

The “X-Engineer”: Engineering Reflexivity and Identity Formation

When confronted with increasing levels of guilt and anxiety, people may begin a period of re-evaluation and renewed intellectual quest. American engineers underwent this experience during the late nineteenth century. Shocked and concerned that the public’s perception of technical work had begun to be characterized more by its negative impacts on society than by its heroic accomplishments, they attempted to define themselves as guarantors of social good [14]. Thus began in America and elsewhere the history of engineering reflexivity—an inquiry into the compatibility between technology and human life.

Contemporary examples in which engineers have not shied away from complex techno-social issues provide information about engineering reflexivity’s specific characteristics, and the actual effects they have on making engineering practice socially just. The readers of this journal will find it encouraging that increasingly, practitioners believe there is nothing “unprofessional” in thinking that considerations about engineering projects extend beyond the spreadsheet and are influenced by subjective value judgments.

The premise of this paper, which I owe to Gary Downey and Matt Wisnioski from Virginia Tech, is quite simple: In conditions of perceived technology crisis, engineers contextualize themselves and the contents of their work. This is similar to, but not quite the same as Thomas Kuhn’s assertion that “in periods of acknowledged crisis... scientists have turned to philosophical analysis as a device for unlocking the riddles of their fields” [13]. Kuhn was referring to *internal* crises; specifically, those involving elite

communities of a handful of practitioners confronting the deadlock of a certain scientific “paradigm.” In contrast, technology crises and engineering reflexivity are mostly due to “external” (i.e., non-engineering) influences. Engineering education is a key locus for engineers to re-contextualize themselves and the type of work they perform [3].

It seems to me that in theory two types of engineering reflexivity exist. In reality, though, the distinction is rather fuzzy or even non-existent: On the one hand, “egoistic” engineering reflexivity is a result of the engineer’s own striving to “restore” his or her status in society and maintain a fair share in the management of technology. This kind of reflexivity goes back to the historical relationship between engineering professionals, status, and social mobility. On the other hand, “disinterested” reflexivity is a “deeper” kind of reflexivity, one that is meant to go beyond some of the structural barriers to socially responsible engineering. To appreciate the evolution of the engineering reflexivity landscape in the English-speaking world, look at past and present activities of national and international groups, such as the Engineers for Social Responsibility (New Zealand), the short-lived American Engineers for Social Responsibility (who helped create the International Network of Engineers and Scientists for Global Responsibility), and Engineering, Social Justice, and Peace. Although for the last twenty-five years it has been primarily endemic to Canada, Australia, New Zealand, and Britain, engineering reflexivity is presently becoming an “invasive species” in the U.S.

An adjective I favor to describe the role of engineers in society comes from the work of an engineer turned historian of technology, Eugene Ferguson. Ferguson wrote in 1979 that engineers are “radical because they [bring] radical changes...” [8]. As

engineers we take pride in asserting that engineering performs admirably well when confronted with technical challenges. Furthermore, the products of engineering *radically* alter people's environments and everyday lives. But the quest to gain an appreciation of engineering's social role prompts "bigger" questions; questions often associated with rethinking the engineer's identity.

My position is that the essence of engineering reflexivity is the study of conditions in which engineering and society optimally complement each other. Sharon Beder, for example, who teaches engineering in Australia, argues that there is an apparent need for the "new engineer, a practitioner "who is aware of the social dimensions and context of engineering work and takes responsibility for its consequences" [1]. Along those lines, engineers in Canada have been writing since the early 1990s about the importance of creating the "preventive engineer" who designs engineering projects "in a negative feedback mode so as to improve [their] compatibility" with society, political life, and the natural environment [20]. Canadian engineers have also built on this work to define the "adaptive engineer." The adaptive engineer advocates preventive engineering. She/he "has increased awareness or reflexivity," is "a broad thinker who strives for multidisciplinary and interdisciplinary interactions," and "works for social justice." In addition, she/he shall be "community-focused" and would make "decisions through Learning Alliances" [21].¹

Social concerns have been articulated by Peter T. Robbins, a policy scholar, who believes that "reflexive engineers approach development problems with a fluid understanding of the ways in which technologies fit and co-evolve within social systems" [17].² Likewise, Aarne Vesilind, the American engineering professor who has written extensively on ethics and the environment, purports that it is time to define the "peace engineer;" one who would employ "technical

skills in problem-solving to promote peace" [23]. The engineer's determination to commit herself to peace engineering, Vesilind adds, "can be based on any number of considerations, religious to political..." a remark that speaks to an earlier point regarding the heterogeneity of deliberations that give essence to engineering projects. For example, religious considerations have prompted engineering professors teaching at Baylor University in Waco, Texas to identify the "Christian engineer," who would be "committed to the ethical and moral aspects inherent in humans as *imago dei* (image of God)." Consequently, according to the authors, "a greater care (responsibility) for the impact of engineering design should be evident" [7].

