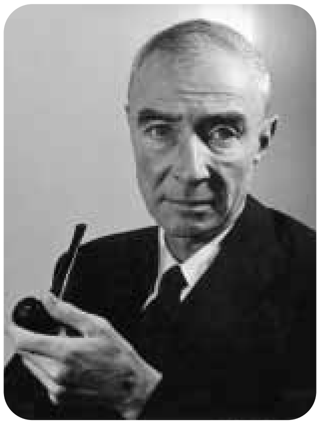
CHAPTER

18

Technology and the Global Environment



J. Robert Oppenheimer, the "father" of the atom bomb.

Web Interactive Exercises
The Surveillance Society

TECHNOLOGY: SAVIOR OR FRANKENSTEIN?

On August 6, 1945, the United States Air Force dropped an atomic bomb on Hiroshima. The bomb killed about 200,000 Japanese, almost all civilians. It hastened the end of World War II, thus making it unnecessary for American troops to suffer heavy losses in a land invasion of Japan.

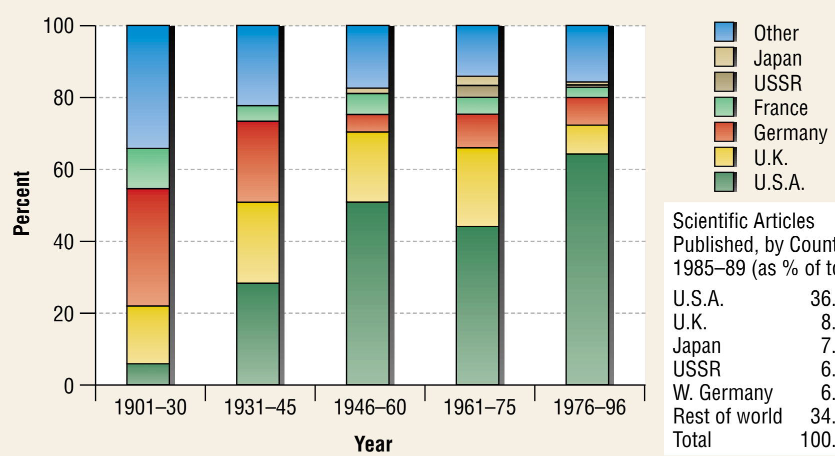
Scholars interested in the relationship between technology and society also recognize that Hiroshima divided the 20th century into two distinct periods. We may call the period before Hiroshima the era of naive optimism. During that time, technology could do no wrong, or so, at least, it seemed to nearly all observers. **Technology** was widely defined as the application of scientific principles to the *improvement* of human life. It seemed to be driving humanity down a one-way street named progress, picking up speed with every passing year thanks to successively more powerful engines: steam, turbine, internal combustion, electric, jet, rocket, and nuclear. Technology produced tangible benefits. Its detailed workings rested on scientific principles that were mysterious to all but those with advanced science degrees. Therefore, most people regarded technologists with reverence and awe. They were viewed as a sort of priesthood whose objectivity allowed them to stand outside the everyday world and perform near-magical acts.

With Hiroshima, the blush was off the rose. Growing pessimism was in fact evident 3 weeks earlier, when the world's first nuclear bomb exploded at the Alamagordo Bombing Range in New Mexico. The bomb was the child of J. Robert Oppenheimer, who had been appointed head of the top-secret Manhattan Project just 28 months earlier. After recruiting what General Leslie Groves called "the greatest collection of eggheads ever," including three past and seven future Nobel prize winners, Oppenheimer organized the largest and most sophisticated technological project in human history up to that time. As an undergraduate at Harvard, Oppenheimer had studied Indian philosophy, among other subjects. On the morning of July 16, 1945, as the flash of intense white light faded, and the purplish fireball rose, sucking desert sand and debris into a mushroom cloud more than 7½ miles high, Oppenheimer quoted from Hindu scripture: "I am become Death, the shatterer of worlds" (quoted in Parshall, 1998).

Oppenheimer's misgivings continued after the war. Having witnessed the destructive power he helped unleash, Oppenheimer wanted the United States to set an example to the only other nuclear power at the time, the Soviet Union. He wanted both countries to halt thermonuclear research and refuse to develop the hydrogen bomb. But the governments of the United States and the Soviet Union had other plans. When Secretary of State Dean

✦ **FIGURE 18.1** ✦
Nobel Prizes in Natural Science by Country, 1901–1996 (in percent)

SOURCES: Kidron and Segal (1995: 92–93); United States Bureau of the Census (1998c).



Scientific Articles Published, by Country, 1985–89 (as % of total)

U.S.A.	36.0
U.K.	8.7
Japan	7.5
USSR	6.8
W. Germany	6.5
Rest of world	34.5
Total	100.0

BOX 18.1
SOCIOLOGY AT THE MOVIES

THE MATRIX (1999)

"Have you ever felt that there's something not right in the world?" With these words, *The Matrix* introduces Thomas Anderson, played by Keanu Reeves. Respectable software programmer by day, notorious hacker by night, Anderson, who goes by the handle "Neo," has been plagued by the thought that there is something wrong with the world. "You don't know what it is, but it's there, like a splinter in your mind."

Neo knows somehow that something is wrong, but he cannot point to anything in particular. His moment of awareness comes when he encounters two legendary hackers, Morpheus and Trinity. They introduce him to the secret of his day world and the reality of the Matrix. It turns out that "reality" lived by Neo and others is a form of collective imagination made possible by a gigantic computer, the Matrix. In fact, Neo and other people are nothing more than power supplies housed in liquid-filled containers. They supply energy for the Matrix. The Matrix, in turn, supplies these "batteries" with images—making them feel they are living, not merely dreaming.

The Matrix is an exciting action-adventure film with extraordinary special effects. Beyond the glitz, however, there is much to ponder in the movie. It depicts a world where information technology and the *representation* of reality have taken over the seemingly stable reality of the physical world. Is this what *our* world is becoming? *The Matrix* also poses a classic sociological question about technology. Is technology always a means of improving human life? Or is it sometimes antagonistic to human values?

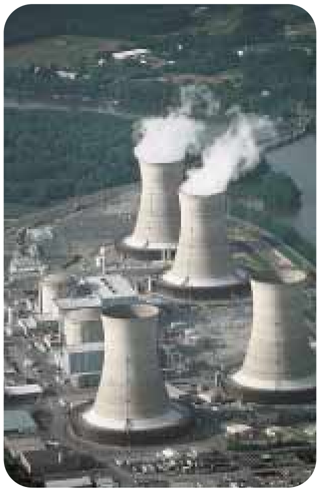
The Matrix, starring Keanu Reaves.

Acheson brought Oppenheimer to meet President Truman in 1946, Oppenheimer said, "Mr. President, I have blood on my hands." Truman later told Acheson, "don't bring that fellow around again" (quoted in Parshall, 1998).

