead, trust the words, authority, opinions, and traditions of the people who need care as they express them.

Learning from Antiracist and Liberatory Feminist Approaches

Theoretical Foundations

The ethic of care approaches discussed above are marked by their grounding in standpoint epistemologies; their goal is to bring a focus on care to the work of social justice, critiquing Rawlsian rights-based perspectives (for example, Gilligan 1982; Noddings 1984; Warren 2000). By contrast, liberatory approaches in general and liberative pedagogies in particular have their roots in struggles for justice in Latin America and elsewhere, grounded in Marxist and critical theory including both feminist and nonfeminist strands (Darder, Baltodano, and Torres 2003). Liberatory approaches are dynamic, continually re-invented for new contexts, and shaped by critiques from feminist and postcolonial scholars. While some would certainly seek to differentiate critical pedagogies, feminist pedagogies, postcolonial pedagogies, and Latin-American pedagogies of liberation (for example, Darder, Baltodano, and Torres 2003; Luke and Gore 1992), our aim is to draw on the best of these traditions to establish a feminist framework we can use for engineering education and practice. Our entry point for such a framework is bell hooks's *Teaching to Transgress* (1994), which offers a feminist approach to pedagogy integrating Paulo Freire's (1970) work with critiques of race, class, and gender. For lack of a better term, we use "anti-racist and liberatory feminist" here to describe this nexus of work that incorporates Latin American liberationist ideas with those of contemporary feminisms.

hooks (1994) lays out key principles of a feminist pedagogy of liberation, which has implications for engineering education and practice. At the heart of the pedagogy is a focus on power relations, seeking to upend traditional power structures in the classroom, placing increased authority in the knowledge and experience students bring on the realities of their lives in their entirety. These pedagogies rely on the notion of what Freire (1970), after Marx ([1845] 1976), calls "praxis," defined as reflective action, a symbiosis of theory and action, driven by and in continual relation with an identified community, thinking critically toward social justice ends. If we recognize connectedness of oppressions, we know that praxis is a feminist project.

One author of this article has integrated feminist and liberative pedagogies into the teaching of engineering thermodynamics (Riley 2003). The course uses shared authority, discussion, and normalizing mistakes in class to create an atmosphere of open inquiry. A reading and essay considers the relationship between truth and power in science through which students learn to read their textbook and the history of thermodynamics critically (Foucault 1980). This leads to questioning sexism, militarism,

and nationalism in their textbook and identifying biases toward nineteenth century European men's and modern industrial conceptions of thermodynamics. Students then explore indigenous energy technologies in South America, Africa and Asia. They also profile a woman in thermodynamics whose racial/ethnic background is different from their own. Questioning the historical thematic content of science—specifically the preferences for parsimony and conservation—supports their understanding of entropy, which defies concise descriptions and is not conserved, but only increases. Entropy and the second law of thermodynamics can confuse students because of multiple statements given in textbooks; to critique the idea of a single law allows for multiple approaches to scientific understanding, so that students can come to terms with different statements without having to decide which one is “right.”

Another strand in liberatory thought that has been transformed by exchange with feminist thought is the work of Latin-American theologian Leonardo Boff, whose contemporary work reflects ideas of ecofeminists (Boff and Berryman 1997). This new scholarship connects the exploitation of the poor with ecological devastation and calls us to a spiritual transformation that leads to liberatory action. Boff and Berryman's (1997) work attends specifically to the problem of globalization and the effects of capitalism run amok in the wake of neoliberalism's growth and spread over the past twenty-five years.

How can we respond to this call to work for social and ecological justice, as engineers and as feminists? What could engineering look like if it committed to end ecological devastation and the exploitation of the poor? One author of this article offers a new way of doing engineering design in which these concerns are central, and provides some helpful case studies (Catalano 2006). The process entails asking for whom are we designing, and broadens the notion of who counts in the process to include human and nonhuman beings and the ecosystem as a whole.

In one example from Catalano (2006), the design of a mechanical grape harvester that would conventionally be a means for automation and layoffs in order to profit a vineyard owner is reconceived to value farm laborers and their families, taking into account the consequences of mechanizing labor. In another example, the design of a tundra-tough ecotourism vehicle designed for close encounters with polar bears is considered. Again, rather than conceiving the problem as a narrow question of delivering the tourism company's needs (safety and comfort for customers, profitable and reliable operation), the problem is reconceived to include the polar bears, neighboring indigenous communities, and the tundra ecosystem.

