Approaches to Managing Organizational Diversity and Innovation

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Chapter 1
Engineering Justice

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ABSTRACT

This chapter addresses how the field of engineering has the potential of being a major force for social justice and how that may be accomplished. With their placement in a wide-range of occupations and job sites and with engineering professionals from many diverse countries, engineers are strategically located for societal impact. Engineers are naturally suited for problem solving and this propensity can be awakened to issues broader than those advanced by an employer or client. Educators can help engineers to think critically about how to think in socially just ways and how solutions will affect people. This chapter demonstrates how educational and training programs may be built around the understanding of the engineering profession and of the use of innovative instructional strategies that inspire and excite an engineer during the learning process. This chapter includes examples of instructional modules that may be used to accomplish these goals.

INTRODUCTION

Author, Joe Grimes, a university faculty member, who founded and administered a university faculty development center for ten years, is well-versed in teaching/learning and engineering publications, has published faculty development engineering material, presented at conferences, completed and designed education and faculty development courses and programs, and taught in a high school. He believes that implementation of a course should focus on learning over teaching. He has taught computer science/computer engineering courses for forty years and served as an engineering consultant for government agencies and industry and has served as an expert witness in civil litigation lawsuits. He also headed the computer engineering program and campus computing for a 20,000-student campus. Much of this chapter is the formulation of his ideas that are a reflection of all of these experiences, the belief that innovation will lead to *Engineering Social Justice*, and the advice of co-author, Mark Grimes.

A universal definition of *social justice* can be difficult since different people will bring their experience and perspectives to their understand-

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ing. For example, in an author led grant program with faculty of five other disciplines, all participants were found to have different definitions of social justice. This chapter defines social justice as an action-oriented goal of making the world's resources more equally accessible and distributed to all individuals and keeping production and use of resources sustainable. It is action-oriented because while equality and social justice are sometimes realized at a local level, global social justice is never fully achieved, as there will always be inequalities. Thus, social justice is the action-oriented pursuit of accessibility and sustainability. However, it is our belief that through the good faith efforts of individuals, the world can approach social justice and become more equitable. It is through the innovative and inventive realization that more can always be done and that progress can be made, that the social justice efforts of individuals are motivated. We also believe this effort can be accelerated through good engineering education, as explored later in this chapter.

Engineering Social Justice is a term used here to describe social justice through the efforts of engineers. *Engineering Social Justice* efforts typically center on product design, specifically designs for *accessibility* and *sustainability*. Accessibility can be broken up into two parts: 1) the ability to functionally use a product and 2) the ability to acquire a product. The ability to functionally use a product means that a person has the knowledge and physical requirements necessary for implementing product use. For example, not all people can functionally use stairs. Another example has to do with the interface of personal computers; graphical user interfaces made personal computers functionally usable to a wider population. The ability to acquire a product mainly concerns monetary and geographical factors that encourage or prevent products from reaching individuals. One might not have enough money needed to afford a product, or the product might not be available to a certain region of the world. Engineering solutions that are completely socially just will provide access to everyone now and in the future.

Sustainability has a few more layers than accessibility. When looking at issues of sustainability, one can look at *production sustainability* and *consumption sustainability*. Both production and consumption sustainability are concerned with the depletion of resources and harm of the environment. These are essential issues of social justice because they have a direct impact on the human condition. Depletion of resources makes them scarce and thus less available to the greater population. Harm to the environment not only hurts nature, it harms humanity's future. In addition to the depletion of resources, *Engineering Social Justice* considers how production and consumption can harm individuals such as workers and consumers resulting in a social injustice both now and in the future.

Table 1 helps provide a foundation for the identification of issues to be addressed by *Engineering Social Justice*. Working with Table 1, engineers can develop an inner-voice that would help self-regulate and identify the possibility of issues related to social justice. This inner-voice could use question prompts to help discover these issues. For example, some self-aimed questions could be:

- Is there something about the design of the product that excludes populations?
- Is there something about the design that can increase the number of people who would have access to the product?
- Have markets made it difficult to reach populations?
- Is there something about the production or use of the product that negatively affects people or the environment?
- Is there a way to produce this product that would use fewer resources?

Understanding issues related to *Engineering Social Justice* is only one component in the

Table 1. Engineering social justice issues of product design

Issues of Product Design	Sub-Issues		Examples
Accessibility	Ability to functionally use a product		Staircase versus ramp
			Text-based versus graphical user interface
	Ability to acquire product		Monetary costs
			Geographic markets
Sustainability	Production	Depletion of Resources	Depletion of valuable materials
			Harm to environment
		Worker Harm	Use of toxic materials
			Hazardous production procedures
	Consumption	Depletion of Resources	Power consumption to run product
			Resources needed to use product
		Consumer Harm	Hazardous materials
			Hazardous for use

implementation of *Engineering Social Justice*. In order for *Engineering Social Justice* to be realized, an engineer's working environment has to accept and encourage it.

A career in engineering has long been associated with being responsive to the declared needs and demands of clientele. Some exceptional pioneers have moved independently to forge their own niches in the market; however, many engineers are bound to the demands of their boss or client. In the somewhat distant past, the engineering profession of the United States had been responsive primarily to the existing money-oriented and military culture (Riley, 2008). Based on the author's experience, this culture has been changing. However, it will require creative innovation and a change to the engineering culture in practice in order to fully integrate social justice into training programs and the engineering professional careers.

Essential to a career that encourages *Engineering Social Justice* is equal accessibility to the profession for all. This is needed in order to help accelerate the change of engineering focus and provide the diverse inputs to realize socially just product design. Equal access to the profession means that groups of people are equally represented in the field of engineering. Inclusion in the profession enhances the possibilities, ideas, and solutions of accessibility and sustainability. For example, people from certain regions of the world may know the issues that are endemic to that region. Thus, they will know better how to build a product that people in that area would not otherwise be able to use. Equality in the engineering profession would mean there is relatively the same proportion of people of demographically defined groups (such as sex, race and ethnicity) in the population as there are working in the profession. Lack of equality among these groups in the field of engineering would suggest unequal access to the profession. Education has a special role in improving the inclusion and success of learners from traditionally unrepresented groups in engineering.

