

Considering Employment Strategies for Socially Conscious Engineers

Laura A. Gelles
Shiley-Marcos School of Engineering
University of San Diego
San Diego, CA, USA
lgelles@sandiego.edu

Susan M. Lord
Integrated Engineering
University of San Diego
San Diego, CA, USA
slord@sandiego.edu

Abstract— This innovative practice work-in-progress explores the development of an Employment Strategies for Socially Conscious Engineers (ESSCE) resource for engineering students and students' initial responses when engaging with it. During a module that focused on incorporating social considerations into engineering decisions in a Materials Science engineering class, third-year students discussed the role that engineers play in making socially conscious decisions within their careers. Students considered whether they, as newly hired engineers, would have the ability, influence, or power to make these types of decisions when they perceived that employers did not prioritize social considerations over economic. Using student and faculty feedback, we created a list of strategies (e.g., seeking out socially conscious employers, networking with likeminded individuals, and leveraging a company's public image to advocate for socially responsible engineering decisions) to empower students to pragmatically include social considerations into their future engineering careers. Feedback from engineering students revealed that they appreciated strategies such as 'wait and see'—which described students being non-selective in their first engineering job and purposively looking for socially responsible company alternatives while building up their engineering skills. One important finding was that students were divided on working for a company that was already socially conscious versus changing a company from within to be more socially conscious. Students also expressed that faculty could play a role in identifying and vetting socially conscious companies.

Keywords— *socially conscious, employment strategies, career development, undergraduates, engineering*

I. INTRODUCTION

The 21st century engineer is called upon to solve increasingly complex issues such as climate change that involve both technical and social factors on a global scale. ABET student outcomes reflect this need to create more socially responsible engineers, stipulating that students should be able to make informed judgments that consider the impact of engineering solutions in global, economic, environmental, and societal contexts [1]. Engineering educators are increasingly incorporating social context into technical curriculum to address this [2]–[5]. Some students also see the

importance of this and self-select into engineering because they believe that engineering can positively impact society or want an impact-driven career [2], [6], [7]. However, these attitudes often change throughout the course of their engineering education as students are exposed to predominantly technical curriculum and personal priorities can shift [8], [9]. In fact, Cech has described a culture of disengagement that increases as engineering students approach graduation [10].

Even when students are attuned to issues of social justice, sustainability, and humanitarianism [11], [12], they may have more immediate job search concerns after graduating [13]. Many students must balance their personal attitudes and inclinations towards socially responsible engineering with their goal to be employed after they graduate. How can we as engineering educators support students in this process? This work-in-progress describes work at the University of San Diego towards this goal. The resource in development may be helpful to other engineering educators and career services professionals.

II. MOTIVATION

The impetus behind the creation of these strategies came from a classroom discussion during a module that focused on incorporating social considerations into engineering decisions in a Materials Science engineering class. This module, described in [14] and [15], centered on material selection decisions for drinking straws through the lens of sustainability and accessibility. The overarching goal of this module was to enhance students' concept of engineering complexity to encompass non-technical (e.g., social, environmental, political) considerations, multiple stakeholders, multi-faceted problems, and the social and environmental implications of design decisions so that students are better prepared to make more socially conscious decisions in their professional careers.

However, during a discussion about the role of engineers in making socially conscious decisions in their careers, students expressed doubt about whether they could make these decisions. Students considered whether they, as newly hired

We acknowledge the support of a USA National Science Foundation (NSF) grant 1519453. Opinions expressed here are those of the authors and do not reflect the views of the NSF.

engineers, would have the ability, influence, or power to make these types of decisions when they perceived that employers did not prioritize social considerations over economic. Students also questioned the authenticity of a company's social and environmental responsibility policies, and how having a good public image may be in conflict with actual business practices. This discussion prompted a spontaneous generation of possible strategies and tactics that students could utilize in their job search and during their first engineering job after graduation. Students immediately brought up seeking out companies that were already socially and environmentally responsible so that they would have the freedom to make these types of decisions. They were simultaneously aware that it was difficult to gauge whether a company's commitment to social and environmental responsibility was authentic and cited examples where a company claimed their practices were ethical, but their actions communicated a different message.

