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Juan Lucena *Editor*

Engineering Education for Social Justice

Critical Explorations and Opportunities

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Engineering Education for Social Justice

Philosophy of Engineering and Technology

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Juan Lucena
Editor

Engineering Education for Social Justice

Critical Explorations and Opportunities

 Springer

Editor

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Contents

Part I Introduction to Engineering Education and Engineering for Social Justice (ESJ)

1 Introduction	3
Juan Lucena	

Part II Where Have We Been? Where Can We Go?

2 Engineering, Social Justice, and Peace: Strategies for Educational and Professional Reform	19
Dean Nieusma	
3 Power. Systems. Engineering. Traveling Lines of Resistance in Academic Institutions	41
Donna M. Riley	

Part III Conceptual Contributions to ESJ

4 The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers’ Ability to Think About Social Injustices	67
Erin A. Cech	
5 What Can Buddhism Offer to a Socially Just Engineering Education?	85
Marisol Mercado Santiago	
6 How Can Engineering Students Learn to Care? How Can Engineering Faculty Teach to Care?	111
Ryan C. Campbell	

Part IV What Gets in the Way and How Can ESJ Live in the Engineering Classroom?	
7 Crossing Knowledge Boundaries and Thresholds: Challenging the Dominant Discourse Within Engineering Education	135
Caroline Baillie and Rita Armstrong	
8 Connecting the “Forgotten”: Transportation Engineering, Poverty, and Social Justice in Sun Valley, Colorado	153
Jen Schneider and Junko Munakata Marr	
9 Integrating Social Justice into Engineering Education from the Margins: Guidelines for Addressing Sources of Faculty Resistance to Social Justice Education.....	179
Jon A. Leydens	
Part V What Thinking about Social Justice in Engineering Practice Can Offer to Engineering Education	
10 What Can Engineering Systems Teach Us About Social (In)Justices? The Case of Public Transportation Systems	203
Andrés Felipe Valderrama Pineda	
11 Exceptional Engineering: Challenges and Opportunities for Socially Just Engineering in Non-governmental Organizations in Colombia	227
Richard Arias-Hernandez	
12 A Framework for Social Justice in Renewable Energy Engineering	243
Nicholas Sakellariou	
Part VI Synthesis and Conclusions	
13 The Road Ahead: Questions and Pathways for Future Teaching and Research in ESJ.....	271
Juan Lucena	
Author Bios	287

Part I
**Introduction to Engineering Education
and Engineering for Social Justice (ESJ)**

Chapter 1

Introduction

Juan Lucena

Keywords Engineering education • Social justice • Education reform

This book contributes to and enhances recent efforts to meaningfully integrate social justice into engineering education. The book's two constituent elements—engineering and social justice—are very much about hope. Separately, the fields of engineering and social justice are about hope because those of us who enact, teach and/or benefit from them hope that their manifestations in the world, in the form of technologies or social policies, will bring some kind of social good and make the world a more compassionate, just place. Yet these two fields of practice and sources of hope have rarely come together, let alone become integrated. When they come together, it is often via clashing organizational, pedagogical, practical or technical manifestations, which often end in exacerbated social inequalities and injustices. So how might engineering educators, students and practitioners begin integrating these two fields of practice in the classroom, the lab, in fieldwork, in conferences, and other spaces of scholarly and pedagogical activity, in a way that results in more just technologies?

Intended for engineering educators, students, practitioners, engineering studies scholars, and many others interested in the interactions between engineering and social justice, this book project was born of a desire to provide examples that have attempted to integrate social justice and engineering education, in different places and taking different forms. This book follows on the footsteps of a growing literature on engineering and social justice (Baillie et al. 2010; Riley 2008; Baillie et al. 2012; Schneider 2010; Leydens et al. 2012) (See Chap. 2 by Nieusma in this volume for a detailed mapping of this body of work). Like some of those books, this one argues for taking seriously the relationship between engineering and social

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justice given the increasing role that technology and engineering play in our lives, sometimes exacerbating injustices and inequalities and other times contributing to a more fair redistribution of resources and opportunities. This book seeks to continue the growth of this new scholarly field.

Many political theorists and philosophers of technology have called to our attention the political dimensions of technology, especially how technologies might contribute to injustices and inequalities (e.g., Noble 1986; Cowan 1983; Wajcman 1991; Slaton 2010; Winner 1986). This scholarship continues to thrive within STS programs and inspire new dissertations, conference papers, course syllabi and book manuscripts. Yet those accounts rarely propose how the relationship between engineering and social justice might live inside the engineering curriculum and how it might be addressed by engineering faculty and students. This book begins to fill that void.

This book also brings together a diversity of perspectives, from junior and senior scholars affiliated in different ways with engineering education, holding different understandings and definitions of social justice, and often motivated by different struggles. It seeks to show that although interventions and curricular work in engineering and social justice are relatively new and risky, these can be done in a variety of ways by committed educator/activists of different ranks, occupying a variety of positions and locations within the curriculum, enjoying different levels of privilege, and living and working in different parts of the planet. I have also learned from research on barriers and opportunities that in order to include controversial topics in engineering education, such as humanitarian engineering (Leydens and Lucena 2009) or climate change (Lucena et al. 2011), one must pay close attention to institutional and political contexts since the success and long-term sustainability of curricular innovations and reforms depends heavily on how these stand in relationship to larger institutional goals and political practices (Spalter-Roth et al. 2007). Hence the contributions of this volume come from scholars studying, teaching, researching and serving in very different universities: small, large, private, public, in and outside the US. This diversity provides a wide spectrum of possibilities to scholars interested in experimenting with the integration of engineering and social justice in different kinds of institutions. This book seeks to provide a diversity of tone, content, strategies, experiences and struggles in its different chapters precisely to show how the integration of engineering and social justice looks like in different contexts.