Because the global economy is continuing to develop, the world society is better prepared for improving social justice as the engineering profession is attracting diverse nationalities, cultures, and more women. The rate of improvement can be boosted through programs that appropriately train engineers and their supervisors including colleges and universities. In order to accomplish

this, the engineering curriculum should include preparation of learners: a) to act to change the profession to be passionate for social justice and peace; and b) to solve problems of their discipline within the engineering profession. Engineering training should prepare learners to: a) execute engineering ethics throughout the world; b) protect human welfare; c) enable social justice; and d) work to attain a sustainable environment while achieving the goal of economic development. The learning outcomes of the curriculum should continue to embrace engineering learning outcomes that include choice-reaching, critical thinking, and effective action skills to realize social change.

Throughout this chapter when the term *engineer* is used, it will apply generally across engineering disciplines, including aerospace, agricultural, architectural, biomedical, civil, computer, electrical, environmental, industrial, manufacturing, materials, mechanical, planetary, and software computer scientists. The term will also refer to all the categories of the discipline including engineering students, professors, government professionals, or industrial professionals. Also, there is interaction between engineers in different engineering disciplines as well as increased interaction between engineering graduates and non-engineering discipline graduates. The importance of these interactions is being recognized through the establishment of new degree programs such as "Liberal Arts and Engineering Studies." This greater interdisciplinary effort should allow those with greater social justice expertise to be engaged with engineers to develop better engineering solutions that are innovative to meet social justice requirements. Thus, the engineering culture should include the enabling of social justice through the expertise of the engineer in partnership with social justice experts.

All of the engineering professions have a code of ethics that each member is expected to subscribe to as a professional. The Institute of Electrical and Electronics Engineers (IEEE) has code of ethics (Institute of Electrical and Electronics Engineers (IEEE) (2013)) with code number eight pointing directly toward this responsibility. Code number 8 is: "to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin." The IEEE mission statement is: "IEEE's core purpose is to foster technological innovation and excellence for the benefit of humanity." This code of ethics and mission statement may be used as a guide for engineering faculty who want to be involved in an effort to incorporate social justice principles (product development and professional inclusion) and their practice as learning outcomes in the curriculum. In order for an engineering discipline to be accredited, it must be demonstrated that its learners are achieving this learning outcome.

Almost 50 years ago, Martin Luther King Jr, (1967) called for a *revolution of values* that would turn the focus of success from objects to people. He warned that, "When machines and computers, profit motives, and property rights are considered more important than people, the giant triplets of racism, extreme materialism and militarism are incapable of being conquered." This philosophy aligns well with social justice and places at the forefront an "all-embracing and unconditional love for all mankind." It is directed towards everyone in society, no matter what profession. This philosophy is particularly relevant in the identification of socially just characteristics in engineering professionals that could be forged and strengthened through schooling and employment. It points to the historical role that engineers have as mediator in the "thing-oriented society" that goes against socially just values. While the promotion of humanity and the improvement of the human condition should be the ultimate goal of an ethically minded engineer, the day-to-day work of engineers generally consists of more mundane and technical tasks that have a focus on objects. Day-to-day activities alone may not motivate concern for fellow humans. Instead, the concern of fellow humans should be an element of every task, woven through even the mundane

actions of engineers. *Engineering Social Justice* is the skill and practice of appropriately integrating engineering specific skills with social justice skills. Understanding how *Engineering Social Justice* can become a part of the profession requires some understanding of the background of the profession and strategies that can be used for engineering schooling and training.

Engineering Social Justice Engineering Social Justice is a people-oriented approach to engineering. In any project, an engineer can ask two fundamental questions:

- Who will benefit from this project?
- Who will be harmed by this project?

Engineers can use these questions to reflect on how the choices that are made will affect stakeholders and impactees and whether their project creates disenfranchised groups. Table 2 shows possible outcomes of choices when working on a project.

A project may have outcomes that fall into multiple quadrants as in Table 2 on this figure. For example a project may benefit stakeholders and consumers but could be harmful to the environment, workers, and parts of society. In this case, the outcomes fall into both quadrant 1 and quadrant 3. Additionally, a project may be beneficial to part of society or harmful in some limited way(s)

Table 2. Project choice outcomes

	Benefits Stakeholders	**Harms Stakeholders**
Benefits Impactees (Environment, Consumers, Workers, and Society)	1 Simultaneously Beneficial	2 Hurts the stakeholders but benefits impactees
Harms Impactees (Environment, Consumers, Workers, or Society)	3 Benefits the stakeholders but hurts impactees	4 Simultaneously Detrimental

to the environment. There are no hard rules. An engineer will often have to consider and may face many moral dilemmas. A culture of social justice in engineering means that engineers incorporate social justice into their engineering practice and this allows individual engineers to make better decisions when they face these dilemmas.

Internal questioning and prompted decision-making process from the questions of "who will benefit and who will be harmed" are not necessarily natural to engineers or engineering culture. This type of self-questioning requires a change in engineering culture and how engineers think. Probably the most effective way to make this change is through changes in engineering education and training. Faculty often do not know how to provide a good social justice themed learning experience for their learners. In this chapter, we address this instructional challenge by providing guidance that should assist faculty to achieve social justice learning goals. In order to understand where this education needs to take the engineering culture, it is important to understand the historical engineer and engineering culture.

BACKGROUND

The Engineer

Some people believe that engineers will have distinguishing characteristics with one being enabling social justice. Many engineers today are prepared to develop creative solutions but do not consider social justice in the solution. In the past and as a result of training, mentoring, and/or the working environment, the private sector engineer has typically been a problem solver without involvement with social justice issues. An innovative change to engineering training and a shift of priorities will provide the engineer an opportunity to be more imaginative, creative and helpful to other people by being socially just in delivered solutions. It is

likely that the engineer may be even more efficient in finding solutions.

The left brained person is one who has a more fully developed left side of their brain that is used for analytical processing. The right-brained person is more developed to be emotional and imaginative. Socially just solutions often require innovative creative processes. Metaphorically, engineers are seen to use only the technical left side of their brain and ignore the right side. This means that it would be desirable for the engineer with a left brain that is as solid as concrete without any right brain ability to move to having an absolutely solid left brain skill set with substantial right brain abilities.

Some engineers are concerned that integrating social justice in engineering solutions will result in more failures. Based on the author's interactions with industry, the view of engineering failure has changed in some companies. In the past, the tendency has been to reward successes in solving problems and to punish failures. Today, a distinction is made between failure based on engineering negligence and failure that has resulted from unforeseen issues despite following good engineering process. Some companies give greater leniency to engineering failures when good engineering processes are used. This allows engineers to move forward with greater confidence so they can gain more engineering skills, state-of-the-art knowledge, and improved understanding of engineering principles.

