THE INVISIBLE ENGINEER

Gary L. Downey
Center for the Study of Science in Society
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
703/961-4761; BITNET = DowneyG @ VTVM1

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In his classic novel Invisible Man (1952) Ralph Ellison wrote of a man who lived between society's lines. He existed, yet he remained invisible. His society treated him as transparent, as occupying a status without definition and having an identity devoid of substance.

Ellison conveyed this social situation by having his unnamed central character actually live unnoticed in the bowels of a great city. His "home" was an abandoned room beneath the city streets. This underground chamber was brightly lit by a system of 1,369 bulbs that he had ingeniously constructed and powered for free by tapping a nearby electrical cable. The man was invisible to the society around him, yet intimately connected to it through a technological link.

Ellison's two metaphors of cultural invisibility and technological linkage can be used to describe the evolving historical experience of American engineers. The picture that emerges also provides a background for understanding what may be a significant, ongoing transformation in contemporary American engineering.

Nineteenth century Americans regarded civil engineers as supreme individualists and celebrated them as national heroes.

These engineers were consummate professionals in a traditional sense. In a class with lawyers, physicians, and clergy, civil engineers possessed esoteric knowledge, served as autonomous practitioners, and exhibited a deep sense of public responsibility. The immensely visible and highly valued structures they produced were physical expressions of their singular craftsmanship. Working as consultants and on commissioned projects, civil engineers became national heroes because their technological works were both symbols of and means to national progress.

But the autonomous civil engineer turned out to be something of a fluke in American history. During this same period, a wholly different kind of practitioner developed that would provide the main descent line of engineering--the mechanical engineer. Mechanical engineers were managers, craftsmen, and designers all rolled into one. They got their hands dirty in machine and manufacturing shops, and they lacked the social status of civil engineers.

Passage of laws such as the Morrill Land Grant Act of 1862 greatly increased the supply of mechanical engineers. School training brought science to engineering practice, and applying science to engineering problems gave birth to new disciplines. Adding physics to mechanical engineering provided the conceptual basis for electrical engineering. Adding chemistry led to chemical engineering, and incorporating the social sciences yielded industrial engineering.

Demand for science-based engineers was accelerated by the rapid growth of large-scale corporations. The big companies increased the rate of product development by establishing new R&D laboratories. They also gained market advantages by aggressively manipulating liberal patent policies.

By the early twentieth century, engineering had been fully integrated into the corporate structure of American business. This process dissolved the direct link between engineers and the advancing nation. Feats of engineering came to be seen as organizational successes rather than individual achievements.

Engineers lost their visibility as individuals and became instead corporate men buried within organizations somewhere between labor and management. These engineers were still connected to external society by shaping new technologies to meet changing social goals. But the image of creative craftsmen who constructed progress through technology was transformed into an image of engineers as cogs in large corporate machines.

Much of the present century has been a struggle for engineers. The technocracy movement provided a brief flicker of public attention during the 1930s. But over the next several decades, engineers served primarily as white collar workers limited to the middle rungs of corporate ladders. As recently as the 1960s and 1970s, most engineering students came from middle-class and lower middle-class families, primarily seeking upward mobility. Cultural invisibility was not a concern for those pursuing economic opportunity. White-collar engineers were

generally satisfied with narrowly-defined careers.

However, this condition appears to be undergoing significant change during the middle and late 1980s. There exists both a pull from society and a push from younger engineers for new social visibility.

The pull is rooted in a newly-developed national insecurity. America has felt its position in the world slip a little, and its citizens have turned collectively to technology and technologists for solutions. There exists a new patriotic fervor that sometimes borders on national chauvinism. "Beat the Japanese" is a widespread, often explicit, battle cry for American industry. "High tech" has achieved high status, and government and industry are forging alliances around technological development like never before.

In response to this change, brighter students are turning to engineering than ever before. Many come for an entirely new reason--as a steppingstone to leadership positions, both within corporations and in society at large. Dramatic increases in the quality of students has forced engineering universities to accelerate upgrades in their faculty and equipment facilities.

It appears that engineering curricula may also be undergoing fundamental change. Existing curricula were not designed to prepare engineers for leadership roles. Although engineers possess the technical competence necessary to understand the technological complexities of the late 20th century, they often experience difficulty in grasping the human and social dimensions

of technological developments. Failing to develop capabilities on the social side of engineering can put the brakes on upward career mobility. As MIT President Gray put it in justifying a sweeping change to broaden the engineering curriculum, "We are tired of MIT graduates working for Harvard and Princeton graduates."

A wide diversity exists, however, in proposals to modify engineering education, and future courses of development are not clear. Existing proposals include a five-year professional degree, sharp increases in humanities and social sciences electives, graduate training in business, and new forms of graduate education focusing on interrelations among engineering and society.

It seems appropriate that engineering publications like this one serve as forums for debating significant outstanding issues. Some key issues include: What sort of educational package is most appropriate for engineers in the 1990s? What options should be made available? In the context of nationalistic fervor, what are the implications of growing foreign student and faculty populations? Can this be turned into a solution rather than a problem, and is there any way to reduce what appear to be escalating tensions? What is engineering leadership, anyway? Should the primary leadership goal be to produce more industrial Rambo's like Lee Iacocca or to find ways to achieve greater national coordination, which is a significant strength of the Japanese?

There are many routes toward reestablishing a direct link between engineers and society. It is not clear how leadership positions might be transformed by an influx of engineers. Heroic status is probably a bit much to ask. Nevertheless, we may indeed be witnessing a national resurgence of engineering in American society.

From this perspective, it seems important for student engineers to go out and learn more about the interrelations between engineering and society. If anybody asks you why you are wasting your time away from your major, tell them you are on a mission--a mission to bring visibility back to engineering.