1.1 Who Is This Book For?

Recently there has been much interest in connecting engineering practice and education with the needs and problems of the underserved and less privileged through programs in humanitarian engineering, community development, service learning, diversity, etc. This interest has resulted in well-intentioned attempts to help others, but it often overlooks any consideration of inequalities and injustices among those helping and those being helped. Most of these initiatives might be driven by a mindset that Donna M. Riley has labeled as “desire to help and the persistence to do it”

(Riley 2008) and can be grouped under the umbrella “Engineering to Help (ETH)” (Schneider et al. 2009). But as Riley reminds us, this mindset can blind engineers, educators and students to the impact of their well-intentioned work on social justice. This book is for them.

Since the 1980s there has been an explosion of diversity initiatives in science and engineering education to populate and diversify the “pipeline” (Lucena 2005). Yet most of these programs have not included analyses, critiques or strategies to deal with systemic inequalities along socio-economic classes or groups of students and practitioners from different sexual orientations. Most of these diversity programs remain focused on increasing numbers of women and underrepresented ethnic and racial minorities in engineering (which is a good and necessary goal) but continue to largely ignore injustices and inequalities in terms of social class and sexual orientation (McLoughlin 2012; Slaton 2010; Cech and Waidzunas 2011; Michaels 2007). This book is for the champions of diversity programs with the hope that they will begin incorporating concerns over social justice in their programmatic initiatives.

There are many engineering educators and students who, although seriously interested in social justice, believe that the place to deal with social justice should be outside of the technical curriculum, perhaps in humanities and social science courses (Johnston et al. 1988). There are others who believe that social justice does not belong in the curriculum at all, as it might be a distraction in an already overcrowded curriculum and as such it might better live in service and/or faith-based student organizations. This book is for them.

Among those who are interested in integrating engineering and social justice are students like those who take my Engineering and Social Justice (ESJ) class or those enrolled in the Design, Innovation and Society (DIS) dual degree program (with engineering) at Rensselaer Polytechnic Institute (See Chap. 2 by Nieuwma in this volume for a detailed description of these curricular efforts). As I have shown in my class, students can learn to analyze the elements of the ideologies undergirding engineering, locate these historically, and then look for them in their sites of engineering education and practice. Once these elements and ideologies become visible, students begin to realize how taking them for granted act as blinders and impediments to their engagement of social justice; they soon wonder where else, and in which forms, we can have social justice integrated in engineering education. This book is for them.

During an ESJ faculty workshop in summer 2011, a privilege walk (see Chap. 9 by Leydens in this volume) revealed to participants key structural and cultural inequalities in engineering education. After 2 days of interactions and analyses of their privileges and mindsets, this group was eager to find out where and how social justice can find space in the engineering curriculum. As revealed by the course module developed by Jen Schneider and Junko Munakata-Marr (See Chap. 8 by Schneider and Munakata-Marr in this volume for a detailed description of the module), created after the workshop, there are engineering faculty not only eager to learn about the integration of engineering and social justice but willing to take it into the classroom. This book is for them.

There is also a growing community of engineering educators committed to bringing service learning into engineering, most of whom participate regularly on Engineering Faculty Engagement in Learning Through Service (EFELTS) workshops, and some who have already developed engineering projects and activities that incorporate forms of social justice and have transcended the blinding effects of the “desire to help” mindset (Tsang 2000; Lima 2006; Bielefeldt et al. 2010). This book is for them.

There are faculty who gravitate towards social justice by other means. For example, after lectures on my campus by some of the authors in this book, many engineering faculty and students have demonstrated a sincere interest in bringing social justice into engineering sciences and design (after Riley’s lecture on social justice in thermodynamics), in making the inequalities experienced by LGBT students more visible to university faculty and administrators (after Cech’s lectures on heteronormativity of engineering education), or in making social justice a more explicit dimension in renewable energy projects (after Sakellireaou’s lecture on renewable energy). Clearly, these visits have left faculty and students energized and wondering how and where else to integrate social justice in engineering. It is possible that this interest is a localized phenomenon, a reflection of the presence of the ESJ lectures and ESJ course in my school. Yet I would argue that many of the faculty and students also attend these lectures because, like many of their peers elsewhere, they are hungry and interested in understanding how social justice can become more visible in their own curricular space. This book is for them.

Finally I am fully aware that there are also engineering faculty and students with apathy towards social justice. Many engineers believe that engineering should not have anything to do with social justice because of their commitment to an ideology of depoliticization of engineering that leads them to draw a boundary around the technical content and leave the non-technical (i.e., the social, the messy, the political, etc.) outside of engineering. This ideology was recently expressed in a *Machine Design* editorial entitled, “Why engineers shouldn’t worry about social justice” (Teschler 2010) or in a recurring act of resistance by one of my students who stated, “I do not need to learn about social justice. That’s what codes of ethics are for.” Donna M. Riley might argue that this attitude reflects the influence of engineering mindsets (Riley 2008) and Erin A. Cech (See Chap. 4 by Cech in this volume) might see this apathy as a reflection of their commitment to the ideologies of engineering. Unfortunately, still many engineers believe that meritocracy in engineering works well, that inequalities are just outcomes of a fair system, and/or that social justice due to its social nature does not belong in the technical realm of engineering. This book is also for them.