Engineering Homogeneity, Personality Stereotypes, and the New Engineer

The field of engineering has suffered from a lack of diversity. It has had an under-representation of ethnic groups and women. In order to move toward a multicultural field that benefits from diverse perspectives, the field of engineering must move to recruit and retain a more heterogeneous population of incoming engineers. In addition to the benefits that multiple perspectives would bring, representation of multiple groups would help to refocus efforts to a broader set of problems. The new engineer would enter into a discipline that has greater population diversity and thus be exposed to broader perspectives during training. This would transfer to contexts in the career. The broader perspective would allow more socially equitable engineering results.

Engineers often face multiple stereotypes about personality. For example, engineers are sometimes labeled as being introverted, socially avoidant, unable to be creative, and one-tracked minded (to name a few). Also, there are numerous jokes about engineers related to the stereotyping with the following as examples. To get a sense of the jokes that the software engineers encounter, the following are three pretty typical ones.

- Joke 1
  - **Q:** How do you tell an introverted computer scientist from an extroverted software engineer?
  - **A:** An extroverted software engineer looks at *your* shoes when he talks to you.
- Joke 2
  - **Q:** Why do software engineers always mix up Halloween and Christmas?
  - **A:** Because Oct 31 == Dec 25! (Note: Oct is an engineering abbreviation for Octal and Dec for Decimal)
- Joke 3
  - Don't worry if it doesn't work right. If everything did, you'd be out of a job.!!!!!!!!!!!

This labeling reinforces the stereotype through social stigma and makes the profession less appealing to those who are more extroverted and socially driven. The extent to which these stereotypes are true can be attributed to the degree to which instructors and employers allow or even encourage these characteristics in engineers. While this strategy

may have worked in the past, new world forces are changing the personality and skills engineer need. The make-up of the New Engineer needs to incorporate all of the positives of the old stereotyped engineer along with characteristics and skills for the 21st century. In addition to having a focused mind, a solid foundation in math and science, the ability to solve problems, and the ability to work independently, the New Engineer must also be able to communicate effectively, work in teams, work with non-engineer co-workers, think about the broader perspective of the problem, think in creative ways, and communicate disagreements with others including management. And as the world population increases and the human's impact on nature and the environment are becoming more apparent, engineers must consider how solutions to engineering problems have a broader impact. So how does this happen? Are engineers suddenly supposed to transform into multi-skilled social extroverts on their own? This transformation would be difficult to carry out or even conceptualize by individual engineers. Venues for the transformation of the New Engineer is in respective departments at colleges and universities and in professional development training programs. Building these characteristics in engineers can be a part of a good engineering education within formal academic training and beyond as a part of a lifelong learning process.

For *Engineering Social Justice* excellence today, the author believes that it will be essential for the engineers of the future to possess the engineering skills of the past. In addition, they will need social justice innovative creativity integrated with their engineering talent. The bottom line is that engineering skills alone will not be enough to achieve the requirements of *Engineering Social Justice.*

Needs of the Engineer

In spite of the stereotyping and jokes about them, the engineer is a human being with needs like all others. Understanding the needs of the engineer is important because it points to what conditions are needed for engineers to solve problems beyond the obvious demands of a project. Some differences arise because of the perspective of the culture of engineering and demands of the profession. Let's first consider the engineering culture by looking at the author's experience and then consider concepts regarding this. The author's personal evolution of his culture of *Engineering Social Justice* has been:

1. Initially engineering work was performed without considering the effect on people.
2. With high school teacher education courses taken and experience in high school teaching, local people as well technical engineering solutions were integrated in the solution process.
3. The experience in PhD work included a large majority of married and international students. So the recognition of diverse needs became more apparent.
4. Ultimately, engineering problem solving culture became one of meeting the technical specification and including social justice specifications using the advice of social justice experts. This approach has been a part of his teaching and engineering practice.

Maslow's hierarchy (Maslow, 1943; Maslow, 1954) is one theory that could be used to frame the needs of the engineer in any specific engineering discipline. In the mid-20th century, Abram Maslow and others developed a Hierarchy of Needs theory related to the development of the person. In this hierarchy, when a person satisfies a lower level need they often become motivated to reach a higher level of need. This motivational psychology is used to explain why people attain their unique top potential for achievement. Engineers often need the highest levels of need fulfillment in order to be innovative in achieving social justice in engineering solutions. In the author generated Table 3, Maslow's theory is adapted and applied

Table 3. Maslow's theory adapted and applied to engineer profession

Level	Need	Individual Engineer Development - Motivation	Engineer - Team Motivation	Engineering Product Development
Highest Level	Self-actualization	Realization of Potential	Team has more freedom to determine its path.	Product is something to be proud of and will be for years to come.
	Esteem	Good opinion of self	Team is evaluated positively for high quality performance	Components of the product can easily be rearranged
	Love	Acceptance by organization	Team members feel they belong to the team	Can make necessary changes to fix any problems that exist.
	Safety	Safety Needs – Safety of the Software from external problem(s) (hardware, malicious behavior, etc.)	Safety of the Software from external problem(s) (hardware, malicious behavior, etc.)	Solution will fall within budget requirement and can be created.
Lowest Level	Physiological	Physical Needs – Engineer can function.	Team members perform their function as a team and can deliver their product.	Specifications need to be defined and a general determination of whether it will be possible to make it work.

to the engineering profession in the three ways: 1) individual engineer development, 2) functioning as a team, and 3) engineering product development (with the table example for software development). This is meant to illustrate how engineers who are simply trying secure their job (basic needs) will feel less able to make decisions with greater societal impact. As engineers have greater security, they can focus less on basic job demands and move toward their goals.

Based on the assumptions of this model, only engineers who have fulfilled high levels of need will be able to freely pursue their higher-level beliefs about product design. However, some of the best ideas come from novice engineers. Additionally, engineers who have just finished school are closest to research and lessons taught in academia. Based on this model, an employer may want to create the conditions under which all employees feel welcome to share their ideas in a non-judgmental way. By opening up the floor to ideas from all employees, there is greater potential for finding product solutions that go beyond the basic requirements, such as solutions that foster social justice. Using Maslow's principles, an appropriate innovative environment can be created that will allow *Engineering Social Justice* to occur.