Overall, Americans value science and technology highly. By a wide margin, the United States is the world leader in scientific research, publications, and elite achievements (see Figure 18.1). In 1998, 59% of Americans agreed that science and technology do more good than harm. Only 18% thought they do more harm than good. The remaining 26% were neutral on the subject (National Opinion Research Center, 1999). However, in the postwar years, a growing number of people, including Nobel prize winners who worked on the bomb, have come to share Oppenheimer's doubts (Feynman, 1999: 9–10). Indeed, they have extended those doubts not just to the peaceful use of nuclear energy but also to technology in general. Increasingly, ordinary citizens—and a growing chorus of leading scientists—are beginning to think of technology as a monster run amok, a Frankenstein rather than a savior (see Box 18.1; Joy, 2000; Kurzweil, 1999: 137–42).

It was only in the 1970s that a series of horrific disasters woke many people (including some sociologists) up to the fact that technological advance is not always beneficial, not even always benign. The most infamous technological disasters of the 1970s and 1980s include the following:

- An outbreak of "Legionnaires Disease" in a Philadelphia hotel in 1976 killed 34 people. It alerted the public to the possibility that the very buildings they live and work in can harbor toxic chemicals, lethal molds, and dangerous germs.
- In 1977, dangerously high levels of toxic chemicals were discovered leaking into the basements and drinking water of the residents of Love Canal, near Niagara Falls.



The Three-Mile Island nuclear facility.

This led to the immediate shutdown of an elementary school and the evacuation of residents from their homes.

- The partial meltdown of the reactor core at the Three Mile Island nuclear facility in Pennsylvania in 1979 caused lethal radioactive water and gas to pour into the environment. (A 1974 report by the Atomic Energy Commission said such an accident would likely occur only once in 17,000 years.)
- A gas leak at a poorly maintained Union Carbide pesticide plant in Bhopal, India, killed about 4,000 people in 1984 and injured 30,000, a third of whom died excruciating deaths in the following years.
- In 1986, the No. 4 reactor at Chernobyl, Ukraine, exploded, releasing 30 to 40 times the radioactivity of the blast at Hiroshima. It resulted in mass evacuations, more than 10,000 deaths, countless human and animal mutations, and hundreds of square miles of unusable cropland.
- In 1989, the Exxon Valdez ran aground in Prince William Sound, Alaska, spilling 11 million gallons of crude oil, producing a dangerous slick more than 1,000 miles long, causing billions of dollars of damage, and killing hundreds of thousands of animals.

Technology Bytes

By the mid-1980s, sociologist Charles Perrow was referring to events such as those listed above as **normal accidents.** The term “normal accident” recognizes that the very complexity of modern technologies ensures they will *inevitably* fail, though in unpredictable ways (Perrow, 1984). For example, a large computer program contains many thousands of conditional statements. They take the form: if x = y, do z; if a = b, do c. When in use, the program activates many billions of *combinations* of conditional statements. As a result, complex programs cannot be tested for all possible eventualities. Therefore, when rare combinations of conditions occur, they have unforeseen consequences that are usually minor, occasionally amusing, sometimes expensive, and too often dangerous. You experience normal accidents when your home computer “crashes” or “hangs.” A few years ago, the avionics software for the F-16 jet fighter caused the jet to flip upside down whenever it crossed the equator. In January 1990, AT&T’s entire long distance network was crippled for 9 hours due to a bug in the software for its routing switches. In Perrow’s sense of the term, these are all normal accidents, although not as dangerous as the chemical and nuclear mishaps mentioned above.

A sea otter covered in oil spilled by the Exxon Valdez in 1989.

German sociologist Ulrich Beck also coined a term that stuck when he said we live in a **risk society.** A risk society is a society in which technology distributes danger among all categories of the population. Some categories, however, are more exposed to technological danger than others. Moreover, in a risk society, danger does not result from technological accidents alone. In addition, increased risk is due to mounting *environmental* threats. Environmental threats are more widespread, chronic, and ambiguous than technological accidents. They are therefore more stressful (Beck, 1992 [1986]; Freudenburg, 1997). New and frightening terms—"greenhouse effect," "global warming," "acid rain," "ozone depletion," "endangered species"—have entered our vocabulary. To many people, technology seems to be spinning out of control. From their point of view, it enables the production of ever more goods and services, but at the cost of breathable air, drinkable water, safe sunlight, plant and animal diversity, and normal weather patterns. In the same vein, Neil Postman (1992) refers to the United States as a **technopoly.** He argues that the United States is the first country in which technology has taken control of culture. Technology, he says, compels people to try to solve all problems using technical rather than moral criteria, although technology is often the source of the problems.

The latest concern of technological skeptics is biotechnology. Molecular biologists have mapped the entire human gene structure and are also mapping the gene structure of selected animals and plants. They can splice genes together, creating plants and animals with entirely new characteristics. As we will see, the ability to create new forms of life holds out incredible potential for advances in medicine, food production, and other fields. That is why the many advocates of this technology speak breathlessly of a "second genesis" and "the perfection of the human species." Detractors claim that, without moral and political decisions based on a firm sociological understanding of who benefits and who suffers from these new techniques, the application of biotechnology may be a greater threat to our well-being than any other technology ever developed.

These considerations suggest five tough questions. We tackle each of them below. First, is technology *the* great driving force of historical and social change? This is the opinion of cheerleaders and naysayers, those who view technology as our savior and those who fear it as a Frankenstein. In contrast, we argue that technology is able to transform society only when it is coupled with a powerful social need. People control technology as much as technology transforms people. Second, if some people do control technology, then exactly who are they? We argue against the view that scientific and engineering wizards are in control. The military and big corporations now decide the direction of most technological research and its application. Third, what are the most dangerous spin-offs of technology and how is risk distributed among various social groups? We focus on global warming, industrial pollution, the decline of biodiversity, and genetic pollution. We show that while these dangers put all of humanity at risk, the degree of danger varies by class, race, and country. In brief, the socially and economically disadvantaged are most at risk. Fourth, how can we overcome the dangers of environmental degradation? We argue that market and technological solutions are insufficient by themselves. In addition, much self-sacrifice and cooperation will be required. The fifth and final question underlies all the others. It is the question with which we began this book (p. 25): Why sociology?

Technology *and* People Make History

Russian economist Nikolai Kondratiev was the first social scientist to notice that technologies are invented in clusters. As Table 18.1 shows, a new group of major inventions has cropped up every 40–60 years since the Industrial Revolution. Kondratiev argued that these flurries of creativity cause major economic growth spurts beginning 10–20 years later and lasting 25–35 years each. Thus, Kondratiev subscribed to a form of **technological determinism,** the belief that technology is the major force shaping human society and history (Ellul, 1964 [1954]).