1.2 Motivations for Putting This Book Together

During a NSF-sponsored workshop on Social Justice, Sustainable Community Development and Engineering at the National Academy of Engineering (NAE) in October 2008, a clear and vivid tension between the engineering profession and

social justice came to life (Advisory Group for the Center for Engineering, Ethics, and Society; National Academy of Engineering 2010). Although NAE fully endorsed the workshop, title, and line-up of speakers, some influential engineers occupying key roles in engineering organizations, such as the US Army Corps of Engineers and National Society of Professional Engineers, strongly resisted proposals for the profession to embrace social justice. Clearly, few felt threatened by some definitions of social justice that made reference to redistribution of resources, opportunities and wealth and thus went as far as to equate social justice with socialism and labeled it as un-American. As Rachelle Hollander, lead organizer of the conference, succinctly puts it “It turned out that the question of engineering and social justice was a hotly contested topic at the meeting, while humanitarianism and engineering or engineering and social responsibility was not” (Hollander 2010). Some engineers participating in that workshop did not think social justice was an appropriate issue for engineering practice or for consideration in their societies; others disagreed. This was an interesting yet problematic dismissal of the possibility that engineering could actually contribute to a more fair and just distribution of resources. Why the anger, quick dismissal and closing of possibilities? Confused, I did not know at the time.

Leaving the NAE building in disbelief and walking around the Washington Mall to reflect on this experience, three of us with chapters in this volume (Leydens, Lucena, Schneider) came across the Franklin Delano Roosevelt (FDR) Memorial and its explicit references to social justice chiseled in rock, especially FDR’s powerful quote that reads, “In these days of difficulty, *we Americans everywhere must and shall choose the path of social justice*, the path of faith, the path of hope and the path of love toward our fellow men.” (emphasis added). The quote came from FDR’s campaign address in Detroit, Michigan, October 2, 1932. The very next day the three of us agreed to begin writing a grant proposal that would allow us to explore, historically, conceptually and pedagogically, the incommensurability between engineering and social justice that we had experienced. Was it rooted in history? Was it a reflection of the ideologies of engineering? Or of the values of organizations where engineers work, teach, and learn? We wanted to know. In 2010 we received an NSF grant, began our research, course development, involvement in a network of engineering educators committed to social justice called Engineering, Social Justice and Peace (ESJP) (See Chap. 2 by Nieuwsma in this volume for a history of ESJP), and scholarly activism through faculty workshops with engineering educators, conference papers and classroom interventions. Along the way, we found people committed to social justice, in and out the ESJP network, many with more experience and courage than we had, facing different challenges and having travelled different trajectories. This book attempts to collect some of those experiences and give voice and visibility to courageous and dedicated scholars and colleagues that before us had begun the difficult and risky task of teaching about social justice in the engineering classroom.

After 2 years of teaching ESJ, I have come to realize how complex the task of bringing social justice into engineering really is. As a tenured male heterosexual Latino middle-class professor, holding two university degrees in engineering and two in science and technology studies (STS) from top research universities, I am fully aware of how these privileges allow me to open space to teach this course without

raising too many questions. I have credibility in front of both engineering and social science colleagues, job security (tenure) that allows me to teach controversial topics, and rarely face discriminatory practices that unfortunately my homosexual and female colleagues encounter often in the culture of engineering education. From this position of privilege, I became intrigued about how others located at different pedagogical and institutional sites, and with more or fewer privileges than I have, conceptualize and propose the integration of engineering and social justice. I wanted us to learn from each other's experiences and struggles, establish a dialogue among ourselves and engage with a larger audience of engineering teachers, practitioners and students. This book hopes to further this dialogue and shared learning.

1.3 Historic Convergence of Circumstances

As we begin this dialogue and engagement, key questions still remain. Why might there be an increasing interest among engineering faculty and students for social justice? Might this be an intrinsic interest rooted in deep personal experiences? Perhaps. But could there also be a convergence of institutional factors and historical circumstances that lead more and more faculty and students to be interested in social justice? Trying to answer these questions clearly opens an opportunity for empirical research by engineering studies scholars. But let me propose a hypothesis here: In spite of individual personal interest for social justice, there is a convergence of two historical circumstances that is creating institutional opportunities to open spaces for an increasing number of engineers to teach and learn about the integration of engineering and social justice inside engineering schools. What might these circumstances be?

1.3.1 *Calls for Change*

As historians of engineering have described elsewhere, the history of engineering education is marked with repeated calls for change. Some of these calls are perennial (Reynolds and Seely 1993) while others have been adaptations to specific political and economic challenges facing the American nation at different times (Lucena 2005). Recently, with the US facing stiff competition in technological innovation and in the production of engineering graduates from countries like China and India, there are new calls to make engineering education more socially relevant as a way to increase the recruitment and retention of particular populations. Particularly, women and underrepresented groups find traditional engineering void of social relevance and want it to be “in touch with the world” as a precondition to stay in engineering (Brainard 2007; Buckley et al. 2004) As the NAE puts it, “curricular approaches that engage students in team exercises, in team design courses, and as noted above, in courses that connect engineering design and solutions to real-world problems so that the social relevance of engineering is apparent appear to be successful in retaining

students” (National Academy of Engineering 2004, 54). These calls for the social relevance of engineering have materialized in programs that connect engineering curriculum with service learning, community development, humanitarian engineering, sustainability, and is perhaps most visible by the explosion of Engineers Without Borders (EWB) chapters in US engineering schools. There are now close to 300 EWB chapters in the US. And, as described above, some of the stakeholders behind these programs are yearning for an understanding of how their initiatives connect with social justice, how to bring social justice into their courses, and, in the process, how to recruit and retain more students.