Social Justice in Engineering

Using social justice in engineering, professionals must move beyond a strict consideration of engineering specifications alone to a thinking that is open to innovation that includes social justice. Engineering is a field marked by math, science, rules, and standards. Engineers use standards to assure product quality and safety; and often, engineers are trained not to move forward until standards are met. Math and science are needed to create products within these standards. Engineering standards are numerous and they provide engineers with the possibility of having a somewhat structured work environment. Just the Internet Engineering Task Force (IETF) alone oversees thousands of standards that are quite specific in detail (IETF, 2013). There are thousands of standards (Official Internet Protocol Standards, 2013). The standards are not laws but exist to simplify design. It is possible to design outside the standards if that is important for a good for engineering and/or social justice. However, even with rules and facts regulating the way engineers work, creativity and critical thinking are needed to help engineers navigate in a world of uncertainties and unknowns. It is within this use of creativity and

critical thinking that *Engineering Social Justice* is able to flourish. Incorporating these skills into engineering education and training has the potential for improving learner abstract thinking when they encounter issues that connect engineering and human experience. *Engineering Social Justice* in education has a promising prospective and room for growth. The following addresses the potential revised engineering process.

Table 4 gives a simple overview of the elements that need to be in place for an engineer to achieve results that are socially just in the project product (deliverable). The engineering process described here is the traditional engineering process integrated with social justice consideration.

Prior to beginning a project, the engineer must have the required skill set. This is achieved through initial training and lifelong learning in order to maintain currency. It is necessary to pay careful attention to the big picture and watch for problems. Before starting, the project specification must be in place and it should include social justice. The engineer should be responsible for organizational requirements or seek to change them. If they are not met, an otherwise excellent solution may be discarded. Continual assessment or testing should occur to evaluate how everything is proceeding. The ideal situation would be to have integrated specification that includes social justice and engineering product requirements. Unfortunately, most often today they are separated and the social justice component is given minimal consideration or overlooked and left by the wayside.

Table 4. Engineering element for social justice success

Project Starting Point Elements	Engineering Care	Engineering Result
• Engineering Skill • Attention • Requirements • Responsible • Specification • Plan for Testing	• Others • World • Self	• Socially Just • Meets Requirements

Based on training and confirmed by his professional graduates, the author has found that excellent communication skill is a necessity for most engineers to be successful. Communication is the act of sharing information. In its ideal form, good communication can be seen as the accurate relay of information with as little information lost (or inappropriately added) during transmission. This ideal form of lossless communication can be seen in computer transmission, as most information is retained. Problems can occur with human communication because learning means that information is reworked into knowledge. Because knowledge is susceptible to the interpretations of a person based on understanding of the world, the information passed from one individual to another through communication is susceptible to change based on thoughts of those involved. In addition to the interpretation of communication, information can also be lost or transformed at the point at which it is spoken, signed, or written, and information can be lost at the point of listening, looking, or reading. Thus human communication is not certain to be an accurate transmission of information. However, in engineering, good communication could be seen to be the transmission and interpretation of knowledge that most accurately reflects original information and the desired interpretation of the communicator.

One practice for improving communication abilities that is used in engineering training is a daily journaling assignment. In this practice, engineering learners journal each day with a record of activities, comments, and/or concerns. In professional practice, this daily journaling is mandated for many engineers that are involved with product development that involves human safety. Precise descriptions and details are valued as they guide the reader through critical information needed to fully understand the engineering complexities. Creating a journal alone is not adequate but does provide a record of what has been accomplished. Oral communication with others and reports, must also be used with the aid

of the journal, as needed. Good communication will only happen if it is multidirectional and done proactively and not waiting until the situation is less than desirable. It should be remembered that a communication failure is not always a problem created by the speaker or the listener alone but can be a problem on the part of both. Communication is important in order to realize better results. For example, if someone does not bring to the consideration of others an improved solution, it will never be realized.

There are countless possibilities for steps to be taken by an engineer for a project with one possible set given in Table 5. The table assumes the engineer was given a specification for the solution and a general anticipated product result. For success, the complete set of elements on the left of Table 5 needs to be clearly understood and everything must be integrated. As the engineer proceeds, steps should include understanding of the highest level of engineering development. This means that effort should include identifying the need, mentally analyzing the need, formulating the desired result, analyzing cost and likelihood of successful solution, and planning for production.

Table 5. Example of some basic steps in an Engineering Social Justice project

Step	Details of Steps
Step 1: Find Need	Understand project / product need – this could include initial meetings with clientele.
Step 2: Understand Project	Develop basic understanding of the project.
Step 3: Contract	If working with clientele, set contract for the project and include a provision for the inclusion of accessible and sustainable solutions.
Step 4: Design	Develop designs and calculations for a project based on requirements, accessibility, sustainability, and costs.
Step 5: Communicate	Communicate the design to appropriate stakeholders and consumers.
Step 6: Production	Plan for and carryout production.

Whenever possible, it would be best that engineers brainstorm and consider several options that meet specifications for the deliverable product and then evaluate; even rank based on social justice impact.

Table 5 lists a number of things that have to come together in an accurate and coordinated fashion. It has a draft list of project starting elements on the left side of Table 5 with the possible need for the addition of more depending on the project. Depending on the project, this list might include working in a team and may include other elements. Now that the reader has been introduced to the traditional steps of the engineering process, the authors will propose Table 6 that provides a list of some possible sub-steps for step 4 of Table 5

- **Sub-Step 4.1 - Evaluate:** First address the engineering result by considering whether or not a solution that meets the requirements will be socially just. There are no standards for meeting social justice requirements. So what constitutes meeting the engineering requirements and is socially just will vary from project to project. There are three possibilities. At this point, it should be noted that for a complex result there might be social justice problems

Table 6. Sub-steps of design (step 4) for Engineering Social Justice

Sub-Step	Details of Sub-Steps
Sub-Step 4.1: Evaluate	Evaluate if solutions meet accessibility and sustainability needed for social justice to be achieved.
Sub-Step 4.2: Envision	Envision accessible and sustainable solutions through reasoning, creativity, and collaboration
Sub-Step 4.3: Implement	Move to implementation when solutions are determined to meet accessibility and sustainability needs.
Sub-Step 4.4: Re-Evaluate	Continuously re-evaluate solutions as implementation of design and project have moved to production. This re-evaluation should look at both the production of the product and the product itself.

that will be encountered at a later time and the following scenarios may need to be addressed. Seeking external input from possible stakeholders and those who potentially could be marginalized or unintentionally impacted by the product design can aid in a critical evaluation of the product.

