

MIT Open Access Articles

The elephant in the room: constraints and consequences of a four-year undergraduate engineering degree

The MIT Faculty has made this article openly available. **Please share** how this access benefits you. Your story matters.

Citation: Silbey, Susan S. "The Elephant in the Room: Constraints and Consequences of a Four-Year Undergraduate Engineering Degree." *Engineering Studies* 7, no. 2-3 (July 3, 2015): 164-167.

As Published: <http://dx.doi.org/10.1080/19378629.2015.1062488>

Publisher: Taylor & Francis

Persistent URL: <http://hdl.handle.net/1721.1/104009>

Version: Original manuscript: author's manuscript prior to formal peer review

Terms of use: Creative Commons Attribution-Noncommercial-Share Alike



The Elephant in the Room: Constraints and Consequences of a Four-year Undergraduate Engineering Degree

[Engineering Studies, Volume 7, Issue 2-3, 2015, Special Issue: Liberal Studies in Engineering, p. 164-167](#)

Susan S. Silbey
Massachusetts Institute of Technology

Keywords: cultural analysis; engineering education; undergraduate; prestige; professional; occupational preparation

Much of the conversation focused on issues generic to higher education, including for example: sorting of students into different programs; the timing of students' program choices; pedagogy of the classroom; mentoring; maturity of students; competing values among students and among faculty; the conditions of work in higher education; the reward and incentive structures attached to tenure and research; the difficulties of collaboration across disciplines, across cultural and epistemological divides; the role of cultural biases; the difficulties of organizational, no less institutional change; and finally, the gap between what is taught in schools and what is expected in the workplace. There were surely additional topics too. Although each of these was often discussed in the context of engineering education, none of these subjects are about engineering per se or engineering alone.

What is left that characterizes engineering and is not a characteristic of other professions? The missing piece is the elephant in the room, and it is my sense that the workshop did not address this sufficiently: the four-year professional degree. All other professions require undergraduate education before deep immersion in and admission to practicing the technical expertise of the profession; that undergraduate education need not be and often is not specifically pre-professional but a general liberal education.

How does the four-professional degree contribute to the culture of engineering education?

What practices are associated with this unique feature of the profession?

During the last several decades, culture has become a popular explanation for all sorts of organizational and institutional failures from oil refinery explosions and the financial collapse of 2008 to binge drinking and sexual assault on college and university campuses. For example, in contemporary engineering and management scholarship, the term ‘safety’ is attached to the word culture, increasingly invoked to refer to a commonly shared, stable set of practices in which all members of an organization learn from errors to minimize risk and maximize safety in the performance of organizational tasks and achievement of production goals.¹ When people want to talk about what does not fit into relatively fixed and concrete phenomena understood as vectors of instrumental rationality, they often talk about culture. We have heard such discourse at this workshop. It is a catch-all phrase for everything that hasn’t got a name yet; it is treated like a black box with unknown interior for those who may be unfamiliar with cultural analysis. As a black box, the concept of cultural analysis — circulating among those who do not look inside the box — is that its mechanisms are not as difficult, for example, as quantum mechanics. After all, as socialized adults we are all competent cultural actors. We know what is in the box. How hard could it be?

Culture is nonetheless a problematic explanation for deficient or insufficient institutional practices, not because the concept is unspecifiable but, because the mechanisms are difficult to

¹ Talk about safety culture has exploded in the last decade, can be usefully understood as a way of encouraging and allocating responsibility, one response to the dangers of technological systems. Invoking culture as both the explanation and remedy for technological disasters obscures the different interests and power relations enacted in complex organizations. Culture is never homogeneous nor uncontested, entirely stable, or fixed. Silbey, “Taming Prometheus,” 2009.

control and the system of interactional forces so complex and reflexive. Culture is a normatively plural *system* of symbols and meanings (and their associated practices) that both enables and constrains, both the product and context, of social action.² As an *analytic* concept, it is invoked (a) to recognize signs and performances, meanings and actions as inseparable; (b) yet, “to disentangle, for the purpose of analysis [only], the semiotic influences on action from the other sorts of influences — demographic, geographical, biological, technological, economic, and so on — that they are necessarily mixed with in any concrete sequence of behavior”³. Thus, for example, safety culture is used to emphasize that organizational and technological performances are not confined to formally specified components, or to language alone. Although at a macro level, we may share symbolic and cognitive resources, cultural resources can be discrete, local, and intended for specific purposes. Despite local variation and heterogeneity, (c) it is possible to observe general patterns so that we are able to speak of a culture, or cultural system at specified scales and levels of social organization. “System and practice are complementary concepts: each presupposes the other”⁴, although the constituent practices are neither uniform, logical, static, nor autonomous. The task of cultural analysis is (d) to map the systematicity of the constituent practices and symbols. (e) As a collection of semiotic and material resources deployed in interactions, “culture is not a power, something to which social events, behaviors, institutions, or processes can be *causally* attributed; it is something within which [events, behaviors, institutions, and processes] can be intelligibly — that is, thickly — described”⁵.