1.3.2 An (In)Visible History

Engineering also has had a relatively invisible history of dealings with social justice (Wisnioski 2012). This history is fragmented, mostly unknown and yet shows promising signs indicating that the present time might be ripe for a wider and more systematic integration of social justice into engineering. As some of the authors in this volume rightly observe, major calls from the engineering profession, such as the publication of the Engineer of 2020 report, the issuing of the NAE Grand Challenges, and the formation of Engineering for Change (E4C), present both challenges and opportunities to an open dialogue about the relationship between engineering and social justice. As Nieusma describes in this volume, this dialogue has already begun in places like the NAE conference on Engineering, Sustainability and Social Justice, the sessions on social justice at ASEE Annual Conference (especially the one on the ethics of NAE’s Grand Challenges in 2011), and even in the technical programs of conferences by engineering societies like ASME and IEEE. For reasons described above, this dialogue has begun to permeate engineering schools in the form of Engineering to Help, some of which are beginning to address important questions about inequalities and discriminations previously invisible to many, as the team-taught module by Schneider and Munakata-Marr exemplifies. Also, an increasing number of students are bringing these interests to the forefront, wanting to connect their engineering education and training with social problems related to the maldistribution of rights, resources and opportunities. In short, the total invisibility of social justice in engineering seems to be a thing of the past.

1.4 Defining Social Justice

As with any new scholarly and activist endeavor that appropriates a difficult term, those of us committed to integrating engineering and social justice face the challenge of defining social justice. Many scholars of social justice remind us that social justice does not have an easy and straightforward definition (Riley 2008; Ayers et al. 1998; Brooks 2008). Its definition depends on our cultural, political or philosophical position in the world (Marxist, feminist, deep ecology, faith based,

Rawlsian, etc.) and on our commitment to social groups experiencing inequalities that we want to correct (working poor, women, LGBT, disabled, etc.). In spite of these ambiguities and not pretending to speak for all the authors in this volume, I begin my ESJ course by providing engineering students with a working definition that relies on key elements drawn from philosopher Brian Barry (2005) on which they can focus their engineering practices and designs:

Social justice practices, including those by engineers, should attempt to an equal distribution of rights, opportunities and resources in order to enhance human capabilities and reduce the risk and harms among the citizens of a society.¹

By recognizing that “attempting” does not necessarily mean “realizing”, I try to persuade those students who, like some of the engineers at the NAE conference, might be initially uncomfortable with or resistant to redistributing resources. Then to fully understand the constituent elements of this definition, and the contributions that engineering might make on these, my students study the following questions:

- where do we look for people’s **rights** (e.g., state and country political constitutions, UN declaration of human rights) and how might engineering, its practices and products enhance or hinder specific human rights?
- how do **opportunities and resources** differ among groups of different races, genders, physical abilities, socio-economic classes, sexual orientations, etc. and how might engineering, and its practices and products, contribute or diminish specific opportunities and resources?
- how can engineering’s contributions to rights, opportunities and resources be, after all, about enhancing **human capabilities** and reducing **risks and harms**?

In short, this definition challenges engineers to focus on specific means (engineering) to contribute to primary ends (rights, opportunities, resources) that will eventually lead to higher goals (enhancing capabilities, reducing risks/harms). Yet I do not assume that this definition, or others that I have tried, might be the most appropriate to engage all engineers in their quest for social justice. Hence the chapters in this volume aim at providing a diversity of definitions, examples and forms of engagement.

1.5 How This Book Approaches ESJ: Autobiographical, Historical, Philosophical, Pedagogical, Practical and Beyond

My ESJ class begins with a privilege walk (see Peggy McIntosh’s chap in Rothenberg 2003) and a series of autobiographical exercises to expose students to the concept of privilege (earned and unearned), how these accumulate (or are diminished) from

¹I am in debt to philosopher Martha Nussbaum for reminding us that social justice practices, like other forms of human and social development, should be, after all, about the development of human capabilities (Nussbaum 2011).

womb to profession, how these are dependent on rights, opportunities and resources, and how these might eventually lead to enhancement of human capabilities. Then we explore the engineering mindsets as outlined by Riley (2008), study where and how these are manifested in engineering, and where they come from in the philosophical, historical and social roots of engineering. Next we explore how privileges and mindsets enhance and/or hinder engineers' abilities to engage social justice issues, and how to resist and/or subvert the negative effect of mindsets and privileges in order to do social justice work. Students research and present on historical and contemporary examples of engineers engaged in social justice work and write a final analysis of how this journey, through the intersections between engineering and social justice, challenge them as persons, future engineering professionals and influence them on the kinds of technologies that they want to design, build and operate.

Yet my course is just an introductory exploration to the intersection between engineering and social justice. There are many aspects, approaches, historical events and exemplars that I cannot cover due to limitations of time, my own expertise and institutional context. I am fully aware that my course is an incomplete micro-cosmos of the larger universe of engineering and social justice. Wanting to explore this larger universe is one of the motivations for this book. So what sort of approaches—conceptual, pedagogical, autobiographical, activist, etc.—can we expect from this book?