- **Scenario 1:** Based on the evaluation of the design, the project result is anticipated to be socially just. If the design is evaluated to meet accessibility and sustainability needs, then the project can move to sub-step 4.3.
- **Scenario 2:** Based on the evaluation of the design, the project result is anticipated to *not* be socially just. However, there is potential that the design could be modified to be accessible and sustainable. In this scenario, the project would move to sub-step 4.2
- **Scenario 3:** Based on the evaluation of the design, it is anticipated that a socially just end result cannot be obtained within the specifications. In this case, it would be desirable to work toward a modification of the specifications in the contract that would allow the end solution to be socially just.

It is possible that significant effort may be needed to make social justice evaluations in each of these cases The conclusions of the evaluations are subject to error, as are engineering conclusions, and may require adjustments later.

- **Sub-Step 4.2 - Envision:** In this sub-step, engineers envision solutions that will make a project design accessible and sustainable. The process of seeking solutions could include reasoning, creativity, and collaboration. Simple reasoning could reveal solutions that were not previously identified. An engineer may also engage in creative thinking that diverges from industry norms. An engineer working on her/his own may also seek out collaborative support in this effort. An engineer can communicate the plans of the project to colleagues, key stakeholders, or stakeholders and seek their feedback. An engineer with a group of colleagues or an engineering team can use activities such as free-flow brainstorming to creatively look for solutions. Having a diverse group participating in the envisioning of solutions can provide strength to the outcome.
- **Sub-Step 4.3 - Implement:** Once the engineer has an accessible and sustainable plan following the prior sub-steps, then the project can proceed to the implementation of the socially just product.
- **Sub-Step 4.4 – Re-Evaluate:** As additional steps are taken in this process, it would be important to follow the guidance of Table 7 and regularly re-evaluate the production and product to assure implementation is yielding quality, accessibility, and sustainability.

The following table presents the logic model of product design. This is a generalization with specific project dependent needed for each unique project.

EDUCATION AND TRAINING TO INCLUDE SOCIAL JUSTICE

Background

The incorporation of social justice culture within engineering culture could be an important and pioneering effort that can be largely accomplished through education. There is movement to make engineering education more inclusive by: a) ensuring all groups have a path to becoming

*Table 7. Logic model of product design with Engineering Social Justice **

Inputs	Activity	Implementation Objective	Outputs
Project Specifics • Project Requirements • Project Leeway • Stakeholder Demands **Engineer Cognitive Attributes** • Engineering Skill • Project-Specific Knowledge • *Engineering Social Justice* Knowledge **Engineer Affective Attributes** • Empathy • Care for Others, the World, and Self • Motivation • Social Skill **Resources** • Money • Labor • Supplies	[Specific activities are dependent on the project] **Design and Calculation** based on: • Project Requirements • Access • Sustainability • Stakeholder Demands **Communications of Design and Calculation Presentations**	To meet the requirements of the project To satisfy stakeholder demands To ensure the product is accessible and sustainable	Project requirements and stakeholder demands are met Solutions to problems of accessibility and sustainability are found Design is completed Designs, including those for accessibility and sustainability are included in the product development Product is completed and made accessible through sustainable means

*Note: Outcomes are project specific

an engineer (making sure k-12 schools provide necessary pre-requisites); and b) inspiring learners of different groups to enter engineering. The education programs should be carefully analyzed in order to make it an important and fun experience. Course transformation planning and implementation should consider Universal Design for Learning (UDL) principles as detailed in the chapter, "Access within the Classroom through Universal Design for Learning and Key Learning Elements." UDL represents a family of principles and strategies that can boost the learning environment for both instructors and learners. As with any change, a good UDL implementation allows learning to be fun without sacrificing academic rigor. Learners may achieve the *Engineering Social Justice* learning outcomes through classroom preparation and activities outside the classroom, such as service learning (defined below) in the community or globally. Specifics regarding learning outcomes will vary from one engineering discipline to another and with the specialization within a given discipline but there will be commonalities between them. Social justice learning outcomes will be included in the "*Engineering Social Justice* Education and Training Examples" section.

The Computer Science Department at California Polytechnic State University, San Luis Obispo, specifically states, "The Computer Science Department educates students in the disciplines of computer science and software engineering, and teaches them to apply their education to solve practical problems in a socially responsible way." The social responsibility learning outcome is a requirement for accreditation. The *Accreditation Board for Engineering and Technology* (ABET) requires all engineering programs to achieve the "professional responsibility" learning outcome for these two programs. Required then is an assessment of this outcome at the course(s) and program level. This requires the department to prepare the students to practice *Engineering Social Justice.*

Usually, the greatest impact on learners can be better achieved if the learning outcome and the implementation of the process for achieving it can be made exciting to them and/or is required by law. Sustainable engineering is one such area because there are an increasing number of laws for sustainable requirements to be met. Also, it does create excitement if it is shown that the sustainable product will cause a product to purchased by more customers. Learners and professional engineers like to see their product used as much as possible.

Good accessible and sustainable design will typically increase the number of products purchased. This can motivate individuals to become excited about *Engineering Social Justice*. The *Engineering Social Justice* Education and Training Examples section will provide more details.

The engineering learner should be asked to work on projects that require the deliverable solution to meet engineering specifications integrated with social justice requirements. The typical "engineering" project has often been seen as one that follows a formulaic approach to the solution void of social justice considerations. One criticism of historical engineering courses is that they focused on preparing people to be compliant only with given engineering constraints. Often, engineers criticize social justice courses as being too theoretical. Integrating social justice learning outcomes with engineering learning outcomes in a single course should help to overcome this concerns. If an engineer and social justice expert worked together to design and implement the learning experience, the result should be an improvement over each working on the implementation separately. This recommends that engineering problems be solved to meet the integration of engineering and social justice considerations. The engineering learners should become aware that typically a mathematical formula will not be used to realize a unique social justice solution. In a complex project, a single "best" software solution typically does not exist. The learner will traverse a series of engineering stages and meet the engineering specifications and social justice requirement but will not be able to show that it is superior to all other possible solutions.

As a part of *Engineering Social Justice* education, the engineer should be prepared to deal with practical issues when dealing with the solution for another culture. The engineer should know everything about what is best for the recipient or have the assistance of someone who does. Success with this will improve accessibility. The social justice engineers of the future must be innovative and prepared for the global impact they can achieve by understanding other cultures or be able to work collaboratively with those who do. This means that they need to be aware of the significant professional impact that can be achieved by an engineer or team of engineers and the responsibility that this creates.