To counter the message that these students would have no power in their first engineering roles, the instructor prompted them to think about how small and seemingly inconsequential design decisions could snowball into a larger impact over time. This strategy was not as well received as using a company's public image claiming social and environmental responsibility to justify socially conscious engineering decisions. The main message the students communicated was that as new engineers, they needed to appeal to a company's bottom-line (i.e., profit) in order to recommend and justify incorporating environmental and social factors into design. The students expressed a fear of professional reprisal if they advocated for their socially conscious values in an engineering workplace. This was a troubling finding given that the majority of these students had no or limited first-hand experience in industry. The students had internalized this message without it being experienced or explicitly taught. This is an example of 'hidden curriculum', or the unwritten, unofficial, and oftentimes unintended, assumptions, lessons, values, beliefs, attitudes, and perspectives that are not openly acknowledged in a given environment [16] – [19]. Hidden curriculum messages can inhibit actions and enforce the existing status quo [20]. The informal classroom discussion with students indicated that they felt a lack of agency to pursue engineering decisions that were aligned with their environmental and social values. In previous research [21], we found that providing resources can help individuals feel more confident to take action if they perceive those resources as useful to them. Thus, we attempted to counter these messages and provide potential strategies for interested students to reinforce their socially conscious values during their job search process and while employed. Also, these strategies reinforced the module's learning objective to prepare students to make more socially conscious decisions in their professional careers.

III. DEVELOPMENT OF THE ESSCE

The initial strategies in the Employment Strategies for Socially Conscious Engineers (ESSCE) resource were discussed in the classroom with third-year students in the Materials Science class as described in Section II. Following

this, the strategies were discussed with several faculty who have expertise in incorporating social context into engineering curriculum. Literature was used to refine and add to the strategies. Finally, the strategies were piloted with students in an Engineering and Social Justice course and presented in their current form to the students in the Materials Science course at the end of the semester.

A. Related Literature

Literature on social responsibility for engineers and engineering codes of conduct [22], [23] were used to inform the development of the ESSCE. Important research on social responsibility in engineering focuses on what social responsibility attitudes students have [24], how they change over time [6], [25], and what curricular activities [26] or extra-curricular activities [27] can be used to engender these attitudes. Professional engineering societies include public service in their codes of conduct [22], [23]. For example, the National Society of Professional Engineers code of ethics states that as part of their professional obligations "engineers shall at all times strive to serve the public interest" [22]. Research shows that students agree that public service should be a part of the engineering profession [28].

While there is considerable literature on career development for engineering students, we could not find any research specific to tangible concrete actions engineering students could take to incorporate socially conscious considerations into the day to day realities of their job search or engineering career. We believe this represents a gap in the literature. Despite this gap, literature directly informed the inclusion of the '*outside community service*' and '*pro-bono work*' strategies [29] – [31] (see Table I). For example, in a study of engineers involved in Engineers Without Borders, the authors described how some companies were flexible and let engineers take personal vacation time for engineering service, provided some monetary compensation in the form of matching funds, grants, or paid vacation time for travel [31]. Moulton found that some engineering students were hesitant to seek out pro-bono engineering work at the start of their careers and those interested in pro-bono work reported they would do so at a later stage of their career and not as newly hired engineers [29].

While the literature and codes of ethics make a case that social responsibility is important and valued in engineering, they do not offer actionable and pragmatic steps for students who value social responsibility as they transition into their new careers. This is the gap that ESSCE seeks to fill.

B. Order Placement of the Strategies

The latest version of the ESSCE resource is provided in Table I where each strategy is listed, described, and specific tactics are provided that students could potentially utilize during a job search or while employed. The strategies were intentionally presented in a chronological order that a student might reasonably approach followed by anticipated level of difficulty. For example, tactics associated with initially searching and applying for jobs were presented first (e.g.,

independently choosing your employer) followed by strategies that could be employed while currently working (e.g., wait and see, networking). Strategies such as ‘outside community service’ and ‘pro-bono work’ were placed near the end of the list as they may be more likely pursued by those who are at a later stage in their career as suggested by [29]. Lastly, we included ‘abstain’ as an option to be inclusive of students who currently have no interest in incorporating social considerations into engineering practice.

IV. STUDENT RESPONSE

A. Engineering and Social Justice Course

This list of strategies was piloted in an Engineering and Social Justice course taught by another faculty member with third and fourth year engineering students. Generally, the students were appreciative of the resource but wished it was offered earlier in the semester. This conversation led to other career resources that undergraduates utilize such as career fairs. Students expressed concern that they are not aware of socially conscious companies coming to the Science, Technology, Engineering, and Math (STEM) focused university career fair. The instructor used this as an opportunity to empower students to approach Career Services and advocate for the inclusion of more socially conscious engineering companies and to engage with them on the role of power and agency of students in higher education governance. One student expressed her concern that she has had to find opportunities through professional societies such as the Society of Hispanic Professional Engineers (SHPE) to find engineering internships that align with her environmental interests.

