In a sense, the goal of combining in one person technological know-how, societal sensitivity, and a humane value system may be considered hopelessly idealistic. Yet all educational processes need a goal, and what better goal than the ideal. Too often, educators are concerned with the art of the fundable rather than the art of the possible or the perfectable.

—Dr. George W. Hazzard, former President of Worcester Polytechnic Institute, 1978 [1]

* * *

In previous chapters, we discussed the engineering education hierarchy of knowledge, wherein the technical is misconceived as separable from the social and also superior to it. Due in part to that hierarchy, integrating social justice (SJ) only in Humanities and Social Science (HSS) courses for engineers sends the message to engineering students that SJ matters only for non-technical professionals—but is not substantively valued in engineering education or practice. Doing so also reinforces the ideology of depoliticization (see Chapter 1) by placing a “social” topic in the social domain of the curriculum and leaving the “technical” domain exempt from interfacing with SJ.
Hence, this book focuses on making SJ visible across much of the engineering curriculum—in design (Chapter 2), in the engineering science courses (Chapter 3), and—the subject of this chapter—in HSS courses for engineers. Though not sufficient by itself, making SJ visible in HSS courses for engineers complements its visibility elsewhere in the engineering curriculum.

Since HSS disciplines often raise important questions about human value(s) and the social contexts in which significant historical and contemporary events occur, HSS faculty tend to be interested in SJ-related inquiries from the outset. We invite our HSS colleagues to explore how SJ can add value to HSS courses, whether those are exclusively for engineering students or for a wide array of majors. In fact, all students stand to benefit by seeing the sometimes nuanced connections between engineering and SJ, as these permeate our everyday modern existence.

We have found the current generation of engineering students to be much more interested in discussing and debating SJ-related issues/movements—racism/Black Lives Matter, classism/Occupy Wall Street, etc.—than previous generations of such students. The growth and remarkable level of enthusiasm among engineering students for involvement in organizations such as Engineers Without Borders suggests a hunger among some students for opportunities to better understand questions of SJ, even within the historically “apolitical” field of engineering. Engineering students are wondering what grand challenges face humanity and how engineering can address those, so SJ helps render visible the human and social dimensions of such challenges. Overall, as we explore below, historically recent changes make this a promising time for rendering SJ visible in HSS and in engineering education.

In this chapter, we begin by discussing how the concept of HSS in the engineering curriculum historically fell prey to the ways in which engineering educators distanced themselves from the pressing social problems of the twentieth century. Building on that brief historical foundation, we explore the ways in which the Cold War (especially after Sputnik) and the anti-technology movement, fueled by sentiments against the Vietnam War and the questioning of the Apollo program’s relevance in the midst of urban and environmental problems, further marginalized HSS from playing a more central role in engineering education. We briefly chronicle an early attempt to make SJ visible via collaborations between engineering educators and scholars in Science and Technology Studies (STS), as we show how the four phases of STS’ evolution meant differing possibilities for such collaborations to flourish. This twentieth century review contrasts with contemporary conditions; unlike past historical moments, the current milieu is ripe for integration of engineering and SJ. HSS disciplines are now poised to take more active roles due to changes in accreditation, institutional landscapes, and scholarly landscapes.

The second part of the chapter mentions various curricular innovations that have emerged at this historical convergence of landscapes, and then delves into three HSS curricular examples that engage the Engineering for Social Justice (E4SJ) criteria briefly described below (and at more length in the Introduction): the courses “Engineering and Social Justice,” “Intercultural Communication,” and “Document Design and Graphics.” Drawing from instructor experiences with these curricular experiments, we end the chapter by identifying the benefits and limitations of rendering visible connections between engineering and SJ in HSS courses.

### 4.1 HUMANITIES AND SOCIAL SCIENCES, THE ENGINEERING CURRICULUM, AND THE DISTANCING OF ENGINEERING EDUCATION FROM PRESSING SOCIAL PROBLEMS

The integration of the HSS in engineering education has a long history, marked by a tension between “the operational aspects of accreditation [which has] the tendency to deemphasize non-technical subjects” and “the engineer’s professional standing [which tends to increase] interest in engineering and liberal arts integration” [3, p. 31]. So at the turn of the twentieth century, we could already see a tension between the needs of industrial bureaucracy, which after the 1960s became represented in accreditation, and the needs of the profession. For example, the first meeting of the Society for the Promotion of Engineering Education (SPEE)—the precursor to the American Society for Engineering Education—in 1893, was marked by “an orientation towards professionalism as opposed to bureaucracy that extended the interest in liberal education as an embedded component of engineering curricula” [3, p. 5]. In 1905, the SPEE presidential address called for a movement toward eliminating all requirements in English and foreign languages, as such courses and the HSS disciplines in general were “considered to have little merit to the engineer” [4, p. 327]. In just 12 years of existence, SPEE had gone from endorsing the HSS to questioning their relevancy.

By the 1920s, conservative ideology had come to dominate the engineering profession, leaving behind any serious attempt for social reform.

Ironically, this call to eliminate HSS from the curriculum took place in the middle of the progressive era (1880–1920), which experienced the largest percentage increase of engineers in US history. In these 40 years, the engineering profession increased by almost 2000%, from 7000 to 136,000 members [5, p. 3]. Even though many progressive thinkers and activists were questioning the injustices of industrial capitalism [6] and its impact on public spaces and infrastructure [7], most engineering educators were busy trying to figure out where the education of the engineer was to be located: in the classrooms of emerging land grant universities that opened up engineering education to unprecedented numbers of Americans, many of them children of farmers and trades people, or in the workshops and public works contexts where engineers could be trained as apprentices.

Meanwhile, most practicing engineers were busy trying to understand how to run and operate within the bureaucracies of the emerging mammoths of industry (corporations), as these were becoming the main sites for engineering employment.
So there was little attention paid to integrating HSS as part of the engineering curriculum, let alone attention to SJ. The trend toward further specialization and relevance to industry in the engineering curriculum not only increased but also moved engineers away from any hopes of casting engineering as a humanist profession. By the 1920s, according to Layton, conservative ideology had come to dominate the engineering profession, leaving behind any serious attempt for social reform:

As America lost interest in reform, engineers either rejected the idea of social responsibility or gave it a conservative interpretation. The close alliance between engineering and business that developed in the 1920s brought many material benefits. But the profession lost much of its precious independence. The studies of waste and the twelve-hour day demonstrated the sort of contributions an autonomous engineering profession might have made to national life… [5, p. 201]

There can be little doubt that engineers derived substantial benefits from their alliance with business. But there was a danger that in gaining worldly things the engineering profession might have lost its own soul. [5, p. 218]

So by the 1920s, “the emphasis shifted to more practical subjects such as engineering economics and Engineering English, subjects specifically designed to preserve the engineer’s jurisdiction over industrial operations amidst management’s stellar ascent” [3, p. 2]. HSS courses aimed at educating the engineer as a citizen found little support. The few HSS courses that found their way into the engineering curriculum were aimed at training engineers to compete with the emerging profession of management.

During the Great Depression and the New Deal, US engineering education had aligned itself primarily with industry interests [9]. Very explicit calls for Americans to enlist in the cause of SJ from key figures like President Franklin Delano Roosevelt (see Figures 4.1 and 4.2) found mixed responses from engineering education. So, for example,

…when engineering educators were challenged by Franklin D. Roosevelt in 1936 to question “whether the curricula in engineering schools are so balanced to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility,” SPEE’s leadership could respond with confidence that this had already been discussed extensively within the society. [3, pp. 8–9]

SPEE had in fact discussed and “accepted the fact that engineering had contributed to the nation’s technological unemployment” [3, p. 9].

On the other hand, the engineering curriculum distanced itself from the realities of the factory worker, as it aspired to educate white-collar professionals divorced from manual labor [12], and from the realities of the urban poor, as engineers increasingly aligned with industry [13]. In the United States, continuing calls for integration of HSS in the engineering curriculum did not gain consistent, long-term traction. For instance, in spite of a proposal known as the Wickenden Report (1930) to closely integrate the scientific, humanistic, and technological elements of the engineering curriculum [14, p. 1072], no such widespread integration occurred: “…through the 1940s, engineering remained, at most institutions, a highly practical subject” [15, p. 167].

Figure 4.1. Stonework at the Franklin Delano Roosevelt Memorial in Washington, DC, USA. FDR uttered these words October 2, 1932 [10]. Courtesy of Daniel Robinson [11].