In order to improve their understanding of the *Engineering Social Justice requirements*, engineers should learn how to collaborate with community or global partners who are involved in the realization of social justice. This can be an exciting and rewarding experience in an innovative activity. It will provide an opportunity for the engineer to develop skills to team with others beyond engineer professionals to develop improved solutions. The projects presented below provide examples of how learners may be given an opportunity to work in these environments. Service learning is a teaching practice that integrates service to outside organizations, usually through community partners, within a course(s). This should include individual consideration and critical thinking with learning about working with outside partners, civic engagement, and responsibility to society. Some possibilities for service learning would involve learners with social justice global organization such as (Engineers Without Borders. (2013)); (Engineering, Social Justice, and Peace (2013)); (Engineers Against Poverty (2013)); and Engineers for a Sustainable World (2013)). Also, there are local community partners who will work with students.

An example of a social justice achievement of a student of the author is the Apple Mac dock that made the Mac computer more accessible to a more diverse set of users resulting in improved social justice but not complete accessibility to all. Some of the software developed today allows the user to choose the language that they want to use. As technology improves the engineer should seek to spread the umbrella of accessibility as far as possible.

Building Learning Transfer into Curriculum

The term *learning transfer* has two fundamental meanings (Barnett and Ceci 2002). First the term can used to describe the degree to which an individual uses knowledge they have gained in one context in a different context. For example, a child may learn to transfer the knowledge of addition (1+2=3) from the classroom onto the playground (1 pebble + 2 pebbles = 3 pebbles). The other property of *learning transfer* is the degree to which one type of knowledge or cognitive process can be stretched into a different type of knowledge or cognitive process. For example, it was previously believed by educational policy-makers that learning Latin would increase the general cognitive abilities of learners across subject matter. In order to achieve transfer, varying contexts, knowledge, and cognitive processes should be encouraged regularly throughout the curriculum. In other words, instructors should encourage learners to think in different ways and with different contexts. In order to do this well, it is important to have an understanding of the engineer. For those educating learners or training professional engineers, it is valuable to be able to understand who the learners or trainees are at a given time and who they could become. This all will change from time to time within a given course and certainly from the time they are seen in one course until they are seen in the next course. Learning is the change of ideas and thoughts of an individual based on the introduction of new information or knowledge. People are constantly learning and learning can be focused and accelerated in schools.

Engineering Social Justice Education and Training Examples

This section of the chapter describes general examples of social justice educational activities for engineering learners. It is intended that these experiences would result in integrated engineering and social justice learning outcomes. This means that each of these examples is meant to result in simultaneous solving of both the engineering problem and achieving social justice in the solution of the problem. This is aimed toward a long-term impact in which social justice is seamlessly integrated into the engineering work environment and product design. The concepts of *Engineering Social Justice* should underlie these efforts.

Specific guidance is provided in these instructional examples. However, there are indefinite possibilities in the ways that these examples could be implemented. Modifications can and should be made based on special circumstances of a class and the interests or expertise of the faculty member. Additionally, the instructional examples presented are meant to provide the basic form and concept of the instruction and thus, there is much more that could be added to each lesson.

The types of activities in these examples will typically take multiple weeks. Since multiple weeks can take up a large portion of the course, it may be beneficial to monitor the degree to which the lessons are going as planned. This monitoring could focus on the instructional processes, learner progress, or student learning. Monitoring of instructional processes is an instructor self-monitoring of the curriculum and the degree to which activities and content has been on task. Monitoring learner progress is an instructor looking at the degree to which learners are completing work, activities, or assignments. Monitoring student learning is assessing the degree to which learners are learning the content. If an activity takes multiple weeks, a practice of monitoring of learner progress is to have the learners submit deliverables (partial solutions) at multiple stages. A practice of monitoring student learning is to give assessments of student learning. These practices are just a couple of examples on how to determine whether or not they are successfully proceeding toward successful completion. Other specific examples include periodic conversations with the class, surveys, and quizzes. This paragraph is based on the author's experience and some teaching and learning resources (Baillie, & Catalano, 2009;

Catalano, & Baille, 2006; National Academy of Engineering, 2010; Riley, 2008).

For all of the examples that follow and depending on the background of the learners and where they should be in their learning, it may be beneficial to provide scaffolding for the learners. Educational scaffolding is analogous to the scaffolding that is used to allow construction workers to reach a higher level than the level that may be reached from the ground. Scaffolding will provide a supplementary student learning opportunity that will bring them to the appropriate level when they start the learning module. This may include definitions and assumptions that learners are expected to use.

Education Example 1: Intellectual Property Activity

For engineers, intellectual property is that which is a result of individual or collaborative work, such as a design, a product, or a manuscript. This work may include completely independent thinking but often it is built on the historical effort of others in the field. When new intellectual property has been formed and is based on creative ideas and efforts, engineers may apply for a copyright or a patent. Issues of intellectual property rights (patents and copyrighted material) are related to social justice. This is important in education because students may face intellectual property issues in their careers. The educational consideration can create a lot of enthusiasm in a debate.

Most people believe that a person should have the right to develop and take use of one's own intellectual property. Sometimes people disagree about extent to which this intellectual property may be used by the owner. Social justice includes the potential of all to be involved in the development of such results and the use of the product (access) resulting from the intellectual property. This could be a valuable experience for learners in any engineering discipline and possibly any discipline because copyright and/or patents are relevant to them. For example, is it just that an individual collect a large sum of money for developing a patented idea that took less than a year to develop with the only out of pocket expense being securing the patent? In this case, there is a question of accessibility for the general public (product cost is too great). Sustainability may be a discussion topic as well. Possible topics include:

- The right of the person to develop and take advantage of his/her intellectual property with specific parameters provided for this.
- The right of all to be involved in the results and the use of the product (access) from the intellectual property with specifics as to what this means defined in the project definition.
- In order to achieve social justice, the idea that there should be equality in access to the product created by the intellectual property with possibility of the term "equality" given a lot of breadth in meaning. The issue here is how the creator (owner) of the intellectual property and the general public will be treated in a just manner. In some cases, the developer of a product may have spent significant time and/or money developing the product and deserves some financial reward with an example being an Apple iPhone. There are software products, such as Linux, that have been developed and distributed without charge.

Possibilities for the activity include the following. More detailed guidelines should be provided as needed in order to make it well defined.