Is it true that technology helps shape society and history? Of course it is. James Watt developed the steam engine in Britain in the 1760s. It was the main driving force in the

✦ **TABLE 18.1** ✦
"Kondratiev Waves" of Modern Technological Innovation and Economic Growth

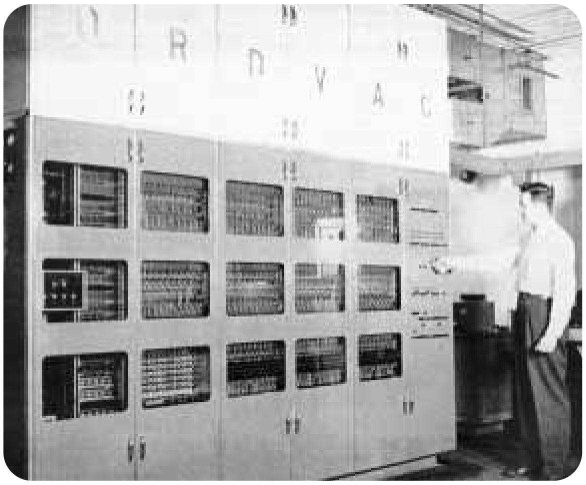
SOURCE: Adapted from Pacey (1983: 32).

Wave	Invention Dates	New Technologies	Base	Economic Growth Spurt
1	1760s–70s	Steam engine, textile manufacturing, chemistry, civil engineering	Britain	1780–1815
2	1820s	Railways, mechanical engineering	Britain, Continental Western Europe	1840–70
3	1870s–80s	Chemistry, electricity, internal combustion engine	Germany, United States	1890–1914
4	1930s–40s	Electronics, aerospace, chemistry	United States	1945–70
5	1970s	Microelectronics, biotechnology	United States, Japan	1985–?

mines, mills, factories, and railways of the Industrial Revolution. Gottlieb Daimler invented the internal combustion engine in Germany in 1883. It was the foundation stone of two of the world's biggest industries, automobiles and petroleum. John Atanasoff was among the first people to invent the computer in 1939 at Iowa State College (now University). It utterly transformed the way we work, study, and entertain ourselves. It also put the spurs to one of the most sustained economic booms ever. We could easily cite many more examples of how technology shapes history and transforms society.

However, if we probe a little deeper into the development of any of the technologies mentioned above, we notice a pattern: They did not become engines of economic growth until *social* conditions allowed them to do so. The original steam engine, for instance, was invented by Hero of Alexandria in the first century CE. He used it as an amusing way of opening a door. People then promptly forgot the steam engine. Some 1,700 years later, when the Industrial Revolution began, factories were first set up near rivers and streams, where waterpower was available. That was several years before Watt patented his steam engine. Watt's invention was all the rage once its potential became evident. But it did not cause the Industrial Revolution, and it was adopted on a wide scale only after the social need for it emerged (Pool, 1997: 126–7).

Similarly, Daimler's internal combustion engine became the basis of the automobile and petroleum industries thanks to changes in the social organization of work wrought by Henry Ford, the self-defeating business practice of Ford's main competitors, the Stanley brothers, and, oddly enough, an epidemic of hoof-and-mouth disease. When Ford incorporated his company in 1903, a steam-driven automobile, the Stanley Steamer, was his main competition. Many engineers then believed the Stanley Steamer was the superior vehicle on purely technical grounds. Many engineers still think so today. (For one thing, the Stanley Steamer didn't require a transmission system.) But while the Stanley brothers built a finely tooled automobile for the well to do, Ford tried to figure out a way of producing a cheap car for the masses. His inspiration was the meat-packing plants of Cincinnati and Chicago. In 1913, he modeled the first car assembly line after those plants. Only then did he open a decisive lead in sales over the Stanleys. The Stanleys were finally done in a few years later. An outbreak of hoof-and-mouth disease led officials to close down the public watering troughs for horses that were widely used in American cities. Owners of the Stanley Steamer used the troughs to replenish its water supply. So we see it would be wrong to say, along with strict technological determinists, that Daimler's internal combustion engine *caused* the growth of the car industry and then the petroleum industry. The car and petroleum industries grew out of the internal combustion engine only because an ingenious entrepreneur efficiently organized work in a new way and because a chance event undermined access to a key element required by his competitor's product (Pool, 1997: 153–5).



ORDVAC, an early computer developed at the University of Illinois, was delivered to the Ballistic Research Laboratory at the Aberdeen Proving Ground of the United States Army. Technology typically advances when it is coupled to an urgent social need.

Regarding the computer, Atanasoff stopped work on it soon after the outbreak of World War II. However, once the military potential of the computer became evident, its development resumed. The British computer Colossus helped to decipher secret German codes in the last 2 years of the war and played an important role in the Allied victory. The University of Illinois delivered one of the earliest computers, the ORDVAC, to the Ballistic Research Laboratory at the Aberdeen Proving Ground of the United States Army. Again we see how a new technology becomes a major force in society and history only after it is coupled with an urgent social need. We conclude that technology and society influence each other. Scientific discoveries, once adopted on a wide scale, often transform societies. But scientific discoveries are turned into useful technologies only when social need demands it.

How High Tech Became Big Tech

Enjoying a technological advantage usually translates into big profits for businesses and military superiority for countries. In the 19th century, gaining technological advantage was still inexpensive. It took only modest capital investment, a little knowledge about the best way to organize work, and a handful of highly trained workers to build a shop to manufacture stirrups or even steam engines. In contrast, mass-producing cars, sending a man to the moon, and other feats of 20th- and 21st-century technology require enormous capital investment, detailed attention to the way work is organized, and legions of technical experts. Add to this the intensely competitive business and geopolitical environment of the 20th and 21st centuries, and one can readily understand why ever larger sums have been invested in research and development over the past hundred years.

It was in fact already clear in the last quarter of the 19th century that turning scientific principles into technological innovations was going to require not just genius but substantial resources, especially money and organization. Thus, Thomas Edison established the first "invention factory" at Menlo Park, New Jersey, in the late 1870s. Historian of science Robert Pool notes:

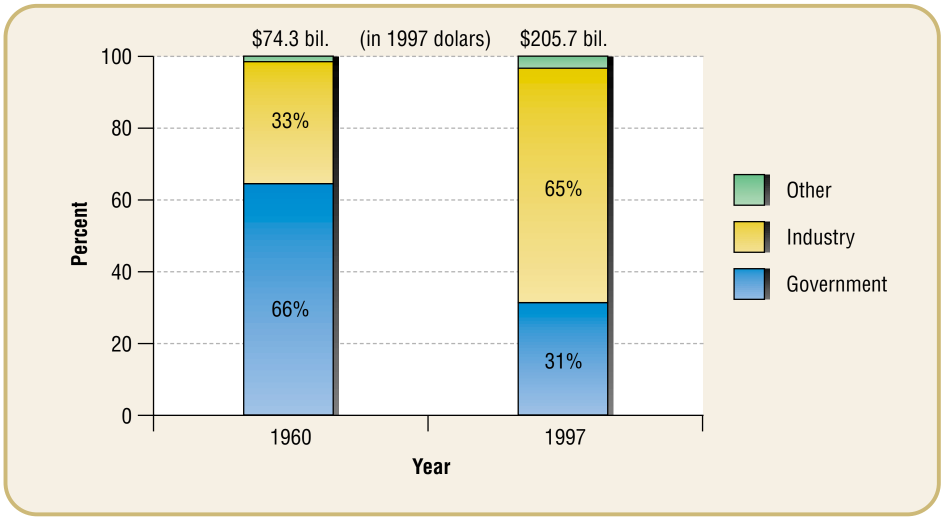
> [T]he most important factor in Edison's success—outside of his genius for invention—was the organization he had set up to assist him. By 1878, Edison had assembled at Menlo Park a staff of thirty scientists, metalworkers, glassblowers, draftsmen, and others working under his close direction and supervision. With such support, Edison boasted that he could turn out "a minor invention every ten days and a big thing every six months or so" (Pool, 1997: 22).