In each case, a creative solution is sought to benefit all community members, with the participation of all concerned, and proposed solutions are evaluated based on their contribution to the goal of social justice, recognizing that sometimes the best solution may be not to engineer in the

first place. Catalano refrains from offering design solutions and instead acknowledges that there are no easy answers and it is not always possible to meet conflicting needs. He suggests that a participatory process in which there is attention given to power dynamics is more likely to generate a broad set of creative solutions, and even when outcomes cannot be favorable to all, decision-making and responsibility are shared.

Framing Questions

A conversation on the topic of engineering and social justice has taken place over the last several years. In November 2003, a conference at Bucknell University brought together faculty, students, and engineering practitioners to address several questions including: (1) Can engineers have a central role in the promotion of peace? (2) How can engineering educators respond to the challenges of preparing engineers to proactively encourage peace? An edited volume edited by Vesilind (2005) outlines the evolution of “peace engineering” over the course of the last several decades.

A group of North American scholars, co-convened by Catalano, has been meeting in a series of workshops and conferences to consider the relationships among engineering, social justice, and peace (ESJP 2009). Questions posed by this group (some of which reinforce those raised previously in other sections of this paper) include:

Who benefits from engineering? Who does not? Who bears the costs of engineering? Who does not?

How does the profession of engineering recognize the extent to which global capitalism drives and is driven by our profession, and respond accordingly? How do we recognize and reverse our complicity in the destruction of the environment and the destruction of the poor? How can we reconceptualize engineering in ways that do not serve engineering’s traditionally historical ends of militarism or consumerism?

- As educators, is it our sole responsibility to prepare engineers for the industrial (or military-industrial) landscape? How can we—should we—educate students for a world that does not yet exist, and how do we work in the present world where neoliberalism and militarism govern everything from national policy to the practice of technical work? How can we build flexibility into the curriculum that allows students to find nonmilitary, nonindustrial career paths?
- Who decides what engineering is, what the “engineering design process” looks like, or what questions or problems engineering addresses? Whose contributions or needs are left out?
- How can we engage our students in social justice projects? What can we do in the face of student resistance to liberative pedagogies or engineering for social justice in order to foster a productive learning experience?

Participants in the movement for peace and social justice in engineering call upon the profession of engineering to take on a far broader sense of responsibility than it has in the past (Baillie 2006; Catalano 2006). Clearly, there is overlap between these questions and the questions raised by the two previous feminist frameworks. In particular, Catalano and Baillie's (2006) work on social justice as a "revolution of the heart" resonates with the feminist ethic of care. Both frameworks argue that engineers must extend the moral sphere or who counts morally to include not only men, or humans, or "our profession," but also to include the entire integral community, the totality of living interests that will be affected by our choices as engineers (Johnson 1993).

Conclusion

The questions that emerge from these frameworks center upon some classic themes of feminism—asking who benefits and who is harmed, critically examining assumptions and presumptions that create injustice, and creatively and energetically working for our dreams of what could be—in engineering education and practice, and in the wider world.

As with all disciplines, scholars taking feminist approaches to engineering and engineering education face power/knowledge issues within the discipline of engineering and its funding structures. Supportive individuals and agencies have created opportunities for pursuing these efforts, which typically occur in mainstream contexts that draw a variety of perspectives. For example, the National Academy of Engineering (2008) sponsored a workshop on Engineering and Social Justice that drew people interested in projects ranging from humanitarian relief work to Catholic social thought. To some extent, these are allies, but it is also important to recognize key differences and be clear about the critiques of structural forms of oppression that emerge from our perspectives discussed here. When we are clear about our goals and our standpoints such that our colleagues recognize what is at stake, we may be dismissed by some, and may risk losing financial or institutional support. At the same time, to remain silent does not further our goals and runs the more dangerous risk of co-optation and our own complicity in the furtherance of the status quo.

Next steps for the authors include supporting the nascent feminist community present among engineering educators and pushing the boundaries of "accepted" engineering education practice in our multidisciplinary contexts, in the publication of interdisciplinary ideas about feminisms in engineering education and practice in mainstream journals and publications, and in the support of independent conference offerings focused on these topics. We hope this work will lead to an agenda for action to

change the discipline and profession of engineering and ultimately develop feminist methods of pedagogy and practice.

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