CHAPTER 10

Global Justice

On September 11, 2001, at 8:46 a.m., Al-Qaeda terrorists flew a hijacked American Airlines Boeing 767 into floors 94 to 98 of the 110-story North Tower of the World Trade Center. Seventeen minutes later, the World Trade Center was hit again as more terrorists flew a United Airlines Boeing 767 into floors 78 to 84 of its South Tower. The impact of the airplanes did not collapse the twin towers, but the firestorm set off by the full loads of jet fuel, together with the tons of combustible office material, created intense heat that weakened the steel supports. First the floor trusses weakened and began to tear away from the exterior and interior steel columns, and then the compromised columns gave way. Once the top floors collapsed, it took only 12 seconds for the pancake-like cascade of the South Tower to occur, followed a short time later by the North Tower. A third hijacked airliner was flown into the Pentagon, and a fourth crashed outside Shanksville, Pennsylvania, as its passengers fought the hijackers. The overall death toll was near 3,000 people, including hundreds of firefighters and police officers.

Engineers were prescient in designing the twin towers to withstand impacts from jumbo jets, but they only envisioned jets that were moving slowly and, with depleted fuel, making emergency landings; they had not imagined the possibility of a terrorist attack like the one on September 11, nor had anyone else (Figure 10–1). Because airplanes had crashed into tall buildings before, engineer James Sutherland had warned in 1974 of the vulnerability of hundreds of skyscrapers to further crashes, but it was only in 1994 that the warning was taken seriously after a terrorist plot to hijack an Algerian airliner to attack Paris was foiled.[1] In addition, a bold decision (costing $300,000) was made

[1] R. J. M. Sutherland, "The Sequel to Ronan Point," *Proceedings, 42nd Annual Convention, Structural Engineers Association of California* (October 4–6, 1973), 167, See also James R. Chiles, *Inviting Disaster: Lessons from the Edge of Technology* (New York: HarperBusiness, 2002).

Figure 10–1
World Trade Center

during construction of the towers to replace asbestos insulation, which had health dangers that were only then becoming clear and which had already been used on the first 34 floors of the towers, with new fireproofing material coming on the market.[2] The impact of the crash, however, stripped the insulation from the steel beams, leaving them unprotected from temperatures over 1,100°F. Nor was there a safe exit for people above the impact area, as sprinkler systems, emergency elevators, and stairways were damaged by the crash. Fortunately, the buildings stood long enough for some 25,000 people to escape.

As the tallest buildings in New York City and as centers of international commerce, the Twin Towers symbolized the global economy and America's dominance within that economy. The terrorists were fanatics who opposed Western capitalism, democracy, and moral pluralism. Politicians portrayed the attack as an assault on civilization, but perhaps a more accurate statement is that the violence expressed "tensions built into a single global

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[2] Angus Kress Gillespie, *Twin Towers: The Life of New York City's World Trade Center* (New York: New American Library, 2002), 117–18.

civilization as it emerges against a backdrop of traditional ethnic and religious divisions."[3]

Globalization refers to the increasing integration of nations through trade, investment, transfer of technology, and exchange of ideas and culture. Daniel Yergin and Joseph Stanislaw distinguish a narrow and broader sense of *globalization*: "In a more narrow sense, it represents an accelerating integration and interweaving of national economies through the growing flows of trade, investment, and capital across historical borders. More broadly, those flows include technology, skills and culture, ideas, news, information, and entertainment—and, of course, people. Globalization has also come to involve the increasing coordination of trade, fiscal, and monetary policies among countries."[4]

Today's interdependence among societies—economic, political, and cultural—is unprecedented in its range and depth. So are the possibilities for increased unity and increased fractures during the process of globalization. Global interdependency affects engineering and engineers in many ways, including the Internet issues addressed in Chapter 8 and the environmental issues discussed in Chapter 9. In this chapter we discuss issues concerning multinational corporations and military work.

10.1 Multinational Corporations

Multinational corporations conduct extensive business in more than one country. In some cases, their operations are spread so thinly around the world that their official headquarters in any one *home country*, as distinct from the additional *host countries* in which they do business, is largely incidental and essentially a matter of historical circumstance or of selection based on tax advantages. The benefits to U.S. companies of doing business in less economically developed countries are clear: inexpensive labor, availability of natural resources, favorable tax arrangements, and fresh markets for products. The benefits to the participants in developing countries are equally clear: new jobs, jobs with higher pay and greater challenge, transfer of advanced technology, and an array of social benefits from sharing wealth.