The phonograph and the electric light bulb were two such "big things." Edison inspired both. Both, however, were also expensive team efforts, motivated by vast

✦ **FIGURE 18.2** ✦

Research and Development, United States, 1960 and 1997, by Source (in percent)

SOURCE: United States Bureau of the Census (1998c); Woodrow Federal Reserve Bank of Minneapolis (2000).



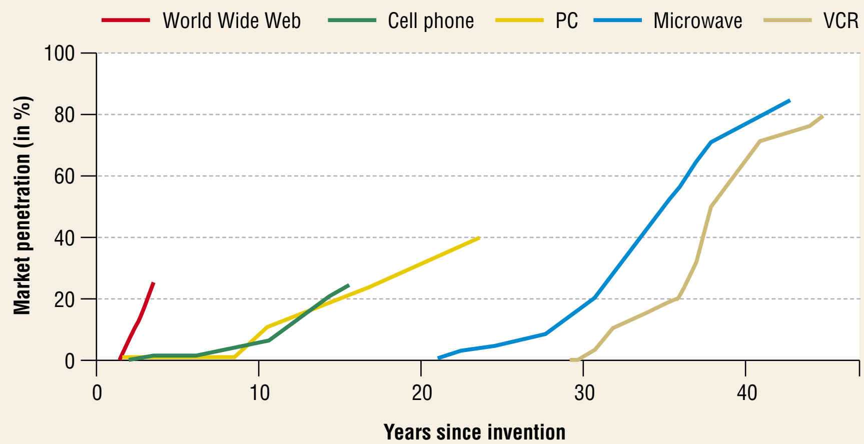
commercial possibilities. (Edison founded General Electric, the most profitable company in the world in 1999 and the second most valuable based on market capitalization; see "Global 1000," 1999.)

By the beginning of the 20th century, the scientific or engineering genius operating in isolation was only rarely able to contribute much to technological innovation. By mid-century, most technological innovation was organized along industrial lines. Entire armies of experts and vast sums of capital were required to run the new invention factories. The prototype of today's invention factory was the Manhattan Project, which built the nuclear bomb in the last years of World War II. By the time of Hiroshima, the manufacturing complex of the United States nuclear industry was about the same size as that of the United States automobile industry. The era of big science and big technology had arrived. Only governments and, increasingly, giant multinational corporations could afford to sustain the research effort of the second half of the 20th century.

As the 20th century ended, there seemed to be no upper limit to the amount that could be spent on research and development. The United States had fewer than 10,000 research scientists before World War I. Today, it has more than a million (Hobsbawm, 1994: 523). In 1997, American research and development spending reached $205.7 billion, up from $74.3 billion in 1960 (calculated in 1997 dollars to take account of inflation). During that same period, industry's share of spending rose from 33% to 65% of the total, while government's dropped from 66% to 31% (see Figure 18.2).

Because large multinational corporations now routinely invest astronomical sums in research and development to increase their chance of being the first to bring innovations to market, the time lag between new scientific discoveries and their technological application is continuously shrinking. That is clear from Figure 18.3, which shows how long it took five of the most popular new consumer products of the 1980s and 1990s to penetrate the United States market. It was fully 38 years after the VCR was invented in 1952 before the device achieved 25% market penetration. It took 18 years before the personal computer, invented in 1975, was owned by 25% of Americans. The World Wide Web, invented in 1991, took only 7 years to reach that level of market penetration.

Because of these developments, it should come as no surprise that military and profit-making considerations now govern the direction of most research and development. A reporter once asked a bank robber why he robs banks. The robber answered: "Because that's where the money is." This is hardly the only motivation prompting scientists and engineers to research particular topics. Personal interests, individual creativity, and the state of a field's intellectual development still influence the direction of inquiry. This is especially true for theoretical work done in colleges, as opposed to applied research funded by governments and private industry. It would, however, be naive to



	Invented	Years till 25% penetration
VCR	1952	38
Microwave	1953	32
PC	1975	18
Cell phone	1983	14
World Wide Web	1991	7

✦ **FIGURE 18.3** ✦
Market Penetration by Years Since Invention, United States

SOURCE: "The Silent Boom" (1998).

think that practicality doesn't also enter the scientist's calculation of what he or she ought to study. Even in a more innocent era, Sir Isaac Newton studied astronomy partly because the explorers and mariners of his day needed better navigational cues. Similarly, Michael Faraday was motivated to discover the relationship between electricity and magnetism partly by his society's search for new forms of power (Bronowski, 1965 [1956]: 7–8). The connection between practicality and research is even more evident today. Many researchers—even many of those who do theoretically driven research in colleges—are pulled in particular directions by large research grants, well-paying jobs, access to expensive state-of-the-art equipment, and the possibility of winning patents and achieving commercial success. For example, many leading molecular biologists in the United States today have established genetic engineering companies, serve on their boards of directors, or receive research funding from them. In not a few cases, major pharmaceutical and agrochemical corporations have bought out these companies because they see their vast profit potential (Rural Advancement Foundation International, 1999). Even in the late 1980s, nearly 40% of the biotechnology scientists who

Research in biotechnology is big business. Even in the late 1980s, nearly 40% of the biotechnology scientists who belonged to the prestigious National Academy of Sciences had industry affiliations.

Due to global warming, glaciers are melting, the sea level is rising, and extreme weather events are becoming more frequent.

belonged to the prestigious National Academy of Sciences had industry affiliations (Rifkin, 1998: 56).

Economic lures, increasingly provided by the military and big corporations, have generated moral and political qualms among some researchers. Some scientists and engineers wonder whether work on particular topics achieves optimum benefits for humanity. Certain researchers are troubled by the possibility that some scientific inquiries may be harmful to humankind. However, a growing number of scientists and engineers recognize that to do cutting-edge research they must still any residual misgivings, hop on the bandwagon, and adhere to military and industrial requirements and priorities. That, after all, is where the money is.

Environmental Degradation

The side effect of technology that has given people the most serious cause for concern is environmental degradation. It has four main aspects: global warming, industrial pollution, the decline of biodiversity, and genetic pollution. Let us briefly consider each of these problems, beginning with global warming.