Educators are particularly concerned about fostering a new engineering identity through a transformation of how engineering students and professors alike are taught. Already in the mid nineteen-nineties, researchers compared changes in engineering curricula internationally, foreshadowing the education of the "renaissance engineer" [10]. Still, the identity of the substitute practitioner is far from clear. As European commentators have pointed out, the new engineer's profile "is not just a summing up of knowledge and skills, but rather an indication of potential and directions in a developmental process" [4]. Bordogna *et al.* for instance, envision the restructuring of engineering curricula "based on the notion that the engineer's essential role in organized society is an integrative one, i.e., emphasizing 'construction of the whole'" [2]. Graso *et al.* have posed the core question of whether "we can truly educate broad-based, holistic engineers without 'watering down' technically rigorous engineering coursework" [12]. The department of Humanitarian Engineering at the Colorado School of Mines typifies this effort to produce engineers that "will try to balance technical excellence, economic feasibility, ethical maturity and cultural sensitivity" (<http://humanitarian.mines.edu/>).

The arena of re-engineering engineering education is also home to an interesting debate between the "globally competent engineer" and the "local engineer." On one hand, the former "is someone who has progressed beyond... 'awareness skills,' which are achieved through the acquisition of knowledge, to achieve 'process skills,' which include a combination of intellectual and behavioral capacities to integrate new forms of knowledge into everyday practices of engineering work" [6]. Yet critics remark that "focusing on global thinking is often mixed up with the hubris of utopian thinking and fixing the world..."

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¹The concept of "Learning Alliances" resonates nicely with Trevelyan's [18, p. 190] description of engineering practice on the basis of "distributed expertise" [18]. The idea here is that "human performance and social interactions lie at the core and constrain engineering outcomes just as material properties constrain the feasible height of buildings."

²"The Reflective Engineer," is also the name of a project initiated in 2007 by Engineers Without Borders (EWB) and SEEK, a Royal Institute of Technology student organization. In addition, "Reflective Engineering" was the name of a panel at the Biennial Meeting (May 26-29, 2011) of the Society for Philosophy and Technology. The aim of the panel is to "encourage reflection on engineering, engineers and technology by both philosophers and engineers."

[22]. On the other hand, they emphasize that engineers' "local placements shall not... be approached with *charity* in mind, but with a notion of *justice*... the focus should be on community transformation and not on giving back or simply on enhancing the educational experience" (emphasis added).

Some thirty-five years ago, Samuel Florman wrote his popular *The Existential Pleasures of Engineering*, in which he asserted that by doing engineering work, professionals respond to their creative impulses [9]. Nowadays, the debate over the adjective that best describes the engineer identity attests to an ongoing existential crisis in the profession. The engineer's identity is first solid, then melts into air—it is in constant flux. As Douglas, Papadopoulos, and Boutelle, authors of *The Citizen Engineer*, put it: "you don't need to 'know' more than a traditional engineer; you'll need to '*be*' more" [5] (emphasis added).

I have argued here that engineering reflexivity relates to evaluating the meaning of engineering work in society. Social scientists have been identifying for a few decades that science is becoming progressively more reflexive and contextualized, for the public is now able to "speak back" to the scientists and demand "socially robust knowledge" [15], [11]. Their observations strengthen the recurring theme of the "socially responsible engineer" [19]. In that regard, Gene Moriarty has written that "focal engineers" work "requires not only knowing-how and knowing-what, but also knowing-why" [16]. Do we want an engineer who is unable to re-engineer herself? I am quite certain we do not. The pertinence of engineering reflexivity lies in exploring the *whys* of technology, and not only the *whats* and the *hows*.

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