Dean Nieuwma's chapter provides a *historical and conceptual mapping* of ESJP, the first network of engineering educators, practitioners and students who organized themselves explicitly "to work toward engineering practices that enhance gender, racial, class, and cultural equity and are democratic, non-oppressive, and non-violent." Furthermore, Nieuwma maps different educational and professional reform strategies that ESJP members have used in order to bring social justice into the engineering curriculum.

Donna M. Riley's chapter provides both an *autobiographical and activist approach* to her experiences of discrimination in engineering and her struggles to bring social justice into the curriculum. Through her journey, Riley reveals practices and systems of inequality and discrimination in engineering education, the importance of crossing disciplinary divides into critical perspectives on education (mainly Paolo Freire and bell hooks), and the courage of teaching engineering students about power by asking important questions: Who benefits from the problems that we solve? What gets in? What stays out? Riley is located where some of us would like to be: inside the engineering science curriculum (thermodynamics), trying to connect apparently abstract and apolitical concepts with questions about power and inequality.

Through *empirical research on students' experiences* with discrimination and inequality in engineering education, Erin A. Cech's chapter provide a very useful refinement two key concepts that most of us take for granted in engineering: the split between the technical vs. non-technical and meritocracy. Then she shows how these work against engineers' ability to engage in social justice, and with these

concepts complement the map that Riley began when mapping the engineering mindsets.

An computer scientist/engineer and doctoral candidate in engineering education, Marisol Mercado Santiago attempts to build a *philosophical bridge between engineering and Buddhism*. Although there are dispersed elements in engineering education that resemble Buddhist principles and values, there is no framework yet to bring a closer integration between Buddhism and engineering, particularly one that serves the interests of social justice. Marisol's chapter attempts to "motivate engineering educators, who are interested in Buddhism and social justice, to connect their engineering knowledge with Buddhist studies in socially just engineering education."

Also a doctoral candidate in a program that combines electrical engineering and engineering education and an engineer himself, Ryan C. Campbell provides a *theoretical outline of caring in engineering*. Although care and caring are common words in the vernacular of some engineering for service programs, Campbell reconceptualizes caring, which he defines as "an active compassion, empathy, and concern for the well-being of other living things," as a key and necessary element for engineering education to truly embrace social and ecological justice.

In their chapter, Caroline Baillie and Rita Armstrong present empirical research that maps how *knowledge boundaries and threshold concepts* influence engineering students' understanding of social justice. Baillie's engineering and engineering education backgrounds come together with Rita Armstrong's anthropological work and activism in a process of negotiation to show their engineering students, many of whom will be hired by extractive industries in Western Australia, a place where aboriginal peoples are experiencing undue pressures on their livelihoods, the value of crossing disciplinary boundaries and identifying threshold concepts in creating a pathway towards social justice.

Jen Schneider and Junko Munakata-Marr describe in their chapter how they guided their students in a sustainable engineering design class to analyze the social justice dimensions of a public transportation project in a neighborhood with people living below the poverty line. Like Baillie's and Armstrong's, this teaching partnership serves as an example of the importance of *interdisciplinary collaborations in creating opportunities for social justice in the engineering classroom*, and shows how we can create a community service activity close to home where the social justice dimensions are more visible, relevant and connected to students.

Jon Leydens' chapter identifies sources of faculty resistance to integrating social justice. Leydens' work challenges us to respect and pay close attention to these forms of resistance, and explores the contributions of Social Justice Across the Curriculum (SJAC) initiatives in *developing guidelines for faculty to facilitate the overall integration of social justice in engineering*. Although initially designed for humanities and social science curricula, the proposed guidelines have multiple implications for addressing faculty resistance across the entire engineering curriculum.

Wanting to contribute to our understanding of how the *politics of technological systems relate to social justice*, Andres Valderrama's chapter presents empirical research on how real engineered systems, in the form of public transportation systems in Colombia, hide biases against marginalized groups. Valderrama goes after a taken-for-granted assumption (*i.e.*, that models and assumptions made in the design of engineered systems are value neutral) to show how engineers, and their political patrons, while often articulate visions of social justice, might be blind to hidden unjust assumptions in their modeling that eventually lead to injustices and inequalities.

In his chapter, Richard Arias explores the *historical emergence of NGOs as sites for work and activism of Colombian engineers committed to social justice* and analyzes the multiple definitions that engineers give of social justice while working in NGOs. This is a topic of great interest to many engineering students as they often wonder what would it be like to work as an engineer for an NGO, to engineering studies scholars as most studies of engineers in the workplace have focused on corporate and government environments, and to engineering educators because, as Arias writes, "universities and engineering schools develop curricula to construct engineers for the private sector and the public sector, but not for the nonprofit sector. Since the nonprofit sector follows a different logic, engineering schools are normally at odds with this kind of engineering."

Finally, in his chapter, Nicholas Sakellariou explores the social justice dimensions in one of the most exciting areas of engineering innovation: renewable energy. He challenges us to explore the unquestioned assumptions about the social good of these technologies by *questioning the social justice dimensions in the production and use of these forms of energy*. He then provides a framework for engineers to engage communities in decision-making processes (procedural justice) in a way that will eventually lead to social justice.