Because culture refers to the pattern of meanings and practices — cognitive, behavioral and material resources — that both enables and constrains action, policy makers are beginning to

² Sewell 2005, pp. 152-175; Silbey 2001; Silbey, 2005, 343),

³ Sewell 2005, p.160

⁴ Sewell 2005, p. 164)

⁵ Geertz, *The Interpretation of Cultures*, 1973, p.14

claim that the global challenges we face — for example in climate change, sustainability, growing inequality — are not necessarily or merely technical, but social and cultural. Similarly, at this workshop concerned engineers call for liberal studies of engineering as a means of embracing this elusive, yet analyzable, phenomena we call culture⁶

What features of the culture of engineering education might we associate with the four year degree, providing opportunities and constraints for the transformations proponents of Liberal Engineering advocate?

First, and most importantly, a four-year professional degree becomes a magnet for those for whom education is an instrumental activity with a clear means-ends relationship; the degree should pay for itself through immediate lucrative occupation. First generation college goers, many working class students, and immigrants cannot afford to go to college without lining up a well-paying job immediately after to pay the college costs. Thus, engineering is particularly attractive, as it almost guarantees a job in the upper half of the income distribution in the US. It is a cost effective professional degree.⁷ It is, however, an example of short-term thinking, more often characteristic of those under financial duress. Pierre Bourdieu (1984)⁸ has shown us that education is more often regarded as occupational training by the working classes and as cultural improvement by the middle and upper classes. Those relatively freer from economic constraint are able to develop tastes and preferences independent of the needs of everyday life; those constrained by economic circumstances more often seek functional reward from their investments of attention and effort. Engineering is not only a cost effective degree, as a

⁶ Silbey, 2001; Silbey, “Legal Cultures,” 2010.

⁷ Chen and Weko, “Stats in Brief,” 2009.

⁸ Bourdieu, *Distinction*, 1984.

profession it expresses an epistemological affinity in terms of fundamental interests in function and efficiency⁹.

Second, the four-year degree encourages tightly packed curricula with limited opportunities for random exploration and inquiry. With increases in scientific knowledge and technological complexity, engineering degrees demand ever more courses.

Third, once this institutional pattern exists, it is very difficult to change, more difficult than getting onto that path in the first place, which could have been entirely contingent at the time. We call this path dependence.¹⁰

Fourth, the four-year degree also relegates engineering to conventionally lower position in prestige hierarchies than law and medicine.¹¹ This relative subordination, if unwelcome, can lead to status instabilities. Unlike the accretion of small changes that slowly transforms organizations and institutions; the engineering profession is unique in its repeated calls for complete overhaul/radical changes, which probably reflect these status ambiguities. Since 1918, there have been more than twenty-five national reports calling for fundamental change of engineering

⁹ The preface of every optimization book argues that whenever a decision is made to allocate scarce, quantifiable resources, and there exists a quantifiable way of measuring quality or efficiency, best includes that efficiency calculation. 1939 article by Leonid See Kantorovich (1939, 1960),

¹⁰ Mahoney, "Path Dependence," 2000.

¹¹ Pollack, "The Harris Poll #85," 2014; <http://www.harrisinteractive.com/NewsRoom/HarrisPolls/tabid/447/mid/1508/articleId/1490/ctl/ReadCustom%20Default/Default.aspx>; "How Millenials Perceive Occupational Prestige Different from Matures," 2014, <http://www.occupationalresearch.com/home/category/occupational-prestige>; Smith, "Job Satisfaction in the United States," 2007; Gilbert, *The American Class Structure in an Age of Growing Inequality*, 2007, pp. 19-37.

education.¹² The reports are often similar, claiming that engineering education needs to incorporate human factors, or business and management considerations, or more science, or more social science, or more contextual knowledge. Most liberal arts and science schools host pre-law and pre-med programs; but, there are very few pre-engineering programs other than the few experiments we have heard described at the workshop.

These repeated calls for fundamental change in engineering education are part of the jurisdictional competitions within the system of professions.¹³ This competition may not be formally organized as such and the actors may not intend nor be aware of their participation. Nonetheless, the boundaries of occupational expertise are regularly negotiated through these curricular changes, as well as occupational licensing and employment requirements. Those who call for fundamental changes in the training of engineers participate, either latently or manifestly, in this competition.

A fifth characteristic differentiating engineering from the other professions as well as the liberal arts and sciences is the dominant embrace of instrumental reasoning.¹⁴ Engineering is the

¹² For example, (1918) Mann Report, *Study of Engineering Education*; (1930) Vol 1, *Report of the Investigation of Engineering Education 1923-1929*; (1934) Vol 2. *Wickenden Report*; (1939) H.P. Hammond Report, *Aims and Scope of the Engineering Curriculum*; (1944) Reaffirmed 1939 report; (1955) *Grinter Report, Evaluation of Engineering Education*; (1956) Burden Report, *General Education in Engineering, The Humanities*; (1959) *du Bridge Eisenhower Report*; (1968) *ASEE Goals of Engineering Education*; (1968) *Olmstead Report for ASEE*; (1975) Hollomon, *Future Directions for Engineering Education*; (1982) *The Quality of Engineering Education*; (1985) NAE, *Engineering Education and Practice in the U.S.*; (1985) NAE, *Engineering in the NSF*; (1986) *National Conference on Engineering Education*; (1986) *Quality in Engineering Education Programs I, II*; (1986) *Impact of Defense Spending on Non-defense Engineering Labor Markets*; (1987) ASEE, *A National Action Agenda for Engineering Education etc.*; (2000) ABET *EC2000*, revision of accreditation procedures; (2005) NAE, *Educating the Engineer of 2020*.

