"Science and Technology in Popular Culture": The Influence of Politics, Entertainment, and Societal Norms on Engineering Education

Bryn Seabrook
University of Virginia

Abstract

The field of Science, Technology, and Society (STS) draws from a full range of disciplines in the social sciences and humanities to examine how science and technology simultaneously shape and are shaped by society, including politics and culture. Some engineering programs have turned to STS to provide students with conceptual tool kits they can use to think about engineering problems and solutions in more sophisticated ways. This study underscores the importance of the nontechnical engineering skills learned through STS education, investigating how a new course titled *Science and Technology in Popular Culture* examines the influence of popular culture on the work of scientists and engineers. The author builds on previous scholarship to demonstrate how a discussion-based course can challenge undergraduate engineering students to think more critically about the integration of the social dimensions of engineering problems into the engineering design process.

Keywords

Science, technology, and society
Diversity, equity, and inclusion
Undergraduate instruction
Popular culture

The Need for Nontechnical Engineering Courses

Current engineering students are asking for spaces where they can freely discuss and understand the nontechnical influences of their profession. At the end of a previous course, for example, one student commented, "There has been no instance where I have talked about race in a serious in-depth discussion in any of my engineering classes. Consequently, I can infer that none of my peers have, either. Nevertheless, the conversation has to be pushed if we're going to get better at making ethical decisions around race." Within the traditional engineering curriculum, nontechnical discussions are brief, if they exist at all. A 1955 report from the American Society for Engineering Education, commonly referred to as the Grinter Report, is still a foundational document for engineering education despite its outdated jargon and approaches, as a recent article by Sheryl Sorby, Norman L. Fortenberry, and Gary Bertoline in *Issues in Science and Technology* shows. The authors stress the need for a revolution in engineering education: "Over the years, we educators have done some tinkering around the edges, such as adding in a capstone design project, or replacing Fortran with other programming languages—

but the basic structure of the curriculum remains unchanged even though our students can now find information on their phones that might have taken us hours to track down in the library."[1] The need for technical training for engineering students is clear, but creating well-rounded engineers requires educators to go far beyond the purely technical. Engineering education curricula need to incorporate opportunities for students to effectively confront, discuss, and understand today's rapidly changing society.

Approaches to Introducing Nontechnical Discussions

There are many ways to engage engineering students in problem solving skills relevant to current curricula. Engineering educators could use a case study approach to analyze and rectify biases embedded in engineering products, using examples such as the well-known case of racist soap dispensers. This case describes how at a Marriott hotel in Atlanta, Georgia, guests of the Dragon Con sci-fi and fantasy convention discovered an issue with an automatic soap dispenser. An African American guest was not able to activate the sensor with his hand, while a white guest was able to use the dispenser without any delay. British company Technical Concepts designed this soap dispenser using an infrared detection system. Users with lighter skin tones reflect an infrared signal back into the sensor, signaling the dispenser to release soap. However, users with darker skin tones absorb the infrared signal instead of reflecting it, effectively eliminating these users' ability to get soap from the dispenser.[2] This flaw in the design of the soap dispenser and the failure of designers to take into account the well-documented correlation between skin tone and reflexivity demonstrates the importance of a holistic approach to engineering and the consideration of different kinds of users. This case study generates a discussion of how technology is often implemented without an understanding of how it works, or might not work, for a diverse group of test subjects.

The field of Science, Technology, and Society (STS) addresses these missing discussions and the lack of nontechnical skills in engineering education. STS draws from a full range of disciplines in the social sciences and humanities to examine how science and technology simultaneously shape and are shaped by society, including politics and culture. The nontechnical approaches offered by STS provide engineering students with conceptual tools to think about engineering problems and solutions in more sophisticated ways. However, there is no universal standard for how these skills are incorporated into engineering curricula. As Seabrook et. al describe in *Teaching STS to Engineers: A Comparative Study of Embedded STS Programs*, "Some programs feature standalone courses from outside the engineering school. Others incorporate STS material into traditional engineering courses, e.g., by making ethical or societal impact assessments part of a capstone project."[3] These mixed approaches indicate the scattershot approach to STS education taken by various engineering programs. Despite the ability of STS courses to enhance ABET accreditation, only a small percentage of engineering programs embed these departments within engineering schools. A more standardized approach to STS education could benefit engineering educators and better prepare engineering students for the nontechnical problems they will face in their careers.