Figure 4.2. The test of our progress is not whether we add more to the abundance of those who have much, it is whether we provide enough for those who have too little.
The engineering curriculum distanced itself from the realities of the factory worker, as it aspired to educate white-collar professionals divorced from manual labor, and from the realities of the urban poor, as engineers increasingly aligned with industry. In the United States, continuing calls for integration of HSS in the engineering curriculum did not gain consistent, long-term traction.

Through the remainder of the twentieth century, the perennial tension between the needs of bureaucracy and the needs of the profession led to many attempts to integrate HSS in the engineering curriculum but without much widespread success. For instance, aspirations beyond largely utilitarian curricula and toward meaningful curricular integration of HSS were articulated in influential engineering education reports (e.g., Hammond in 1940; Grinker in 1955; Gultlette in 1956; and Olmstead in 1968), as cited in [16].

Yet, in spite of these many reports, from the 1950s to the 1990s, the HSS courses only came to comprise between 13 and 20% of the undergraduate engineering curriculum [4] and, more pertinently, this incursion of HSS in engineering education was not necessarily aligned with (explicit or implicit) SJ principles. The focus of the integration was on students as conceived broadly as engineers, citizens, and human beings [17], but not on challenging the social structures that produce and perpetuate social injustices, particularly social structures related to engineered systems and technologies.

The focus of the integration was on students as conceived broadly as engineers, citizens, and human beings, but not on challenging the social structures that produce and perpetuate social injustices, particularly social structures related to engineered systems and technologies.

4.2 THE COLD WAR, THE ANTI-TECHNOLOGY MOVEMENT, AND A MARGINALIZED HSS

A prominent engineering educator had critiqued European-born professors at Harvard as far back as the 1930s for perpetuating “Their sacred cow... ‘engineering science’—meaning theoretical analysis regardless of whether it could be applied... As for applications, the general attitude among these European superstar’s was ‘That’s not our department’” [18, p. 107]. As discussed in Chapter 3, the engineering sciences emerged as the definitional and dominant body of knowledge of the engineering curriculum after Sputnik and fully crystallized as the sacred cow of the curriculum during the Cold War. HSS courses came to occupy 20% of the curriculum in the best-case scenarios ([19], [20]; see also [21], [22]). Yet the percentage of engineering curriculum real estate was not the critical factor compared to the quality of integration of the HSS.

Generally, in the HSS, there was no widespread explicit, consistent concern for SJ. The emphasis was largely on practical forms of communication. Through the first decade of the Cold War, the divide between scientific engineering at the core of the curriculum and the HSS courses at the margins had solidified. “By 1970, engineering education had become thoroughly scientized, closely paralleling academic science education in organization and emphasis” [23, p. 182].

4.2.1 Humanities and Social Sciences in 1960s and 1970s Engineering Education

In some corners of engineering education, public concerns regarding the negative impacts of technology—expressed more vividly by the anti-technology movement in the late 1960s and 1970s—and the end of the Space Race with the moon landing in 1969 were reflected mainly through significant declining enrollments in engineering [24]. As the culture wars of the 1970s entered university classrooms, engineering educators found traditional HSS courses less than adequate to help students understand the negative impacts of technology or new roles of the engineer in society [25, p. 164].

The anti-war movement, environmental activism, and other counter-cultural activities in the 1960s and 1970s produced interesting curricular experiments in engineering education with increased presence of HSS—but still divorced from explicit questions about SJ. Such experimentation involved teaching students not only to understand and work with technology, but also to manage human variables. Also, many of these experiments transcended a simple anti-technology stance. For example, according to historical work on competing technological visions in the 1960s, the Human Values Program at UCLA was aimed at educating engineers to be expert managers of the public good. Caltech’s HSS programs were aimed at educating social scientists to manage social progress instead of relying exclusively on scientists and engineers. And engineering as liberal learning at Harvey Mudd was aimed at educating engineers to manage social change. Technology studies at MIT combined elements of all of the above to create a new form of socio-technologists [25, p. 184]. At Worcester Polytechnic Institute (WPI), a significant curricular revision launched in the late 1960s/early 1970s led to their interdisciplinary project-based curriculum [1], [26].

The anti-war movement, environmental activism, and other counter-cultural activities in the 1960s and 1970s produced interesting curricular experiments in engineering education with increased presence of HSS—but still divorced from explicit questions about SJ.
With the exception of UCLA’s program, which “was discontinued...in a further scaling up of the engineering sciences” [25, p. 172], all other initiatives became institutionalized but did not become mainstream in engineering education and did not focus explicitly on SJ. Tenure and promotion systems that reward siloed disciplinary scholarship led faculty to shy away from further and wider collaborations and integrations [25, p. 185].

4.2.2 The Emergence and Evolution of STS

On the other hand, the emergence of STS as a field of inquiry wherein engineering educators teamed up with humanists and social scientists, in places like Lehigh and Penn State, could be viewed as an early attempt to make SJ visible with respect to technology [27, p. 161]. For example, the publishing in 1972 of the edited book Technology and Man’s Future (now in its 12th edition as Technology and the Future) marks an important event in this questioning of technology in society, including chapters on technology’s impact on the distribution of opportunities and resources [28], and the beginning of “technology studies” in the broader field known as STS. According to Cutcliffe [29], the evolution of STS happened in four phases.

In the first phase, the study of the impact of technology on society (throughout the 1970s) made visible injustices of technology, such as the empty promises of the Green Revolution to ease world hunger. However, this negative impact could happen, for example, via the improper use of technology by corrupt governments or by the unintended consequences of its uses. Technology was still a “black box” and as STS studied its effects only, rather than its workings, it exempted engineers and engineering knowledge of responsibility to questions of SJ as most of the focus was on the technologies themselves and how they were used.

The second phase is technology as a social construction, encompassing the social construction of technology (SCOT) movement in the 1980s and beyond, which highlights how different actors bring value-laden decisions into the making of technologies. Key examples include contributions from technology studies such as the social construction of the bicycle, Bakelite, missile accuracy, and medical imaging, just to name a few [30], [31], and feminist studies of technology [32]–[34], which showed how male actors in charge of decision-making bring masculine biases into the design of technologies that end up disempowering women. As such, SCOT sheds light on the biases of technology making, thus contributing conceptually to our understanding of how technologies interface with social injustice. Unfortunately, with very few exceptions, this way of looking at technology did not make it into mainstream engineering education, remaining in the domain of STS programs [29].

The third phase is technological literacy for engineers and non-engineers, meaning an integrated understanding of both the technical and social dimensions of human life. When the US National Academy of Engineering (NAE) initiated research on the topic in 2000 [35], its findings suggested that most engineers do not understand the complex social dimensions of technology and that non-engineers do not understand the complex technological dimensions of daily life. This phase in the development of STS marked an important milestone in the history of SJ in engineering, because the NAE study explicitly linked technological literacy to SJ: “Levels and types of technological literacy are bound to differ among people from different social, cultural, educational, and work backgrounds. To the extent that these differences put particular people or groups at a disadvantage (e.g., related to educational or employment opportunities), technological literacy can be considered a social-justice issue” [35, p. 4, emphasis added]. For the first time, engineering education had to take account of the far-reaching consequences of technological developments.

Moving from the identification of SJ as an important issue to finding ways for extending SJ in engineering, the fourth and most recent phase is participatory processes in science and technology, including such initiatives as maker spaces and projects in citizen participation in climate change talks. This phase underscores that technology is not a black box and that, in fact, its design, implementation, use, and assessment can be appropriated, thus opening the possibility for participatory justice in the making of technology [29] (see also [36]). Yet this phase takes place mostly in informal educational settings, which are yet to influence the core of engineering education.

Technology is not a black box. Its design, implementation, use, and assessment can be appropriated, thus opening the possibility for participatory justice in the making of technology.

Although STS presents possibilities for important disruptions of technical–social dualism (see Chapter 1), its curricular innovations have not materialized in concrete steps in the integration of engineering and SJ through HSS. So if the history of HSS in engineering education, in spite of the influences of the anti-technology movement and of STS, does not provide much hope, what is different now? Why are we inviting engineering educators and practitioners to consider integrating engineering and SJ through HSS given that previous attempts have been largely unsuccessful?