B. Focus Group in Materials Science Engineering Course

At the end of the semester, students were provided with the list of strategies. A voluntary semi-structured focus group of six students was conducted to seek further input about the resource. This focus group was conducted by the first author, a postdoctoral research associate with expertise in Engineering Education. The instructor of the class (i.e., the second author) was not present before, during, or after the focus group. The participants were reminded that their participation and responses had no bearing on their grade and would be kept in confidence.

During the focus group, the students read the strategies and circled the ones they were most likely to utilize in the future. Responses were highly variable with each student circling a unique mix of strategies. Here we highlight the salient findings discussed during the focus group.

The students stated that they preferred the ‘networking’ and ‘wait and see’ strategies. Some students reiterated that in their position they are just trying to get a job and so the ‘wait and see’ strategy appealed to them. For example, one student said:

I like want to agree but the hard part is when you go into industry you don't have that power immediately. You don't have very much say in what materials are being used. It's more like this is what we need you to do...figure out a way to do it.

Normally you're not capable of changing like the social norms of how you're making it given that amount of money and the time frame you're given. So I feel like it is an engineer's role, but it's kinda hard in this age until the people that are in engineering around the country right now get to those upper roles...I don't think there's much of a say and much change right now because again: it's all about money.

Another student said, “I’m going to be honest...I’m just trying to get a job. I’m doing ‘Wait and See’ as the most probable one for me. I don’t feel like in our position, yeah we have some power but we’ll get more power as we go along.”

One student preferred the ‘snowballing decisions’ strategy as opposed to ‘independently choosing your employer’ because it meant they would be making changes within a company that otherwise might not change. For example, one student stated:

That [snowballing strategy] could also make more of an impact than independently choosing your employer because those companies are going to continue to be sustainable and be environmentally and socially conscious; where if you take the snowballing impact route then you could actually cause companies to change their view.

When asked about which strategies were too difficult to implement at the moment, a student mentioned ‘pro-bono work’. From their current role, they equated it to working an unpaid internship. This suggests that students were not aware that engineers could engage in pro-bono engineering work while still being paid by their employer.

The students also saw that the faculty could play a role in helping to vet socially conscious companies because they have a close relationship with their students and know their interests and students assumed that faculty at their university had these connections to companies. Students expressed feelings of trust in a faculty member's recommendation.

V. SUMMARY AND FUTURE WORK

The ESSCE resource aimed to help students think about different ways they can engage with social responsibility in their careers and includes a range of tactics and strategies in recognition of students’ varying priorities. This resource was developed and refined using student and faculty feedback and supplemented with literature. The feedback from students about the ESSCE resource indicated that students simultaneously care about being socially and environmentally conscious as an engineer and are worried about their future career prospects. They have to balance their current anxieties over finding employment with their values and, in some cases, make difficult decisions and tradeoffs.

These strategies have the potential to be useful for students, faculty, and career services staff. Faculty can provide this resource to their students and also use their social capital and networking connections to help their students meaningfully enact these strategies as they search for employment. Future work will include obtaining feedback from industry partners and engineers to further refine and potentially add to this list

of strategies. Additionally, we plan to expand its offering to other engineering students and faculty within our university and beyond and with engineering-specific career services staff. Future research is needed to follow students longitudinally in their careers as to whether they use these strategies or developed new ones.

We also believe this resource could be useful to professional societies. For example, this could be incorporated into programs such as the IEEE Graduates of the Last Decade (GOLD) program [32] which offers programs and services to graduating students, recent graduates, and young engineers. Likewise, other professional societies offer career development resources to their student members who may also be interested in ways to navigate their careers balancing their values and their roles in the engineering profession.

ACKNOWLEDGEMENTS

The authors would like to thank the students in this class for their enthusiastic participation. We would also like to thank Dr. Alex Mejia for piloting the strategies and reporting student feedback and Dr. Caroline Baillie for contributing to the list of strategies.