- A debate between two individuals. This could be based on instructor supplied material, learner research or a combination of both.
- A debate between two teams of individuals. This could be based on instructor supplied material, learner research or a combination of both.

- A research report by all individuals in the class.
- A research report by teams in the class.

Before any of the previous activities are carried out, the learners might perform a laboratory exercise that demonstrates how an intellectual property product is created (such as the creation of all or part of the iPhone). Components that may be addressed include such things as software, memory, process, screen layout, user interface, container, and battery. Because many iPhone components are intellectual property, it will not be possible to look at all details of the iPhone but significant information about the iPhone is available in documents created by the IFIXIT (IFIXIT, 2013).

Depending on the details of the above activities, the potential learning outcomes include new or increased skills in the following areas.

- Research skills
- Ability to be involved in enabling social justice in one's future work by being able to make good choices regarding social justice.
- Understanding of the life cycle of a product. Consideration of the life cycle is important because this may determine whether or not it is a good sustainable product. If the life cycle is too short and/or major repairs are anticipated, low income people may not find it cost effective and as a result accessibility will be limited.

Education Example 2: Bring the Experience of a Learner with an Outside Social Justice Organization, Such as Engineers without Borders (EWB) into the Classroom

The EWB Web site defines its strategic plan as "The MISSION of EWB-USA is to support community-driven development programs worldwide by collaborating with local partners to design and implement sustainable engineering projects, while creating transformative experiences and responsible leaders. Our core values: Integrity, service, collaboration, ingenuity, leadership and safety."

Suppose a learner in the class was involved with an EWB project that developed a solar energy generator for a community. This could be a valuable experience for learners in any engineering discipline and possibly many other disciplines because EWB and similar organizations require the experience of individuals trained in non-engineering disciplines to complete their project(s) successfully. The following are possible activities that could involve the class.

1. Ask the learners of the class to review the EWB Web site. Ask the class to develop questions that they would like the all learners to answer. Give the learner appropriate questions along with instructor developed additional ones such as the following and ask the learner to report back to the class:
   a. Did the project stages follow good engineering principles?
   b. Did the solution include everyone in the community equally?
   c. Did the solution fail to take into consideration important engineering principles that are relevant to achieve social justice?
   d. Is the solution one that will continue to function for an indefinite amount of time? Consideration of the time of functionality is important because this may determine whether or not it is worth the effort.
   e. Is this solution scalable to a large number of communities?
   f. Would this solution be appropriate?
2. Do the same thing as #1, but have the learner work with a team of other learners.
3. If there was a written project report, have individual learners or teams of learners in the class work on the answers to the questions to the best of their ability. A part of

this particular project could include a learner critique of the project report.

4. Another project could be to have the learners compare the EWB organization to other such organizations. The elements to be compared may be provided in the project definition or be defined by the learners as a part of the project. The experienced learner could be involved by having that person evaluate the conclusions that others are drawing regarding EWB.

Depending on the details of the above activities, the potential learning outcomes include new or increased skills in the following areas.

- Research skills
- Ability to be involved in enabling social justice in their future work by being able to make good choices regarding social justice.
- Understanding importance of the life cycle of a product.
- Gain expertise regarding these engineering related organizations that perform social justice outreach.

In this case, scaffolding would include definitions and assumptions that are expected, laws governing such organization, a list and short description of some organizations like EWB, and background information about EWB.

Education Example 3: Use a Cartoon or Fictitious Scenario to Incorporate the Concept of Justice as a Learning Outcome and Extend it to Social Justice

An excellent one that will be discussed here is a Dilbert cartoon (Adams, (2010)).

If the learners have not had a learning experience regarding social justice or very little experience, an exercise of this nature may be an excellent starting point before going on to the more complex concept of social justice. This example provides experience with: a) Accessibility. If the potential user knows about the warranty, he/she will choose not to use the product; and b) Sustainability: 1) Will there be waste because products can't be maintained; and 2) Does it fail even if maintained causing waste. The cartoon is just one of many possibilities for an exercise of this type. Asking learners to reflect on a project or product specific to their discipline is important in the personalization of the exercise. For example, in computer science the product might be the memory of the computer, cell phone, or another type of electronic device. Some of the possible activities that can be used for the facilitation of critical thinking could include:

- Have individuals or teams write a report regarding this cartoon and specifically have it address why the maintenance requirement proposed by the boss will create social injustice. It would be appropriate to give them clear specifications regarding the breadth of the report.
- Have individuals or teams debate:
  - This is just to have such a maintenance requirement.
  - It is not the responsibility of the employee if this is required by the boss, as in this case.
- Have individuals or teams write a report and/or give a presentation to the class regarding the approach they would take to remedy this unjust approach to product marketing.
- Once the learners understand the concept of justice, ask them to consider a person who can not read the warranty statement of this cartoon with understanding and ask to write a report or present to the class as individuals or in teams to determine why the approach of this cartoon is not socially just for the class of individuals who can not

read with understanding. Also, it would be good to have the report extended to illustrate why it is a socially unjust approach in other ways.
- Ask the learners as individuals or in teams to write a report or present to the class regarding a non-maintenance product issue that would create a social injustice.

Depending on the details of the above activities, the potential learning outcomes include new or increased skills in the following areas.

- Research skills
- Ability to be involved in enabling social justice in their future work by being able to make good choices regarding social justice.
- Understanding importance of the life cycle of a product.
- Learn about the general concept of justice and its connection with social justice.

In this case, scaffolding would include an additional background needed to get the learners on track regarding ethical behavior.

Education Example 4: Review the Status of an Engineering Effort

For this example, the status of Internet coverage and quality is being used in this example and the current high quality Internet access availability throughout the world (Submarine Cable Map, (2013)) would be the basis for the learner exercise. The bottom line is that the picture should indicate that "high quality" Internet service (broadband) is provided for a subset of the citizens of the world. The social justice issue here is equitable accessibility. This picture will vary through time, although that would not be absolutely necessary if social justice is the most important issue and currency of the figure is not important. For this example the most extensive learning would likely occur if the learners were advanced computer science/computer engineering learners and had a fair amount of knowledge of computer networks, but there are potential exercises that merely required knowledge of networks and have used the cell phone data resources or computer browsers, email, or computer network resources. Possible activities include:

- **Prepare a Report:** Without discussing computer technology, have the learners, individually or in teams, prepare written reports or report orally to the class regarding the issue of social justice when some people have inferior or no network access. Part of this exercise might be to ask them to research the network access quality in some specific location and ask them to evaluate what that means in their lives.
- Learners with an adequate background in computer science, could address the same issue as given in the previous exercise, but with the added responsibility of finding a socially just solution for everyone in a particular region of the world that does not have high quality network access available. In this case, it would be appropriate to consider such things as cost and those solutions that would enable persons who do not have the technical support of our experts in stores to successfully use the product. Another project might be to research what an organization like EWB is doing to eliminate this problem.