4.3 IT IS TIME: INTEGRATION OF ENGINEERING AND SOCIAL JUSTICE THROUGH THE HSS—THE HISTORICAL CONVERGENCE OF ABET 2000 AND MORE

The Accreditation Board for Engineering and Technology (ABET) produced ABET 2000 criteria—including general engineering program educational objectives shown in Figure 4.3—which were limiting yet also liberating for HSS programs. Prior to the sweeping shifts in ABET engineering criteria at the end of the 1990s (sometimes called EC or ABET 2000), HSS courses had a stable, if not always respected place in engineering curricula. However, the ABET 2000 criteria changed the equation by
(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) An ability to function on multidisciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) A recognition of the need for, and an ability to engage in life-long learning
(j) A knowledge of contemporary issues
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Figure 4.3. ABET 2016–2017 Criterion 3. These “a-k” items refer to standard student outcomes aimed at preparing graduates of engineering baccalaureate programs to attain program educational objectives [39].

removing “the half-year floor and one-year ceiling” for HSS curricula [37, p. 260]. Yet the ABET 2000 criteria also eliminated bean counting and rigidity, especially the previous ABET criteria’s emphasis “on examining what courses students passed rather than what they learned and could do, as well as a lack of encouragement for experimentation with new pedagogy and curricula” [38, p. 6].

So were ABET 2000 criteria a burden or a boon for HSS? Arguments for both could be marshaled. They could be seen as a burden because removing the 13–20% range eliminated a certain guarantee of stability for HSS curricula. But they could also be conceptualized as a boon by providing more freedom to experiment outside previous bounds: “Brevity and open-endedness are two of the most striking features of EC 2000 criteria; the latter, therefore, not only permit but demand interpretation” [40, p. xiv].

The promise of such experimentation largely resuscitated the aspiration in many of the twentieth century ASEE reports: greater HSS integration. “The important difference [between old and new ABET accreditation criteria] is that HSS elements are now to be seen in relation to, rather than distinct from, other elements [of the engineering curriculum]” [40, p. xv].

Interdisciplinary hopes abounded. Some researchers have pointed out that only four of the eleven program outcomes (of Criterion 3 in Figure 4.3) are purely or primarily technical, while the remaining ones all have significant nontechnical emphases [37]. ABET Criterion 3 is currently under review as of this writing and may change substantively, but the above technical–nontechnical distinction may miss the point: “Unlike so much of the previous literature about liberal education within engineering education, Criterion 3 does not separate between [what were mistakenly named and dichotomized as] ‘soft skills’ and ‘hard skills,’ nor does it relegate (as often was the case earlier) humanities and social sciences to a second step” [16, p. 22].

The hope that HSS could enliven the whole student, articulated in so many twentieth century ASEE reports, came to be seen as a more realistic goal: “[Under ABET 2000, students] must perform effectively as professionals, and presumably also as citizens (outcomes f, h, and j) and as self-reflective humans, (outcomes f–j)” [16, p. 22]. Cautious optimism surfaced in some researchers’ take on the ABET 2000 criteria, as they noted in 2004 that “[a] decade from now, we will know if this freedom [catalyzed by ABET 2000] brought either invention by and integration of faculty, or simply curricular anxiety and loss of a unique opportunity to bridge the ‘two cultures’ of C.P. Snow” [40, p. xii]. That decade is now behind us, and curricular anxiety does not seem to be the status quo. Rather, some innovation has occurred, and SJ is one of the key themes to move us toward the long-sought aspiration of HSS integration. However, other factors are converging in the wake of ABET 2000, including changes in institutional and scholarly landscapes.

4.3.1 Changes in the Institutional Landscape

In 2008, sustainable development and SJ were the two foci of a workshop sponsored by the NAE. Perhaps for the first time in the history of the NAE, practicing engineers and HSS scholars entered into dialogue in the Washington, DC headquarters over the relationship between engineering and SJ [41]. Although the workshop did not conclude with a major change or finding for engineering education, the fact that SJ was a key theme of a dialogue inside the hallways of NAE was significant.

From 2013 to 2016, Dr. Donna Riley (Purdue University) served as program manager at the National Science Foundation (NSF) Engineering Education Division, making SJ visible in NSF’s many engineering education solicitations. Among these is the Revolutionizing Engineering Departments program which, among others, granted a $2 million grant to the University of San Diego’s College of Engineering to “address how an engineering education that integrates traditional technical skills, enhanced social awareness, and an integrated professional spine produces connected learning that empowers graduates to improve society—by practicing engineering within the contexts of social justice, peace, humanitarian advancement, and sustainable practices” [42].

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In addition, the NAE Grand Challenges Scholars (NAE GCS) program has allowed some of the participating schools to appropriate what originally were challenges divorced from addressing the needs of underserved populations—see...
Many faculty involved in our NAE GCS program come from the HSS and are working together with engineering faculty to deliver on this commitment [48]. Furthermore, the growth of Engineering to Help (ETH) student organizations across US engineering schools, which also includes Engineers Without Borders (EWB), Engineers for a Sustainable World (ESW), and Engineering World Health (EWH), among others [49], provides new avenues for students to engage with HSS faculty and for HSS faculty to influence engineering projects by making the E4SJ criteria visible. (See Introduction for an overview and Section 4.4 for a synopsis of E4SJ criteria.) For example, a cultural anthropologist served as faculty advisor of our campus’ (CSM’s) EWB chapter for many years, regularly challenging students to listen contextually and to identify structural conditions that reinforce social injustices. Some of our EWB students have come to recognize on their own the need for more HSS education in order to understand their interactions with communities, enrolling in our HSS courses like Engineering and Sustainable Community Development, Community Engagement and Indigenous Peoples, and Natural Resource Development.

In short, the sum of these changes creates an institutional landscape that did not exist back in the 1970s, when the dialogue was very polarized between pro- and anti-technology ideologues or in the 1980s and beyond when STS became institutionalized in some universities but did not find permanent inroads into the engineering curriculum. While few institutions such as CSM, University of San Diego, and others might be at the leading edge of seizing these opportunities for SJ, the fact that these programs now have resonance in major institutions, at NSF, EWB, and NAE, for example, opens the opportunity for other institutions to follow suit.

4.3.2 Changes in the Scholarly Landscape

Along with changes in the institutional landscape came conference, publication, and grant opportunities for HSS scholars interested in contributing to the integration of engineering and SJ that did not exist in the 1970s and 1980s. For example, the Engineering, Social Justice and Peace (ESJP) Network has been holding conferences since 2004 (annually since 2006) and gathers a mix of HSS and engineering educators to reflect, discuss, and exchange projects, opportunities, and ideas at this intersection (see http://esjp.org/, and for a complete history of ESJP, see [50]). In addition, the integration of engineering and SJ has become visible as a theme in ASEE Liberal Education/Engineering and Society (LEES) division sessions with titles like “Engineering for Social Justice” (2006), “Integrating Social Justice in Engineering Science Courses” (2015), and many paper titles including the term social justice. Papers on SJ have also appeared at the Institute of Electrical and Electronics Engineers (IEEE) Professional Communication Society conference, for example, [51]–[54].

Publication opportunities for HSS scholars working in this integration have also increased. For example, the Morgan & Claypool series Engineering, Technology and Society (edited by Caroline Baillie) has more than 20 titles published with contributions from scholars from anthropology, communication, philosophy, and STS. The ESJP network also has its own International Journal of Engineering, Social Justice, and Peace with contributions that highlight the importance of the HSS in the education of engineers in SJ such as “What can engineers learn from the past? A potential role for history in engineering education,” which shows that by studying the history of technological projects at different times and places, and observing the impacts of these projects on communities, engineering students can learn valuable information about identifying structural conditions [55]. Clearly, history matters in understanding the impact of engineering on SJ. Recently, some of us have approached university and other presses with SJ-related book projects, that include significant contributions from HSS, that have been well received by both publishers and readership, including [56], [57], and this book.

Equally important for those of us seeking tenure and promotion is the availability of grant monies from NSF of the United States for projects seeking to integrate HSS in engineering education. A search of NSF awards of projects aiming at integrating engineering and SJ in the last 10 years reveal several titles, some noted in Table 4.1.


The emergent movement is not anti-technology but instead advocates for technological change that consciously accounts for SJ. It is an attempt to marshal the power of technology—guided by SJ means and ends—to enhance human capabilities.