REFERENCES

- [1] ABET, "Criteria for accrediting engineering programs effective for the evaluations during the 2019-2020 accreditation cycle," 2020.
- [2] N. Okamoto, J. Rhee, and N. Mourtos, "Incorporating the impact of engineering solutions on society into technical engineering courses," *Glob. J. Engng. Educ.*, vol. 9, no. 1, pp. 1–8, 2005.
- [3] S. M. Lord, B. Przystrzeliski, and E. Reddy, "Teaching social responsibility in a circuits course," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2019.
- [4] E. A. Reddy, B. Przystrzeliski, S. M. Lord, and I. Khalil, "Introducing Social Relevance and Global Context into the Introduction to Heat Transfer Course," in *ASEE Annu. Conf. Proc.*, June, 2018.
- [5] R. W. Welch, "Humanities and social sciences within Civil Engineering curriculum," *ASEE Annu. Conf. Expo. Conf. Proc.*, 2011.
- [6] A. R. Bielefeldt and N. E. Canney, "Changes in the Social Responsibility Attitudes of Engineering Students Over Time," *Sci. Eng. Ethics*, 2015.
- [7] E. R. Brubaker, M. Schar, and S. Sheppard, "Impact-Driven Engineering Students: Contributing Behavioral Correlates," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2017.
- [8] N. E. Canney and A. R. Bielefeldt, "Differences in Engineering Students' Views of Social Responsibility between Disciplines," *J. Prof. Issues Eng. Educ. Pract.*, vol. 141, no. 4, , 2015.
- [9] G. Rulifson and A. R. Bielefeldt, "Engineering students' varied and changing views of social responsibility," in *ASEE Annu. Conf. Expo. Conf. Proc.*, June, 2015.
- [10] E. A. Cech, "Culture of disengagement in engineering education?," *Science, Technology, & Human Values*, vol. 39, pp. 42-72. 2014
- [11] R. DeBard, "Millennials coming to college," *New Dir. Student Serv.*, 2004, no. 106, pp. 33–45, 2004.
- [12] K. Moore, C. Jones, and R. S. Frazier, "Engineering Education For Generation Z," *Am. J. Eng. Educ.*, vol. 8, no. 2, pp. 111–126, 2017.
- [13] J. Margolis and D. Kotys-Schwartz, "The post graduation attrition of engineering students: An exploratory study on influential career choice factors," in *Proc. of the ASME 2009 Int. Mech. Eng. Con. & Expo., IMECE2009*, FL, USA, November 13-19, 2009, pp. 1–14.
- [14] L. Gelles and S. Lord, "The final straw: Incorporating accessibility and sustainability considerations into material selection decisions," in *ASEE Annu. Conf. Expo. Conf. Proc.*, June, 2020 [Virtual Conference].
- [15] L. Gelles and S. Lord, "Investigating using a "social impact audit" tool to support students' decision-making in a materials science course," in *2020 IEEE Frontiers in Education Conference (FIE)*, October, 2020 [Virtual Conference].
- [16] H. A. Giroux and A. N. Penna, "Social education in the classroom: The dynamics of the hidden curriculum," *Theory & Res. in Soc. Educ.*, vol. 7, pp. 21-42, 1979.
- [17] J. P. Portelli, "Exposing the hidden curriculum," *Journal of Curriculum Studies*, vol. 25, pp. 343-358, 1993.
- [18] E. Margolis, *The Hidden curriculum in higher education*. Routledge, New York, 2001.
- [19] I. Villanueva, L. Gelles, M. Di Stefano, B. Smith, R. Tull, S. Lord, L. Benson, A. Hunt, D. Riley, and G. Ryan, "What does hidden curriculum look like and how can it be explored?," in *ASEE Annu. Conf. Expo. Conf. Proc.*, June, 2018.
- [20] L. Gelles, K. Youmans, and I. Villanueva, "Sparking action: How emotions fuel or inhibit advocacy around hidden curriculum in engineering," in *Proc. of the 47th SEFI Annu. Conf.*, Budapest, Hungary, 2019.
- [21] L. Gelles, K. Youmans, I. Villanueva, and M. Di Stefano, "Hidden curriculum advocacy and resources for graduate students in engineering," in *Proc. of the CONECD Conference*, Crystal City, VA, 2019.
- [22] NSPE, "Code of Ethics for Engineers," 2020. [Online]. Available: <https://www.nspe.org/sites/default/files/resources/pdfs/Ethics/CodeofEthics/NSPECodeofEthicsforEngineers.pdf> [Accessed May 28, 2020].
- [23] ASCE, "Code of Ethics," 2020. [Online]. Available: <https://www.asce.org/code-of-ethics/> [Accessed May 28, 2020].
- [24] N. E. Canney and A. R. Bielefeldt, "A framework for the development of social responsibility in engineers," *Intl. Jour. of Eng. Educ.*, vol. 31, pp. 414–424. 2015.
- [25] G. Rulifson and A. R. Bielefeldt, "Evolution of students' varied conceptualizations about socially responsible engineering: A Four year longitudinal study," *Sci. & Eng. Ethics*, vol. 25, pp. 939–974. 2019.
- [26] A. R. Bielefeldt, and N. Canney, "Impacts of service-learning on the professional social responsibility attitudes of engineering students," *Intl. Jour. for Service Learning in Eng.*, vol. 9, pp. 47-63, 2014.
- [27] G. Rulifson, and A. R. Bielefeldt, "Influence of internships on engineering students' attitudes about socially responsible engineering," in *2018 IEEE Frontiers in Education Conference (FIE)*, pp.1–6. 2018.
- [28] J. J. Duffy, L. Barrington, and M. A. Heredia, "Is Service an expected part of the engineering profession?," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2011.
- [29] B. Moulton, "Pro bono in engineering: Towards an improved understanding," in *Technological Developments in Education and Automation*, M. Isander et al., Eds. Springer, 2010.
- [30] K. M. Passino, "Education the humanitarian engineer," *Sci. Eng. Ethics*, vol. 15, pp. 577-600, 2010.
- [31] G. Rulifson, N. E. Canney, and A. R. Bielefeldt, "Service-motivated students' transitions to industry," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2015.
- [32] J. W. Meredith and P. M. McCarter, "History of IEEE-USA: 1973-2009 – An Overview of Four Decades," in *Proc. of 2009 IEEE Conf. on the History of Tech. Societies*, 2009.