Yet moral challenges arise, accompanying business and social complications. Who loses jobs at home when manufacturing is taken "offshore"? What does the host country lose in resources, control over its own trade, and political independence? And what are the moral responsibilities of corporations and individuals

[3] Benjamin R. Barber, "Democracy and Terror in the Era of Jihad vs. McWorld," in *Worlds in Collision: Terror and the Future of Global Order*, ed. Ken Booth and Tim Dunne (New York: Palgrave Macmillan, 2002), 249.

[4] Daniel Yergin and Joseph Stanislaw, *The Commanding Heights: The Battle for the World Economy* (New York: Touchstone, 2002), 383. See also Joseph E. Stiglitz, *Making Globalization Work* (New York: W.W. Norton, 2006).

operating in less economically developed countries? Here we focus on the last question. Before doing so it will be helpful to introduce the concepts of technology transfer and appropriate technology.

Technology Transfer and Appropriate Technology

Technology transfer is the process of moving technology to a novel setting and implementing it there. Technology includes both hardware (machines and installations) and technique (technical, organizational, and managerial skills and procedures). A novel setting is any situation containing at least one new variable relevant to the success or failure of a given technology. The setting may be within a country where the technology is already used elsewhere, or a foreign country, which is our present interest. A variety of agents may conduct the transfer of technology: governments, universities, private volunteer organizations (such as Engineers Without Borders), consulting firms, and multinational corporations.

In most instances, the transfer of technology from a familiar to a new environment is a complex process. The technology being transferred may be one that originally evolved over a period of time and is now being introduced as a ready-made, completely new entity into a different setting. Discerning how the new setting differs from familiar contexts requires the imaginative and cautious vision of "cross-cultural social experimenters."

The expression *appropriate technology* is widely used, but with a variety of meanings. We use it in a generic sense to refer to identification, transfer, and implementation of the most suitable technology for a new set of conditions. Typically the conditions include social factors that go beyond routine economic and technical engineering constraints. Identifying them requires attention to an array of human values and needs that may influence how a technology affects the novel situation. Thus, in the words of Peter Heller, "appropriateness may be scrutinized in terms of scale, technical and managerial skills, materials/energy (assured availability of supply at reasonable cost), physical environment (temperature, humidity, atmosphere, salinity, water availability, etc.), capital opportunity costs (to be commensurate with benefits), but especially human values (acceptability of the end-product by the intended users in light of their institutions, traditions, beliefs, taboos, and what they consider the good life)."[5]

Examples include the introduction of agricultural machines and long-distance telephones. A country with many poor farmers

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[5] Peter B. Heller, *Technology Transfer and Human Values* (New York: University Press of America, 1985), 119.

can make better immediate use of small, single- or two-wheeled tractors that can serve as motorized ploughs, to pull wagons or to drive pumps, than it can of huge diesel tractors that require collectivized or agribusiness-style farming. Conversely, the same country can benefit more from the latest in wireless communication technology to spread its telephone service to more people and over long distances than it can from old-fashioned transmission by wire.

Appropriate technology also implies that the technology should contribute to and not detract from *sustainable* development of the host country by providing for careful stewardship of its natural resources and not degrading the environment beyond its carrying capacity. Nor should technology be used to replace large numbers of individually tended small fields by large plantations to grow crops for export, leaving most of the erstwhile farmers jobless and without a source of home grown food.

The word *appropriate* is vague until we answer the questions, appropriate to what, and in what way?[6] Answering those questions immediately invokes values about human needs and environmental protection, as well as facts about situations, making it obvious that *appropriate* is a value-laden term. In this broader sense, the appropriate technology might sometimes be small-, intermediate-, or large-scale technology. Appropriate technology is a generic concept that applies to all attempts to emphasize wider social factors when transferring technologies. As such, it reinforces and amplifies our view of engineering as social experimentation.

With these distinctions in mind, let us turn to a classic case study illustrating the complexities of engineering within multinational settings.

Bhopal

Union Carbide in 1984 operated in 37 host countries in addition to its home country, the United States, ranking 35th in size among U.S. corporations. On December 3, 1984, the operators of Union Carbide's plant in Bhopal, India, became alarmed by a leak and overheating in a storage tank. The tank contained methyl isocyanate (MIC), a toxic ingredient used in pesticides. As a concentrated gas, MIC burns any moist part of bodies with which it comes in contact, scalding throats and nasal passages, blinding eyes, and destroying lungs. Within an hour the leak exploded in a gush that sent 40 tons of deadly gas into the atmosphere.[7] The

[6] Langdon Winner, *The Whale and the Reactor* (Chicago: University of Chicago Press, 1986), 62.

[7] Paul Shrivastava, *Bhopal, Anatomy of a Crisis* (Cambridge, MA: Ballinger, 1987).