None of these scholarly activities threatens the status quo in ways that initiatives inspired in anti-technology sentiments in the 1970s did. Perhaps different from the anti-technology movement of the 1970s, the emergent movement is not anti-technology but instead advocates for technological change that consciously
TABLE 4.1 Select NSF grants with social justice foci. That the NSF is funding such grants suggests an interest in curricular experimentation in SJ-engineering integration.

<table>
<thead>
<tr>
<th>Principal Investigator/Amount/Years</th>
<th>PI Institution</th>
<th>Award Title/Number</th>
<th>Grant Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donna Riley/ $404,813.00 2005-2011</td>
<td>Smith College (Dr. Riley is now at Purdue University)</td>
<td>CARER: Liberative Pedagogies in Engineering Education/ 0448240</td>
<td>This grant allowed work on her first book (Engineering and Social Justice) and to begin work on a second.</td>
</tr>
<tr>
<td>Rachelle Hollander/ $25,361.00 2008-2010</td>
<td>National Academy of Engineering</td>
<td>Engineering, Social Justice, &amp; Sustainable Community Development/ 0750007</td>
<td>Grant allowed scholars to organize an NAE conference with the same title.</td>
</tr>
<tr>
<td>Regina Stevens-Truss/ $48,481.00 2015-2016</td>
<td>Kalamazoo College</td>
<td>Science and Social Justice Think Tank/ 1600120</td>
<td>Grant brought together HSS and other scholars to plan for the inclusion of SJ issues in science.</td>
</tr>
</tbody>
</table>

accounts for SJ. It is an attempt to marshal the power of technology—guided by SJ means and ends—to enhance human capabilities. Both the institutional and scholarly landscapes are different now and will continue to change. If we are aware of their dynamic features, contours, and possibilities, strategically we can make a difference.

4.4 EMERGING CURRICULAR INNOVATIONS

In addition to the three courses described in detail below, several innovative curricular and pedagogical integrations have emerged in engineering education during this historical convergence and change of landscape. The courses mentioned below are not an exhaustive review of curricular innovations but give the reader a feel for the kinds of courses seeking to integrate engineering and SJ, using in many cases content from and/or partnerships with HSS (see Table 4.2). Also, in our own institution, CSM, social scientists work with petroleum engineering faculty to introduce SJ through corporate social responsibility in a senior-level seminar [58], and, as described in Chapter 3, in an upper-division Introduction to Feedback Control Systems course [59].

Historical and institutional conditions are right for talented innovators to develop and deliver such courses, and many of these have inspired our own efforts. Below, we interface our own HSS courses at CSM and another HSS course from Utah State University, USA, with the E4SJ criteria (see Introduction, also reiterated briefly below).

As noted in the Introduction, we define E4SJ as engineering practices that strive to enhance human capabilities (ends) through an equitable distribution of
opportunities and resources while reducing imposed risks and harms (means) among agentic citizens of a specific community or communities. (This definition is a unique synthesis drawing from [63]–[68]). Six E4SJ criteria emanate from that definition:

1. Listening contextually
2. Identifying structural conditions
3. Acknowledging political agency/mobilizing power
4. Increasing opportunities and resources
5. Reducing imposed risks and harms
6. Enhancing human capabilities

See Introduction for a more complete explanation of the E4SJ definition and criteria.

4.5 ENGINEERING AND SOCIAL JUSTICE AT COLORADO SCHOOL OF MINES

After describing the catalysts that led to the course “Engineering and Social Justice,” we describe course content and some key learning outcomes.

4.5.1 Background

The course “Engineering and Social Justice” was inspired by our experiences at a 2008 NAE workshop with engineers who assumed, some even claimed vehemently, that engineering and SJ were completely separate [41]. The summary of that workshop accentuates the diversity of views on SJ, with some in breakout groups saying SJ is irrelevant or tangential to engineering (see also [69]), some even equating it with socialism, and others claiming its centrality:

Plenary discussions following the summaries by the rapporteurs (from breakout groups) revealed sharp differences in opinion about the concept of social justice and its implications, including its implications for engineering. Despite these differences, one group put forth the following “declaration for engineering”:

Engineers and engineering societies have a heritage of concern for ethics and ethical issues. Yet in fulfilling its professional responsibilities, engineering has for too long neglected questions about social justice and sustainable community development. As in other professions, engineers are obligated to serve the public interest. To honor this commitment to public service, engineers should pay greater attention to social justice and sustainable community development. In this way, engineering can take a leadership role in developing a vision of a professional that provides integrated solutions [41, pp. 29–30]

Through an NSF grant, possible in great part thanks to the institutional landscape described above, we set out to explore the historical origins of where and how engineering-SJ (dis)connections actually took place and what conditions led to their separation (and seeming incommensurability) throughout the late twentieth century.

We discovered, for example, that during the Progressive Era some engineers integrated SJ concerns into their designs of fare boxes in early urban public transportation [70] and of mechanisms to reduce industrial pollution from factory smokestacks to protect the urban poor [8]. As with many other instances, we realized that these examples are missing from the history of engineering and we wanted to make them visible as exemplars for our students.

At CSM, the NSF grant provided legitimacy to develop, pilot, and make permanent our course “Engineering and Social Justice,” in an institutional setting that tends to be conservative and aligned with powerful corporate interests, and, like many engineering schools, an embodiment of the ideology of depoliticization (see Chapter 1). Courses with titles “Engineering and X” wherein X is a social subject, tend to raise suspicion and one wherein X is “social justice” even more so given the history of misunderstanding of what SJ means. So the NSF grant was instrumental in getting the course approved and becoming permanent in the schedule. Now the words “Social Justice” appear in the tag line of our program in Humanitarian Engineering, serving as one of the justifications for our NAE Grand Scholars program, and as inspiration for other courses and initiatives throughout campus.

4.5.2 Description of the Course “Engineering and Social Justice”

According to the course description, “Engineering and Social Justice offers students the opportunity to explore the relationships between engineering and SJ through personal reflection and historical and contemporary case studies.” The upper-division course is an elective taken mostly by seniors and is required for students in the Humanitarian Engineering minor. The course begins by distinguishing helping and charity from SJ, followed by a Privilege Walk [71], [72] to debunk the myth that students, by virtue of being in the same class or enrolled in the same school, start and live life from the same position of advantage. As students take steps forward (or backward) according to the privileges they have (or do not have), based on the social categories to which they belong (gender, race, ethnicity, socio-economic class, first generation to attend college, religious affiliation, physical ability, etc.), a social hierarchy of privileges is revealed in front of their eyes. Students end up in a physical, visual manifestation of that hierarchy, so it becomes difficult to deny.

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We follow the Privilege Walk with Tim Wise’s video on White Privilege so that students understand how privilege is historically constructed and maintained [73].
Questioning the ideology of meritocracy early on allows students to embrace the rest of the course with a more welcoming attitude (see Appendix 4.4 for an overview of the Privilege Walk activity).

We then devote one third of the course investigating the historical development and institutionalization of the engineering ideologies [74] and mindsets in engineering [75] (see Chapter 1), as these constitute the primary blinders that hinder engineers’ ability to engage in SJ, another third devoting strategies to counteract the ideologies and mindsets, and the final third exploring examples of real engineers who put SJ at the center of their practices and designs.

4.5.3 Course Learning Outcomes

When students learn that helping and charity are different than SJ, they come to understand that the former focuses on individual actions that try to minimize immediate human suffering (e.g., handing out change to a homeless person; volunteering for Habitat for Humanity) while the latter challenges people to reflect and act on the underlying systemic forces that cause the suffering and try to change them (e.g., identifying root causes of homelessness and what engineers can do to overcome these). Making this distinction is the first step in listening contextually and identifying structural conditions as students come to understand that one listens and views very differently a person that one tries to help with a hand-out than a person who is systematically oppressed by structural conditions.

By learning about the historical development of engineering mindsets and ideologies, students learn to further listen contextually and identify structural conditions, for example, by paying attention to how people define engineering differently and how these definitions empower and exclude different groups (e.g., see [76] for a historical analysis of exclusion by definition). The combination of historical and contemporary experiences of privilege help students challenge the ideology of meritocracy [74], [77], identify further structural conditions and begin to acknowledge that, by virtue of their own privileges, they have augmented political agency that can be marshaled to benefit those most impacted by engineering outcomes. This historical analysis also helps students see how engineering education and the profession have historically increased opportunities and resources for some—but not for all. For example, evidence exists of historical, systemic, and/or systematic discrimination against female [78], African American [79], LGBT [80], and low-income students [81] in engineering programs.