In addition to these individual chapters, the organization of this book in parts is also aimed at making the following contributions to engineering education and practice relevant and useful to those who might have specific concerns or needs:

- **Part II. Where Have We Been? Where Can We Go?** A map of where ESJ has been (Nieusma) and how some of us have experienced injustices and what have we done about it (Riley).
- **Part III. Conceptual Contributions to ESJ.** New philosophical (Campbell, Santiago) and sociological (Cech) concepts that can enhance our understanding of how to integrate engineering and social justice.
- **Part IV. What Gets in the Way and How Can ESJ Live in the Engineering Classroom?** Specific examples of threshold concepts that get in the way and need to be overcome to enhance students' understanding of social justice (Baillie and Armstrong), how social justice can be integrated in an engineering course (Schneider and Munakata-Marr) and guidelines to facilitate the integration of social justice education within engineering education (Leydens)
- **Part V. What Thinking about Social Justice in Engineering Practice Can Offer to Engineering Education.** Empirical evidence of how the integration and conflicts

between engineering and social justice looks like in practice in transportation systems (Valderrama), NGOs (Arias), and renewable energy projects (Sakellariou).

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Part II
Where Have We Been?
Where Can We Go?

Chapter 2

Engineering, Social Justice, and Peace: Strategies for Educational and Professional Reform

Dean Nieuwsma

Abstract This chapter surveys a range of educational and professional reform efforts in engineering carried out by the Engineering, Social Justice, and Peace network and its members. These efforts are categorized in a way that highlights the diversity of the approaches taken as well as their interconnections. Beyond documenting and categorizing a range of contemporary initiatives in engineering and social justice, the chapter argues that, to be most effective, ESJP members attempt to integrate their particular values orientations and commitments with systematic attention to a wide range of organizational and conceptual problems that inhibit engineering for social justice and peace.

Keywords Engineering, Social justice, and Peace network • Engineering educational reform • Engineering professional reform • Engineering conceptual reform • Social-technical integration

2.1 Introduction

Social justice is a big idea, with multiple meanings—some of which exist in tension and others of which are simply contradictory. From certain perspectives, the very concept of *social* justice is fraught. Spirited debate over the appropriateness of the

This chapter refines and considerably extends a paper presented at the 2011 Annual Conference of the American Society for Engineering Education in Vancouver, Canada (Nieuwsma 2011a) and a related presentation at the 2011 annual meeting of Engineering, Social Justice, and Peace in Bogotá, Colombia (Nieuwsma 2011b).

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terminology was a highlight of the US National Academy of Engineering (NAE) workshop, “Engineering, Social Justice, and Sustainable Community Development,” held in October of 2008 at the NAE headquarters in Washington, DC. At this event, a small but vocal minority expressed dismay over use of the term “social justice” by the esteemed NAE, suggesting it represented a socialist political agenda that members of the NAE should appropriately reject, not embrace.

Despite such resistance, many engineers and engineering commentators take the desirability of social justice—and the appropriateness of the engineering profession to work systematically toward it—as being self-evident. Directing engineering initiatives at individuals and social groups with particular vulnerabilities—including the global poor, local community groups, disabled persons, and many others—is on the rise, with an explosion in the number of organizations or affiliates engaging in on-the-ground, service-oriented engineering work over the past decade (Nieuwsma and Riley 2010).

Numerous approaches to social justice are represented in contemporary engineering practice and education. Many of these approaches use the terminology of social justice explicitly.¹ Others are motivated by concerns about social injustices, but avoid applying the label of “social justice” to their efforts for strategic or other reasons. Much of the work of Engineers Without Borders–USA and Engineers for a Sustainable World fits this description. For instance, Engineers Without Borders uses the language of “social responsibility” in describing its values, but avoids explicit reference to “social justice” throughout its 2010 Strategic Plan (EWB-USA 2010). Similarly, Engineers for a Sustainable World uses the term “social sustainability” in describing its vision and goals (ESW 2012).

Still others carry out work with immediate implications for advancing social justice without being motivated directly by that particular goal. For instance, the widely referenced 2008 NAE report, *Grand Challenges for Engineering*, promotes the application of engineering ingenuity to contemporary social problems in a way that is broadly consistent with a social-justice agenda. Despite non-trivial shortcomings,² this report represents a larger trend within engineering toward explicit efforts to advance “the social good.”

This chapter describes the efforts of a network of engineering educators, practitioners, and students who take a further step in promoting social justice. This group, collaborating under the banner, Engineering, Social Justice, and Peace (ESJP), promotes a vision of social justice that goes beyond helping vulnerable populations to identifying and confronting the *systems and structures that lead to*

¹Donna M. Riley’s *Engineering and Social Justice* (2008) is noteworthy for its attention to the intersection of engineering and social justice as its primary analytic theme. Other work by members of the Engineering, Social Justice, and Peace network—the topic of this chapter—obviously fits here as well. See, e.g., Caroline Baillie and George Catalano’s *Engineering and Society: Working Toward Social Justice, Parts I, II, and III* (all 2009a, b, c).

²A session at the 2011 Annual Conference of the American Society for Engineering Education was dedicated to critically analyzing the approaches and underlying assumptions represented in the NAE’s (2008) *Grand Challenges of Engineering* report (see Catalano 2011; Herkert 2011; Nieuwsma and Tang 2011; Riley 2011; Slaton 2011).

injustices. As a network of affiliated participants, ESJP's mission (and name) lies at the exact intersection of engineering and social justice. ESJP "works toward engineering practices that enhance gender, racial, class, and cultural equity and are democratic, non-oppressive, and non-violent. We seek to better understand the relationships between engineering practices and the contexts that shape those practices, with the purpose of promoting local-level community empowerment through engineering problem solving, broadly conceived" (ESJP 2012).