One institution that has an STS department embedded within its school of engineering is The University of Virginia. The mission of the School of Engineering and Applied Science

(SEAS) at the University of Virginia "is to make the world a better place by creating and disseminating knowledge and by preparing engineering leaders to solve global challenges."[4] The STS department plays an essential role in achieving the mission of SEAS by providing four courses—required for all engineering students—that address the dynamic interplay of technology and society. The first course in this sequence is *STS 1500: Great Inventions that Changed the World*, required during the first year in the engineering program. The second course is an STS 2000 or STS 3000 level course that engages engineering students in deeper examinations of the social and ethical issues of science and technology. These courses offer a variety of topics, such as the evolution of the iPhone or Thomas Jefferson's scientific interests, to improve students' grasp of how contextual factors shape science and technology. The third and fourth courses, *STS 4500: STS and Engineering Practice* and *STS 4600: The Engineer, Ethics, & Professional Responsibility*, are dedicated to creating a prospectus and writing an STS research paper included in the undergraduate thesis portfolio. The overall goal of this four-course sequence is to integrate the contributions of the humanities and social sciences in general, and STS in particular, into the engineering curriculum to promote student understanding of the sociotechnical systems that practicing engineers help create and manage.

STS 2500: Science & Technology in Popular Culture

One of the STS 2000 level courses offered by SEAS is *STS 2500: Science & Technology in Popular Culture*. The course description articulates that popular culture is shared culture. Shared culture is created around campfires, in libraries, in movie theaters, at comic book conventions, and wherever people gather to contemplate a common understanding of our history, our present, and our future. Inspired by Gary Downey's concept of dominant images, this course explores how works of culture, stories, and images reflect shared beliefs and examines how those beliefs influence the work of scientists and engineers. Downey defines a dominant image as "an image whose acceptance has scaled up sufficiently across a specific population to become given, or true, for that population."[5] Images in popular culture reflect not only what other people think of engineers, but also what images engineers have of themselves. What happens if engineering students take seriously the proposition that the persistence of these images reveals collective attitudes and popular perceptions surrounding science and its practitioners? Some of the questions in this class include: How do representations of scientists and engineers change over time? What patterns emerge? What effect do popular representations have on the working lives of scientists, engineers, or policy makers? Are there ways to influence popular perceptions to benefit the goals of science and engineering?

Course Goals

The discipline of Science, Technology, and Society combines the methodologies of diverse scholars to understand the interactions between people and their environment—the places, artifacts, and processes that shape their lives. This analysis explores the complex ways humans both deploy the tools of scientific knowledge and technology to shape the world, and distill certain lessons from the past and present to provide a better understanding of the ways these powerful tools can be used to moral, productive human ends. The lessons considered in this course include:

- Technologies are not just "things," but rather goal-oriented human activities.
- Technology is always good, or always bad, but it is never neutral. As such, technology should be used deliberately, and not just because it can be used at all.
- Engineers should integrate social and ethical considerations into the process of problem definition, problem solving, and technological innovation.

After taking STS 2500, engineering students should be able to critically examine the relationship between technology and society, objectively analyze problems of how science and technology are portrayed in popular culture, and confront a deeper level of understanding about their own relationships to science and technology. These goals are fulfilled through the following objectives: collaborating and communicating with colleagues across other engineering disciplines to explore engineering problems relating to science and technology in popular culture; reflecting on how the social dimensions of engineering problems are integrated into the engineering design process; and comparing real-world examples of challenges and changes in relation to science and technology in popular culture.

Assessments

The assessments for STS 2500 fall into three categories: participation, written skills, and oral presentation skills. Combining these assessment methods allows the students to demonstrate their analytical strengths in a variety of ways. The purpose of these assessments is to encourage a growth mindset. Incorporating ungraded opportunities for students to struggle with difficult concepts without the fear of a stigmatizing grade encourages growth over the course of the semester. Many engineering students feel that they are not capable of effectively communicating their ideas outside of a technical setting, especially in written assignments. However, these skills are a desirable hiring trait. Some of the writing opportunities in STS 2500 designed to build these skills include discussion posts (generating original posts as well as responding to their classmates), review essays, and a written description of their group presentation. Nontechnical discussion-based classes like STS 2500 are essential in preparing engineering students for careers by strengthening their analytical thinking and writing skills.