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In light of this historical legacy, in their final presentations, students explore how to begin changing engineering education and professional practices in order to decrease risks and harms for those groups of society that have been marginalized by engineering. For example, after reading ethnographies of women’s experiences in the engineering workplace [82], [83] and learning how micro-aggressions are built in language and group dynamic practices, students devise practices and guidelines to counteract discrimination.

Students also learn from real case studies of exemplary engineers, such as Transmilenio engineers in Bogotá, Colombia [84] and engineers fighting against a community relocation in a mining site in Peru [85], who have engaged the E4SJ criteria to work toward increasing resources and opportunities and decreasing risks and harms for the purposes of enhancing human capabilities.

In this course, we assess pre- and post-course student understanding of SJ and the past and present intersections of engineering and SJ, including students’ current relationship with SJ as engineers. Early in the course, students accept ignorance (“I have almost no understanding of social justice”) or display knowledge of traditional ways of understanding retributive justice (“when the legal system decides consequences of crimes”). At the same time, they view engineering relationships with SJ in either a negative way (“engineers causing harm to people via flawed designs”) or in a positive way, but focusing mainly on microethics (“engineers working as professionally and ethically as possible”) while ignoring macroethical dimensions [86] of SJ. Early answers also reflect their own ideology of depoliticization, which engineering students have not yet learned to see, question, and resist. By the end of the course, most students have learned to question the ideology of depoliticization, have moved away from retributive notions of SJ to emphasize redistribution (promoting equality of opportunity), and now see themselves as agents with the capacity to engineer to try even the field for those with less privilege.

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4.6 INTERCULTURAL COMMUNICATION AT COLORADO SCHOOL OF MINES

Whereas “Engineering and Social Justice” has the advantage of being built around—and helping to sharpen—the E4SJ criteria, most HSS courses do not start from scratch with SJ at their core. What value can SJ add to existing courses that have other foci? In this section, we describe “Intercultural Communication,” first offered in 2014 at the request of engineering students interested in better understanding how to effectively navigate and communicate in international and intercultural contexts; such understanding is particularly relevant since our graduates often enter
multinational corporate contexts and/or work (as well as travel) abroad. Here we focus primarily on how students engaged the E4SJ criteria through sample case studies.

4.6.1 Course Background

Like “Engineering and Social Justice,” “Intercultural Communication” is an upper-division elective course offered by an HSS department for (mostly senior) engineering and applied science students, who investigate communication cases across a range of cultural contexts. Broad definitions of culture are drawn from anthropology (culture as shared and sometimes contested meaning), cultural studies (culture as contested meaning), and global studies (culture as resource) [87].

4.6.2 Course Description

In “Intercultural Communication,” students examine the intersections of intercultural communication theory and practice, including how intercultural miscommunication arises, evolves, and is (or is not) resolved. Communication cases engage a broad range of cultural divides, such as national, gender, social class, ethnic, corporate, and engineering cultures.

Course learning objectives focus broadly on increasing tolerance for ambiguity and intercultural competence, and more specifically on four outcomes:

1. demonstrating cultural self-awareness and other-culture awareness
2. identifying diverse cultural communication approaches
3. recognizing systems of exploitation and developing approaches to challenge them
4. forging links between local and global SJ issues as informed by historical, political, and economic dimensions.

To achieve these outcomes and engage engineering students, multiple case studies are situated in or related to engineering and applied science contexts.

For instance, the following case study serves as an introduction to the E4SJ criteria. Students read excerpts of those criteria [88] so they can apply and analyze them in a case study (from [89]). To provide context, a synopsis of the case study appears in Box 4.1, drawn from [53].

BOX 4.1 CASE STUDY—SIKA DHARI’S WINDMILL.

Dr. Rani Natarjan (a pseudonym) visited the village of Sika Dhari in western India in 2004 with a group of her JS engineering graduate students, after having teamed up with a local (Indian) non-governmental organization (NGO) and the U.S. Environmental Proteccion Agency. The NGO told Natarjan that local villagers desired water and sanitation services, which aligned with her and her students’ background in civil engineering and their sustainability focus.

Originally from India, Natarjan had completed her doctorate and was working at a US university. When she arrived in the village Sika Dhari, they discovered that the villagers actually expressed strong interest in a windmill to generate electricity.

The students had devoted months to learning Hindi and about local culture and customs, but they encountered unexpected difficulties: many locals only spoke a tribal language, and one villager—a technical engineer who had relocated from Mumbai—served as translator. That engineer also indicated that he did not trust foreigners, and for various reasons, Natarjan and the students were not sure they trusted him [53].

Students were asked to take a position on which one of the E4SJ criteria the project engineers working in Sika Dhari engaged most and least effectively. For instance, in one course iteration, some student groups said the engineers most effectively enacted listening contextually, largely due to the engineers' elaborate participatory community mapping process, wherein local community members mapped who is and is not part of the community and how the community relates to its surrounding environment. Other groups chose identifying structural conditions that maintain (inequalities, mostly because the windmill served as a form of protest against hydropower dams, which had flooded and displaced residents of nearby villages.

When taking positions on the least effectively engaged E4SJ criterion, some groups indicated that the civil engineers could have improved by acknowledging political agency and mobilizing power, particularly after discovering language barriers and translator issues. By contrast, other groups said improvement was most needed in reducing risks and harms, since the windmill could not be thoroughly safety tested in the brief timeframe. After groups identified and justified their choices for most and least effectively engaged E4SJ criteria, separate debates ensued, wherein each group tried to persuade others of the validity of their positions. In most cases, students stay with their original votes but indicate a better understanding of alternative viewpoints. Generally, students think that while the windmill in Sika Dhari may have enhanced human capabilities, that decision could only made over the long run and primarily by locals.

Students' work applying and analyzing the E4SJ criteria to the Sika Dhari case made a foundation for future cases and activities. For example, students drew from the E4SJ criteria as they analyzed a case study of how heteronormativity serves as a structural condition that constrains engineering students who are lesbian, gay, or bisexual [80]. Students in the class listened contextually to the narratives in the case study but also to in-class narratives, either autobiographical (if volunteered) or about peers who had experienced similar discrimination at CSM. Some students indicated
that as heterosexuals, many of them enjoyed what sociologist Allan Johnson calls the “luxury of obliviousness” [90, p. 22]; that is, they were unaware of both their privilege and the sexual-orientation-based discrimination that permeated their everyday engineering education context. This realization empowered some to discuss not just heteronormativity—the idea that heterosexuality is the social norm from which all other sexual orientations deviate—but other forms of (in)visible discrimination and ways to address them on campus and beyond. For instance, some students fostered campus conversations via an organization called Equality Through Awareness—a form of acknowledging (their own) political agency and mobilizing power.

The course also featured a Privilege by Numbers activity, a variation on the Beads of Privilege activity, described in more detail in Appendix 4.B. That experience allows students to tally unearned privileges by walking around the classroom and giving themselves a point for every privilege they do have and no point for a privilege they lack, at eight different privilege stations, each of which contains eight privilege statements. Total numbers out of 64 are then compared anonymously as a class. Prompts include, for instance, “If I want to, I can easily find a religious community that will not exclude me for my sexuality” and “I can do well in challenging situations without being told what an inspiration I must be to other people of my ability status.” Debriefing from this activity, students realize how many privilege issues were heretofore invisible, especially for students with higher scores.

Students realize how many privilege issues were heretofore invisible.

Students also explored issues of SJ and power in case studies, such as [91]. This case study—on corporate social responsibility—include analyses of sustainability values reports published by two corporations, The Body Shop International and Royal Dutch Shell; students analyzed evidence indicating whether the reports constituted transformative acts of corporate citizenship and/or clever public relations campaigns—that is, whether the sustainability values reports undermined or promoted public trust in these corporations [91]. Such discussions explored whether corporations increase opportunities and resources and reduce risks and harms and for whom—shareholders, the public, customers, and communities.

In another case study, involving indigenous community members near a mining operation in Venezuela, students identified structural conditions that appear to have prevented the resource curse [92]. The resource curse maintains that over time, dependence on finite natural resources such as oil can spur widespread corruption and greed, contributing to economic contraction and possibly the failure of petro-states. However, among the indigenous Sanema of the Venezuelan Amazon, wealth is not a sign of status or prestige as much as is sharing wealth with one’s kin. Since their cultural conceptions of wealth center on a network of human relationships rather than individual self-interest, the predicted corruption and greed did not occur as the Sanema gained significant wealth by selling (highly subsidized) gasoline to gold mining companies.

