of your first job. You are invited to interview with a research division of Philip Morris that is about to begin research to develop the Accord. Would you have any reservations about accepting such a position? Discuss.

- If you have some reservations, would the fact that this job pays $10,000 more per year than any other offer you have convince you to take the Philip Morris offer?
- Assuming you took the job, what kinds of ethical concerns might you have about how the device should be designed? For example, would you agree that it should have a locking device?

CASE 38

Software for a Library[104]

A small library seeks a software system to catalogue its collection and keep records of materials checked out of the library. Currently, the records of who has checked out what, when materials are due, and the like are kept in a file drawer behind the check-out desk. These records are confidential. Patrons are assured that these records are not accessible to anyone other than library personnel. But, of course, drawers can be opened when no one is looking. What assurance is there that the software systems under consideration will provide as much, if not greater, security? Assuming that no one in the library is a software specialist, the library has no alternative but to place its trust in someone who presumably has the requisite expertise. How concerned should that expert be (again, bearing in mind that even the best system is not completely sleuthproof)? Furthermore, what assurance has the library that it is not being oversold or undersold in general? To what extent should software specialists be concerned with determining precisely what the various needs of the library are—and to try to meet those needs rather than offer more than is necessary in order to secure greater profit or less than is needed in order to come in with a lower bid?

CASE 39

Sustainability

Scientists, engineers, and the government are publicly expressing urgent concern about the need to address the challenges of sustainable scientific and technological development. Global warming, for example, raises concern about glacial meltdown and consequent rising ocean levels threatening coastal cities. A related concern is the lowering of levels of freshwater in the American West as a result of lowered levels of accumulated mountain snow. In Joe Gertner's "The Future Is Drying Up," Nobel laureate Steven Chu, director of the Lawrence Berkeley National Laboratory, is cited as saying that even optimistic projections for the second half of the 21st century indicate a 30 to 70 percent drop in the snowpack level of the Sierra Nevada, provider of most of northern California's water.[105] Gertner goes on to discuss other likely freshwater problems that will have to be faced by Western states as a result of both global warming and the consumption needs and demands of an increasing population. He also outlines some of the efforts of engineers to address these problems aggressively now rather than wait until it is too late to prevent disaster.[106]

We noted in Chapter 9 that most engineering society codes of ethics do not make direct statements about the environmental responsibilities of engineers. However, in 2007 the NSPE joined the ranks of engineering societies that do. Under section III. Professional Obligations, provision 2 reads, "Engineers shall at all times strive to serve the public interest." Under this heading, there is a new entry, d: "Engineers are encouraged to adhere to the principles of sustainable development in order to protect the environment for future generations." Footnote 1 addresses the conceptual question of what is meant by "sustainable development": '"Sustainable development' is the challenge of meeting human needs for natural resources,

industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development."

Although this definition of sustainable development leaves many fundamental conceptual and value questions in need of further analysis (e.g., What are human needs? What is meant by "environmental quality"?), it provides a general framework for inquiry. It also identifies a variety of fundamental areas of concern (e.g., food, transportation, and waste management). Of course, responsibilities in these areas do not fall only on engineers. Government officials, economists, business leaders, and the general citizenry need to be involved as well. Thus, a basic question relates to how those who need to work together might best do so and what role engineers might play. We offer three illustrations for discussion. The first is an early effort to involve students from different disciplines in a project that supports sustainable development. The second is the recent proliferation of centers and institutes for sustainability on college campuses throughout the country. The third is service learning opportunities in support of sustainable design and development.

RENEWABLE ENERGY[107]

Dwayne Breger, a civil and environmental engineer at Lafayette College, invited junior and senior engineering, biology, and environmental science students to apply to be on an interdisciplinary team to design a project that would make use of farmland owned by Lafayette College in a way that supports the college mission. Twelve students were selected for the project: two each from civil and environmental engineering, mechanical engineering, chemical engineering, and Bachelor of Arts in engineering, plus three biology majors and one in geology and environmental geosciences. These students had minors in such areas as economics and business, environmental science, chemistry, government, and law. The result of the project was a promising design for a biomass farm that could provide an alternative, renewable resource for the campus steam plant.[108]

Professor Breger regards projects such as this as providing important opportunities for students to involve themselves in work that contributes to restructuring our energy use toward sustainable resources. ABET's *Engineering Criteria* 2000 for evaluating engineering programs includes the requirement that engineering programs demonstrate that their graduates have "an understanding of professional and ethical responsibility," "the broad education necessary to understand the impact of engineering solutions in a global and societal context," and "a knowledge of contemporary issues." Criterion 4 requires that students have "a major design experience" that includes consideration of the impact on design of such factors as economics, sustainability, manufacturability, ethics, health, safety, and social and political issues.[109] Discuss how the Lafayette College project might satisfy criterion 4, especially the ethical considerations.

ACADEMIC CENTERS FOR SUSTAINABILITY

Historically, joint research in colleges and universities is done within separate disciplines rather than in collaboration with other disciplines. Thus, biologists collaborate with other biologists, chemists with other chemists, economists with other economists, and political scientists with other political scientists. The recent emergence of centers and institutes for sustainability represents a significant and important break from that tradition.

In September 2007, the Rochester Institute of Technology initiated the Golisano Institute for Sustainability.[110] Noting that it is customary for new programs to be run by just one discipline, Nabil Nasr, the institute director, comments, "But the problem of sustainability cuts across economics, social elements, engineering, everything. It simply cannot be solved by one discipline, or even by coupling two disciplines."[111]

Dow Chemical has recently given the University of California at Berkeley $10 million to establish a sustainability center. Dow's Neil Hawkins says, "Berkeley has one of the strongest chemical engineering schools in the world, but it will be the M.B.A.'s who understand areas like microfinance solutions to drinking water problems."[112] The center is in Berkeley's Center for Responsible Business, directed by Kellie A. McElhaney. Commercialization of research undertaken by students and professors is expected. However, McElhaney notes, "Commercialization takes forever if the chemical engineers and the

business types do not coordinate. So think how much easier it will be for chemistry graduates to work inside a company if they already know how to interact with the business side."[113]

Discuss how considerations of ethics might enter into the collaborative efforts of centers and institutes for sustainability.

SERVICE LEARNING OPPORTUNITIES

The first two issues of the recently launched *International Journal for Service Learning* feature three articles promoting the notion that service learning projects can provide hands-on opportunities to undertake sustainable design and development. In "Service Learning in Engineering and Science for Sustainable Development," Clarion University of Pennsylvania physicist Joshua M. Pearce urges that undergraduates should have opportunities to become involved in projects that apply appropriate technologies for sustainable development.[114] Especially concerned with alleviating poverty in the developing world, Pearce argues,

> The need for development is as great as it has ever been, but future development cannot simply follow past models of economic activity, which tended to waste resources and produce prodigious pollution. The entire world is now paying to clean up the mess and enormous quantities of valuable resources have been lost for future generations because of the Western model of development. For the future, the entire world population needs 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.[115] 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.[116]

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.[117]

CASE 40

Testing Water … and Ethics

The video *Testing Water … and Ethics* is a fictional portrayal of a young engineer facing his first professional dilemma. He attempts to solve the problem by treating it as analogous to a design problem in engineering. He also employs the method of seeking a creative middle way. This video is available from the Institute for Professional Practice, 13 Lanning Road, Verona, NJ 07044-2511 (phone, 1-888-477-2723; e-mail, Bridge2PE@aol.com).