Placing Nontechnical Skills in Context

One STS concept useful for analyzing *Science and Technology in Popular Culture* is the Social Construction of Technology (SCOT) framework. The SCOT framework encapsulates the sociotechnical processes that drive technological change by considering system stakeholders and influences as interacting entities.[6] Originally introduced by British sociologist Trevor Pinch and Dutch philosopher Wiebe Bijker, SCOT outlines four main components that can help organize this analysis: interpretive flexibility, relevant social group, closure and stabilization, and wider context. By viewing STS 2500 through this lens, educators can analyze the benefits and risks of nontechnical engineering courses and consider recommendations to improve engineering curricula.

One of the issues that complicates an analysis of engineering curricula, aside from the fact that relatively few STS programs exist, is that there is no standardization for embedding existing or new STS departments within engineering schools. This lack of standardization presents a wicked problem of the kind outlined by Rittel and Webber. Rittel and Webber's wicked problem framing accounts for the complex network of social, economic, and political factors associated with technology—in this case, undergraduate STS courses. The wicked problem framework outlines an approach to inherently unsolvable challenges, problems with complex systems that prevent the analyst from defining strict problem boundaries.[7] The interrelatedness of wicked problems is an important contributor to their complexity; attempting to solve one issue can subsequently affect other sociopolitical wicked problems. Some scholars have claimed that the wicked problem interpretation that "the planner has no right to be wrong" no longer holds true today, given that rapid prototyping and "fast failure" are touted as the keys to good design strategy.[8] Even so, the core facets of the framework regarding solution quantification and stopping criteria are extremely applicable to this analysis. The wicked problem framework acknowledges factors that can impede the realization of theoretical projections. This lens also provides a means to compare the relative power of stakeholders in the system, one commonly cited drawback of the social construction of technology approach. By using SCOT and wicked problem framing to examine the effect of STS 2500 on engineering education at one institution, this paper argues for the benefits of and provides a framework for the expansion of STS education as an essential part of a well-rounded engineering curriculum. The next stage of research is to cross examine STS 2500 *Science and Technology in Popular Culture* with other 2000 and 3000 level STS courses at the University of Virginia to assess how these nontechnical engineering skills support sociotechnical systems thinking.

References

1 Sorby, S., Fortenberry, N., & Bertoline, G. Stuck in 1955, Engineering Education Needs a Revolution. *Issues in Science and Technology*. Retrieved from https://issues.org/engineering-education-change-sorby-fortenberry-bertoline/

2 Plenke, Max. "We Figured Out Why Some Electronics Don't Work For Black People." (n.d.). Retrieved from https://mic.com/articles/124899/the-reason-this-racist-soap-dispenser-doesn-t-work-on-black-skin

3 Seabrook, B., K. A. Neeley, K. Zacharias, and B. Carron, "Teaching STS to Engineers: A Comparative Study of Embedded STS Programs," *2020 ASEE Annual Conference & Exposition.* Montreal, Quebec, Canada: 2020.

4 University of Virginia Engineering, "Our Mission, Vision and Core Values." [Online]. Available: https://engineering.virginia.edu/about/mission-vision

5 Han, K. & Downey, G. (2014). *Engineers for Korea*. Morgan & Claypool Publishers.

6 Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science, 14(3)*, 399-441. Retrieved from http://www.jstor.org/stable/285355

7 Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences 4(2)*, 155-169. doi:10.1007/BF01405730

8 Zellner, M., & Campbell, S. (2015). Planning for deep-rooted problems: What can we learn from aligning complex systems and wicked problems?. *Planning Theory & Practice*, *16*, 457-478. doi:10.1080/14649357.2015.1084360.

Bryn Seabrook

Bryn Seabrook is an assistant professor of science, technology, and society at the University of Virginia. Her research interests include bioethics, public participation in environmental policymaking, energy efficiency, climate change, the environmental–consumer nexus, American consumer culture, engineering education, engineering responsibility, and disability studies. Membership/leadership: American Society for Engineering Education, Society for Social Studies of Science (4S), STGlobal.