Rather, due to cultural mores on compassion, shared community wealth increased [92]. For students, this case reinforced how structural conditions can be cultural and not universal.

4.6.3 Learning Outcomes

Generally, student engagement with and application of the E4SJ criteria suggests positive learning outcomes. For instance, in-class discussions and debates on the Sika Dhari and other cases promoted what Felder and Brent call “professional skill development” [93, p. 219]. Specifically, such activities provided opportunities to improve communication and metacognitive skills, to encourage them to apply and analyze prior (E4SJ) knowledge, to motivate interest in the course by applying theory to a case study, to broaden and deepen conceptual understanding of E4SJ, and to improve critical thinking skills by exploring multiple, viable interpretations [93]. Importantly, by applying and analyzing the E4SJ criteria vis-à-vis engineering-related case studies, students were thinking sociotechnically, focused on the how social justice emerges at the complex intersection of the social and the technical.

Importantly, by applying and analyzing the E4SJ criteria vis-à-vis engineering-related case studies, students were thinking sociotechnically, focused on the how social justice emerges at the complex intersection of the social and the technical.

To understand the cumulative effects of the case studies and other readings, students wrote a final synthesis paper that identified how their pre and post-course perspectives on 11 foundational questions had changed (see Appendix 4.C). Evidence from content analyses of these papers suggests diverse forms of student perspective shifts, including shifts in (a) why SJ matters yet is often invisible due to lack of awareness regarding privilege, intersectionality, and more, (b) how they inquire into, frame, position themselves and others within, dialogue, reflect, and act on intercultural communication conflicts, and (c) what assumptions, ideologies, or cultural lenses shaped prior and current ways of knowing and solving communication issues at the micro (among individuals), meso (among groups), and macro (among larger entities) levels (see [87]). Additional assessment data on this course appears in [2], [53].

4.7 DOCUMENT DESIGN AND GRAPHICS AT UTAH STATE

In the graduate program in Technical Communication and Rhetoric at Utah State University, SJ is a programmatic centerpiece [94], [95]. In its undergraduate program, SJ is rendered visible in multiple courses including an upper-division course, “Document Design and Graphics” (DDAG), described below, and drawn from a
2015 interview with Dr. Rebecca Walton, Technical Communication and Rhetoric Curricular Chair and DDAG course instructor.

4.7.1 Course Background

Most students have participated in multiple community service projects, and service is part of the Utah State University mission. So the service focus in DDAG is not new; however, the term social justice is often new. In a client-based, service learning course, DDAG students partner with AmeriCorps VISTA (AV) to design important documents and graphics, particularly those that promote AV’s mission (italicized in Box 4.2).

4.7.2 Course Description

The course overview, taken from the course syllabus and appearing in Box 4.2, includes explicit reference to the relevance of SJ.

**BOX 4.2 COURSE OVERVIEW FOR DOCUMENT DESIGN AND GRAPHICS.**

This course will provide you with a solid foundation of knowledge about document design to enable you to make and defend design decisions when creating print documents for professional contexts. You will learn useful frameworks for design, such as user-centered design and visual rhetoric. You will also learn about the human visual system and how the human body perceives visual information. You will learn about working with clients, sketching, typography, color, and graphics.

You will have multiple opportunities to apply your nascent skills within complex, real-world contexts by partnering with AmeriCorps VISTA Public School Partnership throughout the semester. You will work in teams to produce documents and graphics to support its mission of providing community members with access to resources, education, and opportunities to elevate themselves and their neighbors out of poverty. As you work with this organization, it will be important for you to learn about social justice and to reflect upon your own perspectives, particularly regarding its relevance to your professional field and professional goals. This will enable you to better serve your clients; to develop a more nuanced perspective on service, equality, advocacy, and justice; and to acquire an applied understanding of document design (emphases added).

The course has adopted an SJ framework, which has facilitated important student transformations.

Service learning courses hold significant promise for enacting SJ. Of course, "...there is no magic pedagogy to increase students' engagement and intrinsic motivation. But courses and projects that create authentic contexts for collaboration and writing have been shown to not only address these issues but also to improve student learning and teamwork skills" [96, p. 130]. However, for SJ to be enacted effectively in service learning courses, certain guidelines need to be in place so that members of the service-learning triad—community partners, students, and instructors—act in ethical, professional ways that ultimately aid intended beneficiaries. Among other issues, students can feel as though they are providing "free" labor, community partners can be exploited by unmotivated or ill-prepared students, and communication can break down at multiple junctures [97], [98].

Conscious that "much of service-learning's promise, including its promise of civic engagement, goes unrealized in many technical communication courses" [99, p. 289], Walton engaged in two specific actions to promote SJ outcomes: acting as communicative liaison and working to ensure fairness. As liaison between her students and the AV client, she maintained regular communication throughout the course, receiving frequent updates on student progress and fulfilling some student information requests.

Conscious that "much of service-learning's promise, including its promise of civic engagement, goes unrealized in many technical communication courses," Walton engaged in two specific actions to promote SJ outcomes: acting as communicative liaison and working to ensure fairness.

More importantly, she worked to ensure that student groups and the client had clear, fair, and mutual expectations in terms of responsibilities and deadlines. Although exploitation of student labor is a legitimate concern in some cases, in this case, AV is a nonprofit, national service organization designed for volunteers who serve their nation. Thus, no for-profit entity—no company owners, no shareholders, or others—benefited financially from student labor; in fact, taxpayers benefit from their work indirectly or directly, so the end is a public good.

While some could claim students were coerced into "volunteering," Walton noted that such "coercion" is consistent with the goals and mission of the university and with programmatic and course goals. In this case, Walton indicated that the danger is not student but organizational exploitation; having invested considerable time and effort for potentially no or little benefit, AV cannot predict the quality and reliability of student work, which can vary (students can drop the course mid-project, can produce substandard work, etc.). Although Walton consistently reinforced the importance of high expectations and responsibilities from both students and the AV coordinator, some go a step further and advocate a contract, or a "learning agreement" that stipulates responsibilities and deliverables [97].

4.7.3 Learning Outcomes

According to Dr. Walton, most students report having engaged in a different form of technical-social dualism (see Chapter 1), not bifurcating engineering and social
dimensions but technical communication and SJ. The collapsing of that dualism occurs in different ways for different students but begins when students start the course by trying to define SJ. For instance, one student was already engaged with SJ via LGBTQ issues, but had seen SJ as separate from technical communication. By the end of DDAG, he had identified concrete professional communication skills he can use to enact meaningful SJ work.

Other students reported realizing for the first time how SJ was already inherent in the ways in which marginalized populations interact with their documents, whether via print or online. That recognition has opened new, intriguing questions: How do I avoid triggering negative frames? How do I ensure that readers/viewers make associations that are aligned with my intentions? Such questions require students to step outside of their—sometimes highly privileged—perspective and listen contextually, so they empathize with the perspectives of others, especially others with diverse racial, ethnic, class, and other backgrounds.

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- How do I avoid triggering negative frames?
- How do I ensure that readers/viewers make associations that are aligned with my intentions?

Such questions require students to step outside of their—sometimes highly privileged—perspective and listen contextually.

How do students transform from knowing little to nothing about SJ to seeing how it is both inherent in and crucial to effective technical communication? Although answering that question completely is outside our current scope, one reason for the transformation is that in DDAG, students engage all six of the E4SJ criteria, some more than others.

First, students learn to listen contextually through client interactions. Since meetings with community members that AV serves are not always logistically feasible, students begin by interviewing the AV client, to better ascertain broad issues of audience and purpose (e.g., AV organizational issues, key struggles, and SJ concerns), but especially identify the needs, goals, and aspirations of AV community members. Students next listen to diverse perspectives in readings on SJ-related topics linked to the AV mission, including some readings selected by the AV client. Student engagement tends to be high since they are working with a real client on authentic document projects.

In DDAG, students identify structural conditions that maintain conditions of (in)equity, albeit indirectly. For instance, in a reading on intergenerational poverty, students attempt to identify common root causes of poverty and also delineate why trying to enact SJ can be problematic, as who benefits and who suffers from SJ can be a question of interpretation—but one worth wrestling with. Other readings focus on structural inequality, such as a reading on the unpacking of our invisible privilege knapsacks [72], and general discussions of privilege help uncover structural conditions.