Depending on the details of the above activities, the potential learning outcomes include new or increased skills in the following areas.

- Research skills
- Ability to be involved in enabling social justice in future work by making good choices regarding social justice.
- Understanding the importance of the life cycle of a product.

- Gain expertise about the differences in quality of resources available in different parts of the world.
- Exposure to a "real-world" global case to study.

In this case, scaffolding would include the additional background needed to give them some assistance in finding research resources related to this exercise.

Education Example 5

Planning the design and evaluation of product sustainability. In this education/training effort, learners learn to design a product with sustainability in mind. This could be a real project or a hypothetical project. It could be a single lesson/assignment or could be built into every project in a department. A department-wide initiative would require buy-in on the part of faculty. The point of this effort is for learners to consider sustainability of products resulting from their project.

Key issues that learners could be encouraged to explore are:

- Production
- Consumption
- Company Acceptance
- Procedures for Evaluation

While these issues are fundamental sustainability issues, they might not be relevant for every field of engineering or every project that learners work on. For example, computer programmers might not need to consider production in all of their projects, since programming uses minimal resources. Other departments or projects may need to consider additional sustainability issues. So, these issues provide a general framework for curriculum design, but the learning module is not fixed or restricted to just these issues. These issues can be integrated into the curriculum in ways that learners can naturally engage. As learners are working on a project, question prompts can be used for project planning, project reports, and project presentations. The following are some questions that could be used as prompts:

- In what ways might product production deplete natural resources? Is there a renewable resource solution?
- Could the production be conceptualized in a way that would minimize the depletion of natural resources?
- How might production be planned in a way that reduces the risks to workers?
- How might the use of the product deplete resources?
- How could the product be designed in a way that would reduce the risk of consumer harm?

Learners will need to also consider how others in a company will view efforts of sustainability. For example, there may be opposition to product sustainability because it would hurt the bottom line of the company. Therefore, engineers who want to create sustainable products must be able to communicate the benefits of designing and producing with sustainability. Maybe it will help the bottom line in the long run because users want sustainable products and will pay more for such a product. These questions should help learners begin to think about this type of communication:

- How might you convince others in the company that the reduction of resource depletion is important?
- Is there a way to design the product that would both reduce resource depletion and reduce product costs?
- How might you convince others in the company that building a longer lasting product is good business even if it means consumers are buying fewer products?

- How might the consideration of sustainability in the design of the product be more cost-effective than waiting until after production has started?

By integrating issues of sustainability into the curriculum, learners should learn to naturally think critically about these issues. And if they are embedded in multiple projects throughout the curriculum, it is hoped that learners will learn to consider sustainability on projects they encounter far into the future.

The examples of this section illustrate how *Engineering Social Justice* may be included in the curriculum in courses. Another resource for material might be newer university programs that provide examples of what might be done including the "Engineering Scholars=Engaged Scholars (ES)2" (University of California Berkeley (2013)) that was launched in the fall of 2013.

FUTURE RESEARCH DIRECTIONS

It is stated that in regard to science currently, "modern scientists are doing too much trusting and not enough verifying – to the detriment of the whole of science, and of humanity" (Economist, 2013). Although engineering is a field separate from science, the engineer uses scientific principles in the development of new theories, products, and decisions (Economist, 2013). At the time of the writing of this chapter, there is minimal published research regarding the successful educational preparation of engineers to engineer with social justice. This is an excellent area of opportunity to perform successful research and provide supportive educational methodologies for those who will be preparing the engineers of the future. Those who want to be engaged in an innovative opportunity should find this exciting.

CONCLUSION

Engineering Social Justice has a strong possibility of taking hold as part of the engineering culture. Understanding accessibility and sustainability and being able to include them in an engineering design and implementation process is a key to achieving social justice. It is the benevolence and work ethic that engineers tend to have and translate into their projects that makes an *Engineering Social Justice* culture a strong possibility. Some of the difficulties that must be faced in order to accomplish this have been: a) the historical shortfall of engineering education and training to focus on a narrow set of engineering learning outcomes that does not include social justice; b) the tendency to ignore creativity and punish failed creativity; c) scientific and engineering learning achievement is given greater value than other human-centered and inventive outcomes; d) in some universities and training programs there are roadblocks to achieving the Engineering Social Justice learning outcomes; and e) achievement of social justice often does not have a simple solution. An innovative and creative approach to realization of excellent social justice in engineering processes is needed and the educational approach will be challenging. As educators embark on these ground breaking trails to include these social justice learning outcomes, they need to be given assurances that they will be rewarded for these efforts and not punished if there are instructional missteps. Instructional missteps may include: a) The faculty is dissatisfied with what has occurred; b) Students are disgruntled; c) A required learning outcome of the course is not occurring; and/or d) Peer faculty members are unhappy with the outcome of the revised course. There is much to be done in creating a good path for engineers to follow or to be successful in *Engineering Social Justice.* There should be many opportunities for research and grants in developing paths to instructional

success. The educational process is analogous to raising a garden. Just as a garden may have unexpected and unplanned gardening needs, a good instructor cannot always follow a formula in the recognition of difficulties but needs developed skills and innovative intuitive awareness. Thus, developing social justice engineering requires engineers and engineering instructors and mentors to be critical and creative thinkers.

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KEY TERMS AND DEFINITIONS

Engineering Social Justice Education and Training: Process of educating an engineer that results in integrated engineering and social justice learning outcomes.

Engineering Social Justice: Social justice through the efforts of engineers focused on accessibility and sustainability.

Product Accessibility: The ability to functionally acquire a product and the ability to use a product.

Product Sustainability: The creation of products in a manner that realizes production sustainability and consumption sustainability.

Service Learning: A teaching practice that integrates service to outside organizations, usually through community partners, within a course(s).

Social Justice: An action-oriented goal of making the world's resources more equally accessible, and distributed to all individuals while keeping production and use of resources sustainable.

Sustainability: Production and product use that does not excessively deplete resources or harm of the environment.