ways to achieve economic, social, and environmental objectives *simultaneously*.

He cites successful projects in Haiti and Guatemala that make use of readily available materials in the locales in which they have been undertaken.

In "Learning Sustainable Design through Service," Stanford University PhD students Karim Al-Khafaji and Margaret Catherine Morse present a service learning model based on the Stanford chapter of Engineers for a Sustainable World to teach sustainable design.[90] They illustrate this model in discussing a Stanford project in the Andaman Islands that focused on rebuilding after the December 26, 2004, earthquake and tsunami. Behind such projects is a student-led course, "Design for a Sustainable World," that seeks to

- Develop students' iterative design skills, project management and partnership-building abilities, sustainability awareness, cultural sensitivity, empathy, and desire to use technical skills to promote peace and human development.
- Help developing communities ensure individuals' human rights via sustainable, culturally appropriate, technology-based solutions.
- Increase Stanford University's stewardship of global sustainability.[91]

In "Sustainable Building Materials in French Polynesia," John Erik Anderson, Helena Meryman, and Kimberly Porsche, graduate students at the University of California at Berkeley's Department of Civil and Environmental Engineering, provide a detailed, technical description of a service learning project designed to assist French Polynesians in developing a system for the local manufacturing of sustainable building materials.[92]

CASE 26

TV Antenna[93]

Several years ago, a TV station in Houston decided to strengthen its signal by erecting a new, taller (1,000-foot) transmission antenna in Missouri City, Texas. The station contracted with a TV antenna design firm to design the tower. The resulting design employed twenty 50-foot segments that would have to be lifted into place sequentially by a jib crane that moved up with the tower. Each segment required a lifting lug to permit that segment to be hoisted off the flatbed delivery truck and then lifted into place by the crane. The actual construction of the tower was done by a separate rigging firm that specialized in such tasks.

When the rigging company received the 20th and last tower segment, it faced a new problem. Although the lifting lug was satisfactory for lifting the segment horizontally off the delivery truck, it would not enable the segment to be lifted vertically. The jib crane cable interfered with the antenna baskets at the top of the segment. The riggers asked permission from the design company to temporarily remove the antenna baskets and were refused. Officials at the design firm said that the last time they gave permission to make similar changes, they had to pay tens of thousands of dollars to repair the antenna baskets (which had been damaged on removal) and to remount and realign them correctly.

The riggers devised a solution that was seriously flawed. They bolted an extension arm to the tower section and calculated the size of the required bolts based on a mistaken model. A sophomore-level engineering student who had taken a course in statics could have detected the flaw, but the riggers had no engineers on their staff. The riggers, knowing they lacked engineering expertise, asked the antenna design company engineers to review their proposed solution. The engineers again refused, having been ordered by company management not only not to look at the drawings but also not to visit the construction site during the lifting of the last segment. Management of the design firm feared that they would be held liable if there were an accident. The designers also failed to suggest to the riggers that they should hire an engineering consultant to examine their lifting plans.

When the riggers attempted to lift the top section of the tower with the microwave baskets, the tower fell, killing seven men. The TV company was taping the lift of the last segment for future TV promotions, and the videotape shows the riggers falling to their death.

Consider how you would react to watching that tape if you were the design engineer who refused to look at the lifting plans or if you were the company executive who ordered the design engineer not to examine the plans.

To take an analogy, consider a physician who examines a patient and finds something suspicious in an area outside her specialty. When asking advice from a specialist, the physician is rebuffed on the grounds that the specialist might incur a liability. Furthermore, the specialist does not suggest that the patient should see a specialist.

What conceptions of responsibility seemed most prevalent in this case? Can you suggest other conceptions that might have helped avoid this tragedy?

CASE 27

Scientists and Responsible Citizenry

As a young man, Harrison Brown (1917–1986) played a prominent role in the Manhattan Project at the University of Chicago and Oak Ridge. In 1943, he became assistant director of chemistry for the Oak Ridge Plutonium Project. During the very few years it took to develop the atomic bomb, Brown and many of his fellow research scientists had serious and deep discussions of their responsibilities as scientists. After the bomb was used in 1945, Brown immediately wrote a book, *Must Destruction Be Our Destiny?* (Simon & Schuster, 1946), in which he articulated his concerns and those of his colleagues. An ardent advocate for the establishment of an international body that could peaceably control the spread and possible use of atomic weapons, in the space of 3 months in 1946, he gave more than 100 speeches throughout the country presenting the basic arguments of his book.

It is noteworthy that on the jacket of this book, Albert Einstein is quoted as saying the following:

> One feels that this book is written by a man who is used to responsible work. It gives a clear, honest, and vivid description of the atom bomb as a weapon of war, objective and without any exaggeration. It gives a clear discussion, free of rhetoric, of the special international problems and the possibilities for their solution. Everyone who reads this book carefully will be enabled—and one hopes stimulated—to contribute to a sensible solution of the present dangerous situation.

It is also noteworthy that the subtitle of *Must Destruction Be Our Destiny?* is *A Scientist Speaks as a Citizen*. This subtitle reflects the modesty, yet firmness of conviction, with which Brown undertook his effort to communicate his concerns to the public. He was very sensitive to the claim that scientists should restrict themselves to questions of science. Without crediting scientists with special expertise regarding the social or political implications of science and technology, he responded by pointing out that scientists working on the atomic bomb had the advantage of knowing about the potential uses and consequences of this weapon some time before the general public did, and they had given this much careful thought. Convinced that the "man in the street" needs to be well informed before presenting social and political opinions about matters of great importance, Brown held that scientists have a responsibility to acquire and communicate needed information to lay audiences so that they are able to exercise better judgment.

As for himself, Brown said in his preface, "I have written as a man in the street, as an ordinary citizen, possessing primarily the fundamental desires to live freely, comfortably, and unafraid." Implicit here is the notion that *this* ordinary citizen also possessed information needed by all other ordinary citizens—information that, he was convinced, would enable them to join hands with those scientists who "have had the advantage of months and years to become acquainted with the problems and to think of them as would any reasonably literate and sensitive persons." He added, "As scientists we have indicated the problems—as citizens we have sought the answers."

Of course, Harrison Brown the scientist and Harrison Brown the ordinary citizen were one and the same person. He also chose to pursue a career at the California Institute of Technology, holding joint appointments in the geology and humanities divisions. In other words, he deliberately chose an interdisciplinary path in