What do document design and graphics have to do with acknowledging political agency and mobilizing power? Although not the focus of DDAG, students grapple with issues of power, which are central to understanding SJ [100]. Students come to see that as AV representatives respond to parents, school children, principals, and AV supervisors, different levels of power among stakeholders emerge; for instance, students need to obtain parental and school district permission before they can post photos of school kids online. Although Dr. Walton was not sure what percentage of students made the connection between such power issues and SJ, she noted that a majority of students reflected on the power and agency they had in framing public and social issues in the process of designing documents for AV.

A majority of students reflected on the power and agency they had in framing public and social issues in the process of designing documents. Students recognized that avoiding alienating people already marginalized by relatively expensive digital devices was also an SJ issue.

Given the service nature of DDAG, increasing opportunities and resources is an explicit, direct course outcome. Students design and revise a variety of documents for AV, based on peer, instructor, and client feedback. Documents include invitations to AV events, posters, brochures, and instructional forms, such as how to complete the FAFSA (a US federal financial aid) form. Generally, these resources are designed to inform people about multiple AV-related opportunities.

In terms of reducing risks and harms, DDAG emphasizes the normative dimensions in design, via everyday examples—for example, airplane seats not designed for tall people or weight machines designed for male bodies. Students also identify examples related to their document designs. For instance, students encounter studies that show digital technologies vary based on class (e.g., [101]). Since the people most likely to access the Internet primarily or solely through mobile devices include racial, and ethnic minorities, people living in low-income households, and people with lower levels of education [101], websites need to be designed for accessibility and clarity for mobile devices. Students recognized that avoiding alienating people already marginalized by relatively expensive digital devices was an SJ issue.

Finally, the five document designs that students turn in for their final project are specifically engineered to enhance AV’s mission to build capacities in schools, with benefits for at-risk students participating in clubs or other opportunities. Of the four AV core principles, one focuses on capacity building (along with a
focus on anti-poverty, community empowerment, and sustainable solutions) [102]. Collectively, the student documents are designed to enhance human capacities, which vary by document. For instance, documents that announce AV events enhance both practical reason (for critical thinking, freedom of conscience, etc.) and senses, imagination, and thought by promoting educational opportunities. Also, all documents directly or indirectly aim at the overarching goal of providing community members (parents, students, teachers, etc.) with greater control over their political and material environment, via an education that opens additional career, networking, and other opportunities.

4.8 BENEFITS AND LIMITATIONS

HSS courses for engineers constitute a viable site in which to attempt integrations of engineering and SJ—as long as such courses do not constitute the only sites in which SJ is visible in the engineering curriculum, and are buffeted by SJ in courses in engineering design and the engineering sciences. Rendering the connections between engineering and SJ visible in HSS courses comes with particular benefits and limitations, gleaned from the above instructional experiences and modified from previous work [2].

4.8.1 Benefits

1. HSS instructors can render SJ visible through engineering case studies or service learning projects, thereby giving engineering students opportunities to identify sociotechnical connections between SJ and engineering in specific instances. In such instances, students can use the E4SJ criteria as a form of formative and summative project assessment, increasing the probability that students will learn that not all projects are created equal when it comes to SJ contributions.

2. The above cases and projects can be structured so that students become aware of both privilege and power—both the unequal distribution of privilege, and empowering actions that emerge from that awareness. As one former student in “Engineering and Social Justice” wrote, “One cannot control how one’s privileges come about but one can control what one does with privilege.” Helping students become aware of their privilege, without blaming or making them feel guilty about something they did not construct (at least initially), should be one of the first steps of any introduction to SJ (see Appendices A and 4.B for examples of how to approach such issues). Since some HSS (and many engineering) faculty did not have privilege awareness as part of their own scholarly backgrounds, it would be valuable to collaborate with faculty or staff who do.

3. Through many of the resources outlined above (e.g., publications, course activities, and of course the E4SJ criteria), the connections between engineering and SJ can be judiciously integrated to complement new or existing HSS courses, in service learning, STS, communication studies, technical communication, anthropology, and beyond.

4. HSS faculty and their courses can become more visible and relevant to engineering education than just being confined by utilitarian notions of communication, technical writing, or any other discipline.

5. Particularly for very specialized engineering schools like ours, which sometimes have a difficult time connecting with their surrounding communities, HSS can contribute to their universities’ desires to connect with communities in meaningful ways and hence become an integral part of the public face of the university.

4.8.2 Limitations

1. Since SJ content is rich and complex, and SJ research straddles multiple disciplines (social work, sociology, philosophy, economics, etc.), instructors need to remain true to course learning objectives and not let SJ hijack a course. It is useful to guide students initially in recognizing SJ dimensions inherent in course cases and concepts, and to thereafter provide students with opportunities to discover such connections on their own.

2. Integrating all six E4SJ criteria should not necessarily be a goal. Instructors should instead create opportunities for students to identify those criteria most relevant to particular case studies, including those that are nuanced and complex—like actual engineering practice.

3. When undergraduate engineering students arrive in an upper-division HSS course, they already have been socialized to think technical–social dualism is a normative framework for discussing “real” engineering [82], [103]. Hence, instructor patience is warranted to give students time to challenge (invisible) engineering ideologies and educational norms.

4. Some HSS educators design courses not for engineers but for students from multiple disciplines; however, this too can be seen as an opportunity to integrate E4SJ criteria, facilitating cross-disciplinary dialogue and developing understanding of the SJ dimensions of the increasingly engineered world we live in.
APPENDIX 4.A PRIVILEGE WALK QUESTIONS

Acknowledgments

Dr. Peggy McIntosh designed the first Privilege Walk we know of [71][72]. We modified the prompts to fit an engineering education context, and we are indebted to the faculty and students who have provided feedback and insights while debriefing after previous Privilege Walks.

Prompts

Comment to participants: The following activity involves a number of statements related to your identity and relationship to privilege. These are not meant to embarrass you but to make visible our privileges (or lack thereof) in a friendly and trusting environment. After you hear each question, please reflect and honestly take one step forward if the answer to a statement is YES and a step backward if the answer is NO. If a statement is not relevant, ambiguous, or you do not wish to respond, you can stand still. Please try to ensure that your steps are the same length as others, about 2-feet long.

Although we are aware that unfortunately many social practices condemn homosexuality, we did not formulate statements that address sexual orientation because we did not want to create a situation in which we would force anyone to reveal information that one might not want revealed. Also, some of the statements will require you to interpret concepts as you understand them now, such as the concept of ethnicity, which could refer to culture, language, ancestry, and more.

1. At least one of my parents completed a college degree.
2. Growing up, my parents did NOT have to decide whether to pay rent and buy groceries OR pay for my extracurricular activities (sports, summer camps, etc.) as they had enough money to cover both.
3. Now as a young adult, I am able to attend school and not worry about having to work to help support my family.
4. I grew up in a home in which books were available for me to read and we could afford buying books from bookstores.
5. Before I could read, one or both of my parents had the time to read to me often, usually before going to bed.
6. My family has always enjoyed medical insurance. Hence illnesses and accidents have never compromised the financial stability of my family.
7. I would generally describe myself as able-bodied, having no outward physical disability, capable of moving without the assistance of a wheelchair or other adaptive device, and capable of accessing all social institutions (banks, schools, workplaces, churches, etc.) that able-bodied people can access.
8. If I should need to move to a new location, I can be certain of being able to afford rent or purchase housing in that area.
9. If I could afford to live there, I could be reasonably certain that all of my neighbors in such a location would be pleasant to me given my skin color.
10. My family or I have been able to afford having phone (or cellphone), electricity, water, and Internet connected in the houses we have lived.
11. I can open engineering magazines and see people of my skin color WIDELY represented (not just in the sections or articles dealing with diversity) and usually in positions of power or influence.
12. I can open engineering magazines and see people of my gender widely represented (not just in the sections or articles dealing with diversity) and usually in positions of power or influence.
13. When I am told about or read or see on TV engineering accomplishments and their contributions to human progress, I see that primarily people of my ethnicity made it what it is. [Ethnicity = common heritage, e.g., common language, culture, ancestry.]
14. I can be sure that children in public schools will be given curricular materials in engineering and technology subjects that testify to contributions made by people of my gender.
15. Whether I use checks or credit cards, I can definitively count on my skin color not to work against the appearance of my financial reliability in all circumstances.
16. I can swear, dress in second-hand clothes, ride a beat-up bike or car, and even stop for a nap in a park bench without having people I don’t know attribute these choices to the bad morals or financial situation of my socio-economic class.
17. I can speak in public to a powerful group of engineers about controversial issues (and even get emotional and have my voice break) without putting my gender on trial.
18. I can be almost certain that if I ask to talk to “a person in charge” (e.g., dean, provost, president) at my school or during my next visit to another engineering school, I will be facing a person of my ethnicity.
19. I can be almost certain that if I ask to talk to “a person in charge” at my school or during my next visit to an engineering school, I will be facing a person of my gender.
20. I can enter a new professional setting and not think about my gender affecting my interactions with others.
21. I have inherited or am likely to someday inherit significant money and/or property that will allow me to make a down payment for a place to live.
22. At least one of my parents is a professional and has held steady jobs for most of his/her professional life.
23. I can afford auto insurance that allows me to drive to places of employment and/or education without having to depend on public transportation.