Global Warming

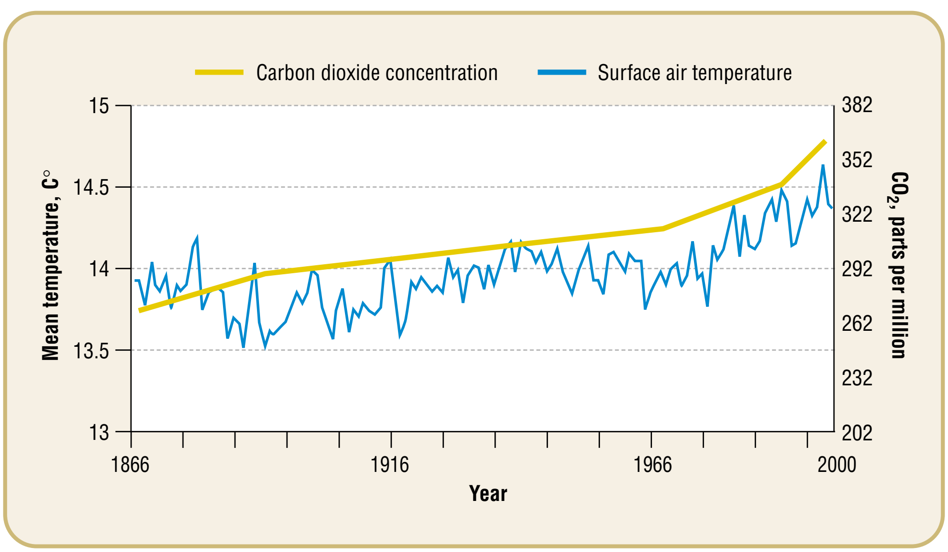
Ever since the Industrial Revolution, humans have been burning increasing quantities of fossil fuels (coal, oil, gasoline, natural gas, etc.) to drive their cars, furnaces, and factories. Burning these fuels releases carbon dioxide into the atmosphere. The accumulation of carbon dioxide allows more solar radiation to enter the atmosphere and less heat to escape. This is the so-called **greenhouse effect.** Most scientists believe that the greenhouse effect contributes to **global warming,** a gradual increase in the world's average surface temperature. Using data from NASA's Goddard Institute for Space Studies, Figure 18.4 graphs the world's annual average surface air temperature from 1866 to 2000 and the concentration of carbon dioxide in the atmosphere from 1866 to 1998. The graph shows a warming trend that mirrors the increased concentration of carbon dioxide in the atmosphere. It also shows that the warming trend intensified sharply in the last third of the 20th century. Between 1866 and 1965, average surface air temperature rose at a rate of 0.25 degree Celsius per century. From 1966 to 2000, average surface air temperature rose at a rate of 1.29 degrees Celsius per century.

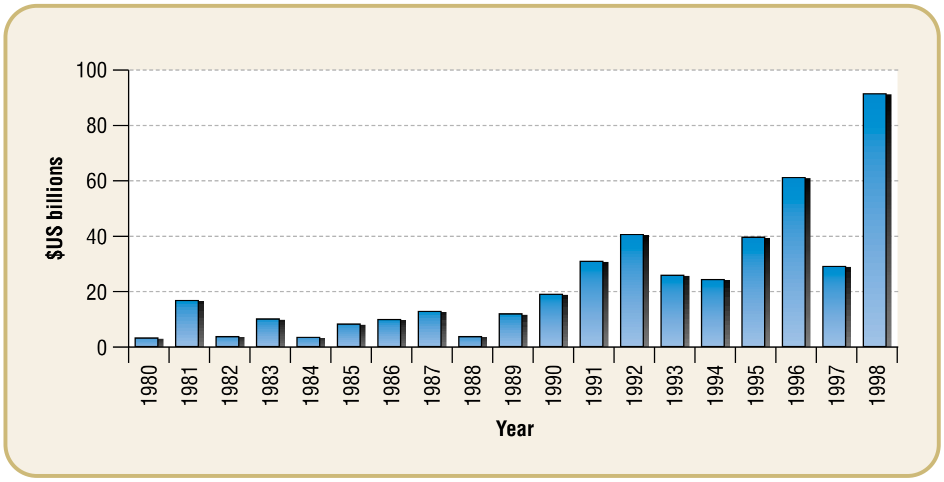
Many scientists believe global warming is already producing serious climatic change. For as temperatures rise, more water evaporates. This causes more rainfall and bigger storms, which leads to more flooding and soil erosion, which in turn leads to less cultivable

✦ FIGURE 18.4 ✦

Annual Mean Global Surface Air Temperature and Carbon Dioxide Concentration, 1866–2000

SOURCES: Goddard Institute for Space Studies (2001); Karl and Trenberth (1999: 102).

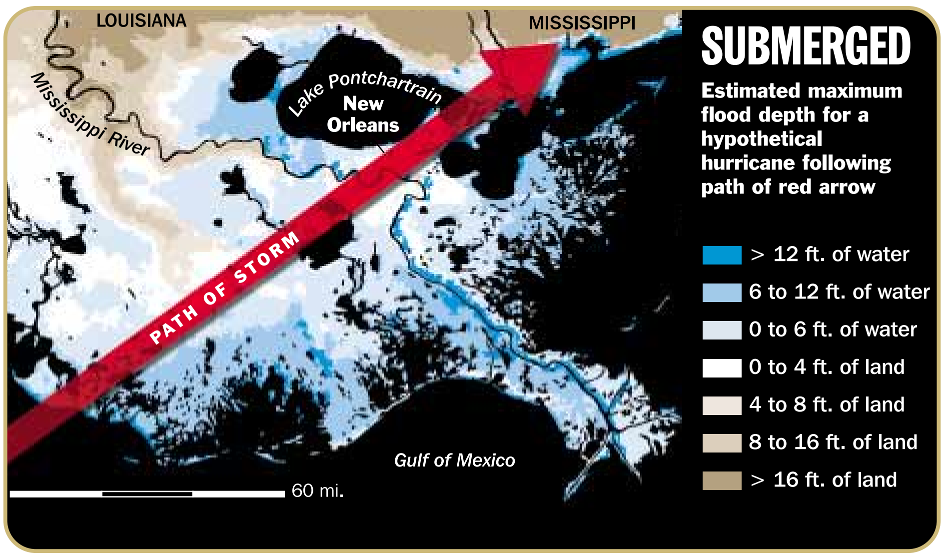




✦ **FIGURE 18.5** ✦

Worldwide Damage Due to "Natural" Disasters, 1980–1998 (in 1998 U.S. Dollars)

SOURCES: Abu-Nasr (1998); Vidal (1999).



✦ **FIGURE 18.6** ✦

Flood Danger in New Orleans

According to Joe Suhayda, a water resources expert at Louisiana State University, if a Category 5 hurricane came barreling out of the Gulf of Mexico and headed straight to New Orleans, the city would likely find itself under so much water it would be almost completely destroyed. The city is already below sea level, and with sea levels rising due to global warming, the potential for a disastrous flood grows.