¹³ Abbott, *The System of Professions*, 1988.

¹⁴ Seron and Silbey, "The Dialectic Between Expert Knowledge and Professional Discretion," (2009).

process of identifying means (methods and matter) to solve identified problems¹⁵. The process — whether thought of as design or problem solving through trial and error, modeling, or calculation — is an efficient allocation of means to meet prescribed ends. By its celebration of efficiency, engineering shares with liberal and neo-liberal economics the notion that this instrumental reasoning is what constitutes rationality, an assertion of a unique human capacity. Economists are moving beyond this simple notion of rationality by appropriating decades' old social psychology and calling it behavioral economics. Actually, the current chairwoman of the Federal Reserve is noted for her work in cultural economics, describing what sociologists and anthropologists have been doing for two centuries, showing how people's choices are shaped by the groups in which they live and work.

What does it take to make a cultural transformation? Certainly the proponents of Liberal Engineering are moving energetically toward their goal. If the engineering degree were a major, like other liberal arts and sciences, much of the critique would dissipate, I imagine. Would the four year degree remain as significant a constraint? I suspect not.

¹⁵ “If we look at basic science, applied science, and engineering as social activities in general, we can see that the aims of these activities are different; these aims are institutionalized norms that govern the activities. A central norm for each of these activities can be formulated as follows: Basic science is oriented to the production and evaluation of knowledge claims. Applied science is oriented to the discovery of new uses for knowledge claims that have been previously evaluated and tentatively accepted. Engineering is oriented to the solution of technical problems where the problem to be solved is regarded as given.” Cohen. *Developing Sociological Knowledge*, (1989), pp. 49-65..

References

Abbott, Andrew. *The System of Professions: An Essay on the Division of Expert Labor*. Chicago: University of Chicago Press, 1988

Bourdieu, Pierre. *Distinction: A Social Critique of the Judgment of Taste*. Cambridge: Cambridge: Harvard University Press, 1984.

Chen, Xianglei and Thomas Weko. "Stats in Brief: Students who Study Science Technology Engineering and Math (STEM) in Postsecondary Education." Washington, D.C.: National Center for Education Statistics, 2009.

Cohen, Bernard. "Two Norms of Science." In *Developing Sociological Knowledge*, 49-65. Chicago: Nelson-Hall Publishers, 1989.

Geertz, Clifford. *The Interpretation of Cultures: Selected Essays*. New York: Basic Books, 1973, p.14.

Gilbert, Dennis L. *The American Class Structure in an Age of Growing Inequality*, , Thousand Oaks, CA: Sage Publications, 2007.

Kantorovich, Leonid V. "Mathematical methods of organizing and planning production." *Management Science* 6.4 (1960): 366-422.
<http://www.jstor.org/discover/10.2307/2627082?uid=3739696&uid=2&uid=4&uid=3739256&sid=21106303105621>

Mahoney, James. "Path Dependence in Historical Sociology." *Theory and Society*, 29(2000):507-48.

Occupational Research. "How Millenials Perceive Occupational Prestige Different from Matures." <http://www.occupationalresearch.com/home/category/occupational-prestige>. Occupational Research Online, 2014. Accessed May 5, 2014.

Hannah Pollack, "The Harris Poll #85," <http://www.harrisinteractive.com/NewsRoom/HarrisPolls/tabid/447/mid/1508/articleId/1490/ctl/ReadCustom%20Default/Default.aspx>. Harris Interactive/Nielsen, 2014. Accessed May 5, 2014.

Seron, Carroll, and Susan S. Silbey. "The Dialectic Between Expert Knowledge and Professional Discretion: Accreditation, Social Control and the Limits of Instrumental Logic." *Engineering Studies*. 1(2009):101-27.

Sewell, Jr. W. H.. *The Concept(s) of Culture, in The Logics of History*. University of Chicago Press, Chicago, p152-174. 2005.

Silbey, Susan S.. "Legal Culture and Consciousness." In *International Encyclopedia of the Social and Behavioral Sciences*, edited by Neal J. Smelser and Paul B. Baltes, 8623-8629. Amsterdam: Elsevier Science, 2001 (2014)

Susan S. Silbey. "Taming Prometheus: Talk of Safety and Culture." *Annual Review of Sociology* 35(2009): 341-69.

Susan S. Silbey. "Legal Culture and Cultures of Legality." In *Sociology of Culture: A Handbook*, edited by John R. Hall, Laura Grindstaff, and Ming-Cheng Lo, 470-79.. New York: Routledge Publishers, 2010..

Smith, Tom W. "Job Satisfaction in the United States." Chicago: University of Chicago/NORC, 2007.