24. I was born and raised in the industrialized, global north, which in most cases means having reliable infrastructure, food and energy production and distribution, and dependable social institutions, all of which facilitate human life.

25. When I was growing up, my parents did not have to use food stamps to buy food for the family.

26. My religious beliefs generally correspond with the most common religion in my country, allowing me to find places of worship regularly.

27. When I was younger, it was assumed by my parents and peers that I would go to college and become a professional.

28. My native language and my accent roughly correspond with the language and accent of most people in positions of power in the country I now live in.

29. For the majority of my childhood, I grew up in a house owned (not rented) by my parents.

30. I do not have to worry about helping my parents financially when they retire or are in old age since they have a stable financial situation settled for their old age.

31. I have traveled abroad (i.e., outside the country in which I was born) for vacation and leisure.

32. I have never had to live in a homeless shelter.

33. If I am stopped by a highway patrol officer, I can be absolutely sure that my skin color has nothing to do with it.

Debriefing Instructions

1. Describe your general thoughts and/or feelings about the Privilege Walk experience you just had.

2. Explain how you felt and/or what you thought about where you ended up relative to others.

3. Explain which prompts you found most meaningful or intriguing, most challenging, or hurtful.

4. Particularly for those doing a Privilege Walk for the first time, describe how your understanding of and perspective on privilege may have shifted.

5. Describe what understanding privilege means for how we view social justice. Explain how you see privilege as it relates to systems of oppression.

6. Explain how privileged social positions (in terms of gender, ethnicity, class, etc.) are related to engineering.

See https://www.youtube.com/watch?v=hD5f8GuNuGQ for an example of how to run and debrief a Privilege Walk.

APPENDIX 4.B PRIVILEGE BY NUMBERS ACTIVITY

Acknowledgments

We are indebted to Dr. Brenda J. Allen at the University of Colorado at Denver for guidelines on how to run the beads of privilege activity [104], which we have modified into the Privilege by Numbers activity.

Setup

The activity begins by setting the context: the instructor notes that the activity is designed to generate discussion beyond issues of diversity and explore SJ by exploring privileges linked to different identities. The activity, the instructor explains, is not designed to blame anyone, make anyone feel guilty or ashamed of having or not having privileges, but instead to reflect on the fact that we all have (and lack) some privilege and that certain actions may or may not ensue from that realization.

Eight stations are posted around a room, and each station focuses on a common privilege within the US context (and it is vital these be tailored to national and other relevant contexts): nationality, sexuality, religious, social class, race, ability, gender, and cisgender privilege. These privilege types are not exhaustive, just commonly invisible for some people. Students are given a piece of paper with eight sections numbered 1–8 and visit each station (in any order). They tally each privilege they have. After about 15–20 minutes, students total those privileges out of 64 possible privileges.

Prompts

Some of the prompts can be found at http://www.differencematters.info/, and readers can also email Jon Leydens (jleydens@mines.edu) for a more complete list. A few sample prompts appear below.

Gender Privilege: When I ask to see “the person in charge,” odds are I will face a person of my gender. The higher-up in the organization the person is, the surer I can be.

Ability Privilege: I have never been taunted, teased, or socially ostracized due to a disability.

Race Privilege: I can look at the mainstream media and find people of my race represented fairly and in a wide range of roles.

Debriefing Instructions

Some of the debriefing questions are included below, and can be done first in dyads or triads before the whole class discusses them, relying on volunteers (not conscripted students) to speak. While the debrief is occurring, students are asked to anonymously
circle their score out of 64 on a covered sheet of paper circulating around the room, which is used in prompt 6.

1. Without getting into discussions of the specific stations/statements themselves, what was this experience like?
2. Why is it important for us to be aware of the privilege aspect of our identities/experience? Why do we (have to) attend to all of these on a regular basis?
3. What does it mean for us to have multiple, intersecting identities—where we experience some privileges (around some identities) and some oppression (around others)? What insight can this give us in connecting with others? Being patient/generous with them and ourselves? Withholding ourselves and others responsible for our actions?
4. What identities (systems of privilege) were not represented here today? If we had them, how could they affect our final scores?
5. Hypothetically, what would it mean for you to wear the number of privileges you had on your shirt every day? What messages could others take from your number? How noticeable, to us and to others, are our privileges on a daily basis? How do we hide (deny, justify, ignore) our privilege on a daily basis? With what consequences?
6. What does the collective privilege present here (all our scores) mean for us as individual leaders? In collaborations on our own campuses? Across campuses/communities?

Optional Debrief Questions

- What impact, if any, can our perceived versus actual identities have on how we are treated and what privileges we get? For example, some individuals can “pass” or be assumed as members of privileged groups even if they are not (e.g., light skinned = White, presumed Christianity or heterosexuality, non-obvious disability).
- What is missing in this statement? “Our oppressions and privileges across multiple identities cancel out to a ‘net’ oppression/privilege score.” Is this oppression/privilege relationship either/or or both/and? So what?
- How do we take this awareness of privilege/oppression and transform it into productive action at the individual, classroom, institutional, societal, and other levels?

APPENDIX 4.C INTERCULTURAL COMMUNICATION FOUNDATIONAL QUESTIONS

Students conducted a self-interview at the outset and end of the semester, video recording themselves responding to the following 11 questions. They then conducted the same video recording near the end of the semester and watched both recordings. They are asked to focus on a few shifts (those most interesting to them), and their final synthesis papers identify how their pre- and post-course perspectives had shifted, based on particular course catalysts (readings, discussions, concepts, etc.), and what specific changes in present and future actions have ensued or will ensue.

Note: IC = Intercultural Communication

1. What are the key challenges and opportunities of IC in a global context? What is culture? How does our social location shape how we experience the world?
2. How do globalization, history, and relationships of power impact IC?
3. In what ways are our bodies sites where categories of social difference (race, gender, etc.) are marked and negotiated? What strategies can help us resist and transform categories that maintain hierarchies of difference?
4. In the context of globalization, what are the relationships among culture, place, cultural space, and identity? Why are they important?
5. What are the key challenges and opportunities of intercultural interpersonal relationships in a global context?
6. In the context of globalization, what are the key challenges and rewards of migration and intercultural adaptation to new cultural contexts?
7. In the context of globalization, what key impacts do mass media and popular culture have on IC? What strategies can help us critically consume, resist, and produce media messages in the global context?
8. How does the culture of capitalism impact IC within the United States and globally? What strategies can intercultural actors use to promote economic and social responsibility in a global context?
9. What conditions lead to intercultural conflict? What IC strategies can increase effectiveness in addressing intercultural conflicts?
10. What capacities are necessary for global citizenship and intercultural competence today, capacities that can help transform apathy into empowerment for social change and promote a more equitable, socially just, and peaceful world?
11. Overall, what role does IC play in your everyday life? What role does IC play in the collective sociocultural experiences of people in and beyond the United States?

ACKNOWLEDGMENTS

This chapter constitutes a substantively revised version of an earlier, preliminary work on links between HSS and SJ [2]. Special thanks go to Dr. Rebecca Walton of Utah State University for sharing her pedagogical insights in this chapter.
REFERENCES


3. A. Aker and B. Seely, "The history of engineering and liberal arts integration and its consequences for SIIOT?", unpublished manuscript.


REFERENCES