SOURCE: Cohen (2000).

land. People suffer and die all along the causal chain. This was tragically evident in 1998, when Hurricane Mitch caused entire mountainsides to collapse on poor villages in Guatemala and Honduras, killing thousands of inhabitants and ruining the fertile banana plantations of those countries.

Figure 18.5 graphs the worldwide dollar cost of damage due to "natural" disasters from 1980 to 1998. ("Natural" is in quotation marks because, as we have just seen, an increasingly large number of meteorological events are rendered extreme by human action.) Clearly, the damage caused by extreme meteorological events was on the upswing throughout the 1990s. This, however, may be only the beginning. It seems that global warming is causing the oceans to rise. That is partly because warmer water expands and partly because the partial melting of the polar ice caps puts more water in the oceans. In the 21st century, this may result in the flooding of some heavily populated coastal regions throughout the world. Just a 1-yard rise in the sea level would flood about 12% of the surface area of Egypt and Bangladesh and 0.5% of the surface area of the United States (Kennedy, 1993: 110; see Figure 18.6).

Industrial Pollution

Industrial pollution is the emission of various impurities into the air, water, and soil due to industrial processes. It is a second major form of environmental degradation. Every day, we release a witch's brew into the environment. The more common ingredients include household trash, scrap automobiles, residue from processed ores, agricultural runoff containing dangerous chemicals, lead, carbon monoxide, carbon dioxide, sulfur dioxide, ozone, nitrogen oxide, various volatile organic compounds, chlorofluorocarbons (CFCs), and various solids mixed with liquid droplets floating in the air. Most pollutants are especially highly concentrated in the United States Northeast and around the Great Lakes. Old, heavy, dirty industries are centered in these densely populated areas (United States Environmental Protection Agency, 2000).

Pollutants may affect us directly. For example, they seep into our drinking water and the air we breathe, causing a variety of ailments, particularly among the young, the elderly, and the ill. A dramatic natural experiment demonstrating the direct effect of air pollution on health occurred during the 1996 Atlanta Olympics. For the 17 days of the Olympics, asthma attacks among children in the Atlanta area plummeted 42%. When the athletes went home, the rate of asthma attacks among children immediately bounced back to normal levels. Epidemiologists soon figured out why. During the Olympics, Atlanta closed the downtown to cars and operated public transit around the clock. Vehicle exhaust fell, with an immediate benefit to children's health. Children's health deteriorated as soon as normal traffic resumed (Mittelstaedt, 2001).

Pollutants may also affect us indirectly. For instance, sulfur dioxide and other gases are emitted by coal-burning power plants, pulp and paper mills, and motor-vehicle exhaust. They form **acid rain.** This is a form of precipitation whose acidity eats away at, and eventually destroys, forests and the ecosystems of lakes. Another example: CFCs are widely used in industry and by consumers, notably in refrigeration equipment. They contain chlorine, which is responsible for the depletion of the **ozone layer** 5–25 miles above the earth's surface. Ozone is a form of oxygen that blocks ultraviolet radiation from the sun. Let more ultraviolet radiation reach ground level and, as we are now witnessing, rates of skin cancer and crop damage increase.

Radioactive waste deserves special attention. About 100 nuclear reactors are now generating commercial electricity in the United States. They run on enriched uranium or plutonium fuel rods. Once these fuel rods decay beyond the point where they are useful in the reactor, they become waste material. This waste is highly radioactive. It must decay about 10,000 years before humans can be safely exposed to it without special protective equipment. The spent fuel rods need to be placed in sturdy, watertight copper canisters and buried deep in granite bedrock where the chance of seismic disturbance and water seepage is small. The trouble is, most Americans are petrified at the prospect of having a nuclear waste facility anywhere near their families. As a result, spent fuel rods have been accumulating since the 1950s in "temporary" facilities. These are mainly pools of water near nuclear reactors. These facilities are a safety threat the American public has not really begun to deal with yet (Pool, 1997).

The Destruction of Biodiversity

The third main form of environmental degradation is the decline in **biodiversity,** the enormous variety of plant and animal species inhabiting the earth. Biodiversity changes as new species emerge and old species die off because they cannot adapt to their environment. This is all part of the normal evolutionary process. However, in recent decades the environment has become so inhospitable to so many species that the rate of extinction has greatly accelerated. Examination of fossil records suggests that, for millions of years, an average of one to three species became extinct annually. Today, about 1,000 species are becoming extinct annually (Tuxill and Bright, 1998: 41). In 11 countries, 10% or more of bird species are threatened with extinction. In 29 countries, 10% or more of mammal species are similarly threatened (Kidron and Segal, 1995: 14–15).

The extinction of species is impoverishing in itself, but it also has practical consequences for humans. For example, each species of animal and plant has unique properties. When scientists discover that a certain property has a medically useful effect, they get busy trying to synthesize the property in the laboratory. Treatments for everything from headaches to cancer have been found in this way. Indeed, about a quarter of all drugs prescribed in the United States today (including 9 of the top 10 in sales) include compounds first found in wild organisms. The single richest source of genetic material with pharmaceutical value is found in the world's rain forests, particularly in Brazil, where more than 30 million species of life exist. However, the rain forests are being rapidly destroyed by strip mining, the construction of huge pulp and paper mills and hydroelectric projects, and the deforestation of land by farmers and cattle grazers.

Similarly, fleets of trawlers belonging to the highly industrialized countries are now equipped with sonar to help them find large concentrations of fish. Some of these ships use fine mesh nets to increase their catch. They have been enormously "successful." Trawlers have depleted fish stocks in some areas of the world. In North America, for example, the depletion of cod, salmon, blue-fin tuna, and shark stocks has devastated fishing communities and endangered one of the world's most important sources of protein. All told, 11 of the world's 15 main fishing grounds and 69% of the world's main fish species are in decline (McGinn, 1998: 60).

Genetic Pollution

Genetic pollution is the fourth main form of environmental degradation. It refers to the health and ecological dangers that may result from artificially splicing genes together (Rifkin, 1998).

The genetic information of all living things is coded in a chemical called DNA. When members of a species reproduce, the characteristics of the mates are naturally transmitted to their offspring through DNA. **Recombinant DNA,** in contrast, is a technique developed by molecular biologists in the last few decades. It involves artificially joining bits of DNA from a donor to the DNA of a host. Donor and host may be of the same or different species. The donor DNA grows along with the host DNA, in effect creating a new form of life. For example, scientists inserted the gene that makes fireflies sparkle at night into a tobacco plant. The offspring of the plant had leaves that glowed in the dark. Researchers inserted human growth hormone into a mouse embryo. This created mice that grew twice as big and twice as fast as ordinary mice. Biologists combined embryo cells from a sheep and a goat and placed them in the womb of a surrogate animal. The surrogate animal then gave birth to an entirely new species, half sheep, half goat.