ESJP carries out a range of direct action, community-based, scholarly, and organization-building activities, and its members individually and in collaboration have initiated numerous efforts aimed at making social justice and peace more central to engineering as a field of practice. This chapter surveys some of these activities, focusing specifically on *educational and professional initiatives* by summarizing and categorizing them to show how they work at various levels of reform. ESJP members also carry out a considerable amount of situated community development work and direct-action and scholarly activism, including issues-based initiatives around themes like: peace advocacy; animal rights; disability support; racial, gender, and economic justice; LGBT rights; and indigenous rights. While an important part of ESJP's overall approach, a review of these activities is left to future research.

Beyond documenting a range of contemporary initiatives in engineering and social justice, the chapter argues that, to be most effective, ESJP members integrate their particular values orientations and commitments with systematic attention to a wide range of organizational and conceptual problems that inhibit engineering for social justice and peace. Hence, the chapter treats ESJP not merely as a network of like-minded individuals collaborating to promote a shared vision of social justice within engineering—although it is that. More important, however, is ESJP's range of strategies that target diverse audiences at multiple scales of intervention to connect social justice commitments with the institutional changes needed for materializing those commitments.

2.2 Background: A Short History of ESJP

While the precise origin of any complex initiative is difficult to specify exactly, the first of what has become an annual meeting of the ESJP network was organized by Caroline Baillie in 2004: The "Engineering for Social Justice" conference was held in November at Queen's University in Kingston, Ontario. That event was attended by over 20 participants, including George Catalano. Catalano collaborated with Baillie to host the second meeting in April, 2006 at Binghamton University in Binghamton, New York, at which point the event was renamed to "Engineering, Social Justice, and Peace" and organized as a workshop.

This second meeting had 31 participants, four of whom (including the author) would go on to become regular collaborators. ESJP's first publication, the 'zine, *Reconstruct*, was issued in the summer after this meeting for distribution at the American Society for Engineering Education's 2006 annual conference. The

meeting also saw the birth of “ESJP” as a signifier pointing to something meaningful in the world—at this time, mainly an event (i.e., the henceforth annual meeting) but also a small community of scholars and activists collaborating around the theme of engineering and social justice.

The third meeting was hosted again by Catalano and held at a retreat setting just outside Binghamton in April, 2007. This meeting had 24 attendees, including two more who would go on to become regular participants, and ended with a commitment to rotate responsibility for hosting future meetings. As a result of this commitment, the fourth meeting was organized—this time in a conference format—by Donna M. Riley and held in April, 2008 at Smith College in Northampton, Massachusetts. With 38 attendees turning out and a growing group of regular participants, this meeting saw the formalization of the ESJP network. Regular participants formed a coordinating committee and established a menu of ESJP-sponsored activities.

The following three annual meetings served to further institutionalize and grow the ESJP network. The June, 2009 meeting, organized and hosted by Chris Byrne in Whidbey Island, Washington (outside Seattle), included significant participation by practicing engineers employed in a range of local engineering firms. At this retreat-style meeting, participants strategized and categorized the full range of activities ESJP would pursue, including organizational development (e.g., commitments, identity, website, outreach), research (e.g., bibliography, conference venues, a journal), and activist initiatives (community engagement, ‘zine).

In 2010, the ESJP meeting first moved outside of North America. Held at the Royal Society for the Encouragement of Arts, Manufactures and Commerce (the RSA) in London, and organized again by Caroline Baillie, this meeting attracted a range of new participants representing international development perspectives, including delegations from Engineers Without Borders Australia and Ingenieros sin Fronteras Colombia (ISFC, Engineers Without Borders Colombia). This meeting put the relationship between social justice and development squarely on the table.

The 2011 meeting saw ESJP’s first move to the global South. Held in Bogotá, Colombia, and organized by Juan Lucena, Maria C. Ramírez, and Andrés Valderrama, this meeting was notable for including a high level of interaction with peoples suffering injustices, particularly Bogotá’s urban poor. This meeting was held in conjunction with an ISFC seminar and entailed considerable reflection on cross-national differences in understandings of social justice.

Currently, “ESJP” points both to a network of engineering reformers (see, esjp.org) and to some of its sponsored activities, most notably the annual meeting. Activities organized in the name of ESJP are overseen by a coordinating committee (numbering eight members as of March 2012), including the authors of this and other chapters in this volume. Several additional people participate regularly in the group’s decision making, and a much larger number contributes to specific ESJP activities or publications. In all, perhaps approximately 500 people have participated directly in an event organized by ESJP, not including the numerous talks, panels, and workshops organized around ESJP’s activities but presented at

independently-sponsored events (e.g., engineering education conferences, community workshops, etc.).

2.3 Methods and Scope

As part of the organizational strategy discussions that took place at the 2009 ESJP meeting, participants agreed to initiate a research project on “approaches to engineering and social justice,” which I volunteered to spearhead. The idea was to initiate a participatory action research project that surveyed members’ approaches to social justice in engineering in order to delineate and share the diversity of approaches taken. This chapter draws on and contributes to that original project, yet the chapter also extends beyond that project by looking reflexively at what ESJP has achieved as a reform initiative in its own right—above and beyond the approaches taken by any of the participants individually or in small groups.

The approaches to social justice-based engineering reform highlighted in this chapter were identified by surveying initiatives carried out by members of ESJP, situated as they are in diverse and geographically dispersed institutions of higher education. For the purposes of this analysis, the approaches surveyed are categorized both around the context of intervention and around the underlying intervention strategy. The empirical material driving the analysis comes from direct participation in a variety of ESJP initiatives, communication and association with ESJP members, and reviews of published literature and Internet material about their activities.