TABLE I. EMPLOYMENT STRATEGIES OF SOCIALLY CONSCIOUS ENGINEERS (ESSCE).

Strategy	Description	Tactics
Independently choosing your employer	You decide only to apply for jobs with an employer who you believe is authentically socially or environmentally conscious.	<ul style="list-style-type: none"> Use B-corp certification or other third party social and environmental standards to vet employers before applying for a job.
Crowdsourcing employers	You utilize social media or other crowdsourcing technology and methods to determine how employers are operating in other countries and whether they are authentically socially and environmentally conscious.	<ul style="list-style-type: none"> Find and amplify the voices of people (e.g., workers) affected by a potential employer's operations inside and outside the United States through social media or non-traditional means. Compare and contrast this perspective with the public face and communications of the company to determine if this employer authentically shares socially and environmentally conscious values.
Wait and see	You focus on getting your first engineering job regardless of the company's actions/values and keep your eyes open for job announcements for more socially/environmentally conscious employers.	<ul style="list-style-type: none"> Apply for relevant engineering jobs everywhere. Develop skills that make you an attractive future employment candidate. Use stability of current engineering job to feel secure in finding a future employer that aligns more with your values.
Snowballing impact	You work long-term at a company regardless of social or environmental focus and bide your time. You incorporate social or environmental considerations into the decisions you are able to make. You accumulate more decision-making authority by transitioning into project management roles and have greater social or environmental impact over time.	<ul style="list-style-type: none"> Apply for relevant engineering jobs everywhere. Incorporate social or environmental considerations into whatever small decisions you can make in your current role. Invest in your current role and develop technical and project management skills. As you slowly accumulate more influence over the years through project management, select team members who share these same values.
Networking	You build a network of likeminded engineers who can give you inside information about employers.	<ul style="list-style-type: none"> Leverage alumni networks to get an insider perspective on different employers and whether their social or environmental commitment is authentic. Reach out to other graduates from your university and keep in contact throughout your career for job opportunities at companies that share your values.
Leveraging Public Image	If your employer publicly communicates a social or environmental commitment, use this to justify environmentally or socially conscious design decisions.	<ul style="list-style-type: none"> Research and be able to articulate your employer's mission and marketing strategy. Use this knowledge to justify or advocate for socially conscious design decisions, which the employer can use to prove the image they want to cultivate.
Outside Community Service	You engage in socially conscious engineering work outside of your job and keep this socially conscious engineering separate from your normal work activities.	<ul style="list-style-type: none"> Join and participate in international groups such as Engineers Without Borders, Bridges to Prosperity, Engineering World Health. Join and participate in domestic groups such as Community Engineering Corps. Actively engage in other community service that involves your engineering skills. Ask if employers allows their employees to use personal vacation days for engineering service activities.
Pro-bono work (i.e., working for free)	You find an employer or engineering professional society that allows, encourages, and supports you to offer your engineering services for free (i.e., pro-bono).	<ul style="list-style-type: none"> Find out if your employer allows for, encourages, and supports pro-bono engineering work. Ask if your employer will donate standard work hours to engineering service such as Engineers Without Borders Ask if employer provides vacation pay, grants, or travel funds for engineering service activities. Find out if your employer has professional liability insurance for pro-bono engineering services. Join an engineering professional society (e.g., ASME, IEEE etc.) and offer pro-bono services through programs covered by their professional liability services.
Abstain	You are primarily focused on finding a career and/or other considerations have greater importance right now.	<ul style="list-style-type: none"> Use available resources to find employment and develop professional skills. Do not actively seek to incorporate social or environmental considerations unless employer requires it.