These wonders of molecular biology were performed in the mid-1980s and helped to dramatize and publicize the potential of recombinant DNA. Since 1990, governments and corporations have been engaged in a multibillion-dollar international effort to create a

Artificially splicing genes together may yield benefits as well as dangers. Woody Allen in *Sleeper* (1973).

complete genetic map of humans and various plants, microorganisms, and animal species. With human and other genetic maps in hand, and using recombinant DNA and related techniques, it is possible to design what some people regard as more useful animals and plants and superior humans. By 2000, scientists had identified the location and chemical structure of every one of the approximately 40,000 human genes. This will presumably enable them to understand the function of each gene. They can then detect and eliminate hereditary propensities to a wide range of diseases. Recombinant DNA will also enable farmers to grow disease- and frost-resistant crops with higher yields. It will allow miners to pour ore-eating microbes into mines, pump the microbes aboveground after they have had their fill, and then separate out the ore. This will greatly reduce the cost and danger of mining. Recombinant DNA will allow companies to grow plants that produce cheap biodegradable plastic and microorganisms that consume oil spills and absorb radioactivity. The potential health and economic benefits to humankind of these and many other applications of recombinant DNA are truly startling.

So are the dangers genetic pollution poses to human health and the stability of ecosystems (Rifkin, 1998: 67–115; Tokar, 2001). Consider, for example, the work of scientists at the National Institute of Allergy and Infectious Diseases. In the late 1980s, they introduced the genetic instructions for the human AIDS virus into mouse embryos. Subsequent generations of mice were born with AIDS and were used for research to find a cure for the disease. But what would happen if some of those mice got loose and bred with ordinary mice? In 1990, Dr. Robert Gallo, codiscoverer of the AIDS virus, and a team of other scientists reported in the respected journal *Science* that the AIDS virus carried by the mice could combine with other mouse viruses. This could result in a new form of AIDS capable of reproducing more rapidly and being transmitted to humans through the air. Recognizing this danger, scientists housed the AIDS mice in stainless steel glove boxes surrounded by a moat of bleach. They enclosed the entire apparatus in the highest level biosafety facility that exists. No mice have escaped so far, but the risk is still there.

Meanwhile, humans are already the recipients of transplanted bone marrow and hearts from baboons and pigs. While the animals are screened for known problems, critics point out such transplants could enable dangerous unknown viruses and retroviruses to jump between species and cause an epidemic among humans. If this seems farfetched, remember that the AIDS virus is widely believed to have jumped between a chimpanzee and a human in the late 1930s. By the end of 1999, the AIDS virus had killed about 14.5 million people worldwide and infected more than 34 million others (United Nations, 2000). Ominously, in 1997 scientists discovered a previously unknown pig virus that can infect humans. And in 2000, scientists reported that at least three known pig retroviruses could infect human cells (Van der Laan, Lockey, Griffeth, Frasier, Wilson, Onions, Hering, Long, Otto, Torbett, and Salomon, 2000).

Genetic pollution may also affect the stability of ecosystems. When a nonnative organism enters a new environment, it usually adapts without a problem. Sometimes, however, it unexpectedly wreaks havoc. Kudzu vine, Dutch elm disease, the gypsy moth, chestnut blight, starlings, Mediterranean fruit flies, zebra mussels, rabbits, and mongooses have all done just that. Now, however, the potential for ecological catastrophe has multiplied. That is because scientists are regularly testing genetically altered plants (effectively, nonnative organisms) in the field. Some have gone commercial, and many more will soon be grown on a wide scale. These plants are resistant to insects, disease, and frost. However, once their pollen and seeds escape into the environment, weeds, insects, and microorganisms will eventually build up resistance to the genes that resist herbicides, pests, and viruses. Thus, superbugs, superweeds, and superviruses will be born. We cannot predict the exact environmental consequences of these developments. However, the insurance industry refuses to insure genetically engineered crops against the possibility of their causing catastrophic ecological damage.

Global warming, industrial pollution, the decline of biodiversity, and genetic pollution threaten everyone. However, as you will now see, the degree to which they are perceived as threatening depends on certain social conditions being met. Moreover, the threats are not evenly distributed in society.

THE SOCIAL CONSTRUCTION OF ENVIRONMENTAL PROBLEMS

Environmental problems do not become social issues spontaneously. Before they can enter the public consciousness, policy-oriented scientists, the environmental movement, the mass media, and respected organizations must discover and promote them. People have to connect real-life events to the information learned from these groups. Because some scientists, industrial interests, and politicians dispute the existence of environmental threats, the public can begin to question whether environmental issues are in fact social problems that require human intervention. We must not, then, think of environmental issues as inherently problematic. Rather, they are contested phenomena. They can be socially constructed by proponents. They can be socially demolished by opponents. This is the key insight of the school of thought known as **social constructionism** (Hannigan, 1995b).

The controversy over global warming is a good example of how people create and contest definitions of environmental problems (Gelbspan, 1997; 1999; Hart and Victor, 1993; Mazur, 1998; Ungar, 1992; 1995; 1998; 1999). The theory of global warming was first proposed about a century ago. However, an elite group of scientists began serious research on the subject only in the late 1950s. They attracted no public attention until the 1970s. That is when the environmental movement emerged. The environmental movement gave new legitimacy and momentum to the scientific research and helped to secure public funds for it. Respected and influential scientists now began to promote the issue of global warming. The mass media, always thirsting for sensational stories, were highly receptive to these efforts. Newspaper and television reports about the problem began to appear in the late 1970s. They proliferated in the mid- to late 1980s. Between 1988 and 1991, the public's interest in global warming reached an all-time high. That was because frightening events helped to make the media reports more believable. For example, the summer of 1988 brought the worst drought in half a century. As crops failed, New York sweltered, and huge fires burned in Yellowstone National Park, *Time* magazine ran a cover story entitled "The Big Dry." It drew the connection between global warming and extreme weather. Many people got worried. Soon, respected organizations outside the scientific community, the mass media, and environmental movement—such as the insurance industry and the United Nations—expressed concern about the effects of global warming. By 1994, 59% of Americans with an opinion on the subject thought that using coal, oil, and gas contributes to the greenhouse effect (calculated from National Opinion Research Center, 1999).

By 1994, however, public concern with global warming had already passed its peak. The eruption of Mount Pinatubo in the Philippines pumped so much volcanic ash into the atmosphere, clouding the sunshine, that global surface air temperatures fell in 1992–93. Media reports about global warming sharply declined. The media, always thirsting for new scares to capture larger audiences, thought the story had grown stale. Some scientists, industrialists, and politicians began to question whether global warming was in fact taking place. They cited satellite data showing the earth's lower atmosphere had cooled in recent decades. They published articles and took out ads to express their opinion, thus increasing public skepticism.

With surface temperatures showing warming and lower atmospheric temperatures showing cooling, different groups lined up on different sides of the global warming debate. Those who had most to lose from carbon emission cuts emphasized the lower atmospheric data. This group included Western coal and oil companies, the member states of the Organization of Petroleum Exporting Countries (OPEC), and other coal- and oil-exporting nations. Those who had most to lose from the consequences of global warming or least to lose from carbon emission cuts emphasized the surface data. This group included insurance companies, an alliance of small island states, the European Union, and the United Nations. In the United States, the division was sufficient to prevent the government from acting. The Clinton–Gore administration pushed for a modest 7% cut in carbon emissions between 1990 and 2012. But the Republican-controlled Congress blocked the proposal. As a result, the United States is now the only industrialized country that has failed to legislate cuts in carbon emissions.