The material reviewed has North American/global North empirical and cultural biases, due to the location of the work and research contexts of most ESJP members, including those of the author. The material is also limited to initiatives spearheaded by regular ESJP participants and does not extend to include the inevitably wide-ranging, related work by reformers in overlapping circles.

2.4 Educational Reform Strategies

The first category of ESJP reform strategies to be reviewed revolves around engineering education, including a range of initiatives in pedagogy, curriculum design, and institutional restructuring. Here, *pedagogy* refers to strategies and methods for teaching engineering students, usually but not always pursued in (and confined to) the context of the classroom. *Curriculum design* entails working at the level of educational program requirements that have impacts beyond individual classes and their instructors. And *institutional restructuring* points to changes to the constraints under which educational programs operate, including institution-wide requirements

maintained by specific educational institutions, voluntary or mandatory accreditation requirements, and so forth. These types of educational reform initiatives turn the engineering learning environment into an opportunity to understand, to identify, and then to confront injustices arising from engineering educational practices and structures.

2.4.1 *Pedagogical Initiatives*

This section reviews different approaches to reforming what and how engineering students are taught within the context of specific courses. As university instructors, members of ESJP regularly bring their reform strategies and social-justice expertise to their teaching. Five separate cases are used to illustrate the different approaches, which are organized in a spectrum of experimentation spanning from course content to the learning process.

2.4.1.1 Liberal-Education Courses

Perhaps the most straightforward strategy for increasing attention to social justice in engineering education is to offer courses with social justice content that fit into existing program requirements. In many educational settings, including in the US context, the most evident place to introduce such content is the general/liberal-education component present in most engineering curricula, historically conveyed as humanities and social sciences (H&SS) requirements.

Most US engineering programs include H&SS requirements, sometimes with modest breadth and depth components. Since these programs typically take an *a la carte* approach to meeting H&SS requirements, students usually have considerable flexibility in selecting general education courses even when their science and technical engineering courses are rigidly specified. For the ESJP participants who are situated in liberal arts units at their respective universities, H&SS requirement combined with *a la carte* course selection provides an opportunity to create courses dedicated to social justice themes, including as they intersect with engineering.

In his 2010 dissertation, Jens Kabo analyses three different “lenses” for social justice as manifest in undergraduate liberal arts-content courses taught by ESJP members. In 2008 and 2009, Kabo’s thesis advisor, Caroline Baillie, taught a Queen’s University course entitled “Engineering and Social Justice,” which brought together engineering and social sciences students to ask: “What is engineered? Who is it engineered for? What happens inside engineering organisations? Is it equitable?” (Kabo 2010, 123). The course entailed two major components: (1) deconstructing dominant rationalities around neo-liberalism and technological progress and (2) identifying alternative engineering practices that are “non-oppressive, non-capitalist, and ecologically sustainable” (124).

The second course Kabo studied was Donna M. Riley's "Science, Technology, and Ethics," which was offered in 2008 as an elective to students in Smith College's Picker Engineering Program. In Riley's words, the course took a "macroethics" approach (see, e.g., Herkert 2005), tackling the "larger question of social decision making" rather than looking more narrowly at professional ethics (cited in Kabo 2010, 179). This course covered themes such as: objectivity and its critique, science and technology funding, consumerism, social inequality, feminist theory, and dissent. (The course also employed a "liberative pedagogy" approach, see below; also, see Chap. 3 by Riley in this volume for an in-depth description of her trajectory before, during, and after this course.)

The third course Kabo studied was my own "Sustainable Design Politics and Culture" course, an upper-level H&SS elective offered in 2008 at Rensselaer Polytechnic Institute. This Science and Technology Studies (STS) course targeted engineering and design students by highlighting the political and cultural underpinnings of sustainable design initiatives. The course was intended to "provide students: (1) the conceptual tools to understand social power, (2) the space to have discussions where that becomes a relevant method to understanding the world, and (3) topics or content that's not about social justice [per se], but has the potential to become a conversation about social justice by its nature...: [Y]ou can't go very far in talking about sustainability before you start to talk about who has what and why" (cited in Kabo 2010, 149–150).

Each of the three courses Kabo studied took a different approach to integrating social justice content into engineering H&SS electives: Baillie addressed the topic directly and explicitly; Riley introduced the topic using the language of ethics; and my course introduced it through the concept of sustainability. Beyond Kabo's study, Juan Lucena developed an H&SS elective course entitled, "Engineering and Social Justice," in 2010. Lucena takes a direct and explicit approach to social justice, which integrates STS theoretical approaches with content on diverse dimensions of social justice involving engineering practice and organizations, including: the objectivity myth, technical narrowness, desire to help, authority structures, and corporate and military influence.

2.4.1.2 Technical Course Modules

A related approach to making social justice content more readily available to engineering students is to introduce it in technical/core engineering courses. This approach was taken by George Catalano at Binghamton University in Binghamton, New York. Catalano spearheaded an effort to create a series of course modules on social justice themes that could be easily integrated into traditional technical engineering courses (Catalano et al. 2008a). This approach also responds to curricular over-crowding: "Realities of the present engineering curricula prevent the possibility of additional courses" (Catalano et al. 2008b). But perhaps more importantly, by providing stand-alone modules, this approach enables engineering educators without expertise in social justice content areas to integrate such content into their