This could change in the near future. In August 1998, the global warming skeptics were dealt a serious blow when their satellite data were shown to be misleading. Until then, no one had taken into account that the satellites were gradually slipping from their orbits due to atmospheric friction, thus causing imprecise temperature readings. Allowing for the slippage, scientists from NASA and private industry now calculate that temperatures in the lower atmosphere are rising, just like temperatures on the earth's surface (Wentz and Schabel, 1998; Hansen, Sato, Ruedy, Lacis, and Glascoe, 1998). These new findings may finally help lay to rest the claims of the global warming skeptics. However, one thing is certain. As the social constructionists suggest, the power of competing interests to get their definition of reality accepted as the truth will continue to influence public perceptions of the seriousness of global warming.

In addition to being socially defined, environmental problems are socially distributed. That is, environmental risks are greater for some groups than others. Let us now examine this issue.

The Social Distribution of Risk

You may have noticed that after a minor twister touches down on some unlucky community in Texas or Kansas, TV reporters often rush to interview the surviving residents of trailer parks. The survivors stand amid the rubble that was their lives. They heroically remark on the generosity of their neighbors, their good fortune in still having their family intact, and our inability to fight nature's destructive forces. Why trailer parks? Small twisters aren't particularly attracted to them, but reporters are. That is because trailers are pretty flimsy in the face of a small tornado. They often suffer a lot of damage from twisters. They therefore make a more sensational story than the minor damage typically inflicted on upper-middle-class homes with firmly shingled roofs and solid foundations. This is a general pattern. Whenever disaster strikes—from the sinking of the Titanic to the fury of Hurricane Mitch—economically and politically disadvantaged people almost always suffer most. That is because their circumstances render them most vulnerable.

In fact, the advantaged often consciously put the disadvantaged in harm's way to avoid risk themselves. For example, oil refineries, chemical plants, toxic dumps, garbage incinerators, and other environmentally dangerous installations are more likely to be built in poor communities with a high percentage of African Americans or Hispanic Americans than in more affluent, mainly white communities. That is because disadvantaged people are often too politically weak to oppose such facilities and some may even value the jobs they create. Thus, in a study conducted in the mid-1980s, the number and size of hazardous waste facilities were recorded for every ZIP code area in the United States. At a time when about 20% of Americans were of African or Hispanic origin, ZIP code areas lacking any such facilities had, on average, a 12% minority population. ZIP code areas with one such facility had about a 24% minority population on average. And ZIP code areas with more than one such facility or with one of the five largest landfills in the United States had on average a 38% minority population. The study concluded that three out of five African Americans and Hispanic Americans live in communities with uncontrolled toxic waste sites (Szasz and Meuser, 1997: 100; Stretesky and Hogan, 1998). Similarly, the 75-mile strip along the lower Mississippi River between New Orleans and Baton Rouge has been nicknamed "cancer alley" because the largely black population of the region suffers from unusually high rates of lung, stomach, pancreatic, and other cancers. The main reason? This small area is the source of fully one quarter of the petrochemicals produced in the country, containing more than 100 oil refineries and chemical plants (Bullard, 1994 [1990]). A final example: Some poor Native American reservations have been targeted as possible interim nuclear waste sites. That is partly because states have little jurisdiction over reservations, so the usual state protests against such projects are less likely to prove effective. In addition, the Goshute tribe in Utah and the Mescalero Apaches in New Mexico have expressed interest in the project because of the money it promises to bring into their reservations (Pool, 1997: 247–8). Here again we see the recurrent pattern of what

Petrochemical plants between New Orleans and Baton Rouge form what local residents call "cancer alley." Here, the Union Carbide plant in Taft, Louisiana.

some analysts call **environmental racism** (Bullard, 1994 [1990]). This is the tendency to heap environmental dangers on the disadvantaged, and especially on disadvantaged racial minorities.

What is true for disadvantaged classes and racial groups in the United States also holds for the world's less developed countries. The underprivileged face more environmental dangers than the privileged (Kennedy, 1993: 95–121). In North America, Western Europe, and Japan, population growth is low and falling. Industry and government are eliminating some of the worst excesses of industrialization. In contrast, world population will grow from about 6 to 7 billion between 2000 and 2010, and nearly all of that growth will be in the less developed countries of the Southern Hemisphere. Moreover, Mexico, Brazil, China, India, and many other southern countries are industrializing rapidly. This is putting tremendous strain on their natural resources. Rising demand for water, electricity, fossil fuels, and consumer products is creating more polluted rivers, dead lakes, and industrial waste sites. At a quickening pace, rain forests, grazing land, cropland, and wetlands are giving way to factories, roads, airports, and housing complexes. Smog-blanketed megacities continue to sprawl. Eighteen of the world's 21 biggest cities are in less developed countries.

Given the picture sketched above, it should come as no surprise that, on average, people in less developed countries are more concerned about the environment than people in rich countries (Brechin and Kempton, 1994). However, the developing countries cannot afford much in the way of pollution control, so antipollution regulations are lax by North American, Western European, and Japanese standards. This is an incentive for some multinational corporations to site some of their most environmentally unfriendly operations in the Southern Hemisphere (Clapp, 1998). It is also the reason the industrialization of the less developed countries is proving so punishing to the environment. When car ownership grows from less than 1% to 10% of the population in China, and when 50 or 75 million Indians with motor scooters upgrade to cars, environmental damage may well be catastrophic. That is because the Chinese and the Indians simply cannot afford catalytic converters and electric cars. They have no regulations phasing in the use of these and other devices that save energy and pollute less.

For the time being, however, the rich countries do most of the world's environmental damage. That is because their inhabitants earn and consume more than the inhabitants of less developed countries. How much more? The richest fifth of humanity earns about 80 times more than the poorest fifth (up from 30 times more in 1950). In the past half century, the richest fifth doubled its per capita consumption of energy, meat, timber, steel, and copper and quadrupled its car ownership. In that same period, the per capita consumption of the poorest fifth hardly changed. The United States has only 4.5% of the world's population, but it uses about 25% of the earth's resources. It also produces more than 20% of global emissions of carbon dioxide, the pollutant responsible for about half of global warming (Ehrlich, Daily, Daily, Myers, and Salzman, 1997). Thus, the inhabitants of the Northern Hemisphere cause a disproportionately large share of the world's environmental problems, enjoy a disproportionate share of the benefits of technology, and live with fewer environmental risks than people in the Southern Hemisphere.

Social inequalities are also apparent in the field of biotechnology. For instance, the large multinational companies that dominate the pharmaceutical, seed, and agrochemical industries now routinely send anthropologists, biologists, and agronomists to all corners of the world. There they take samples of wild plants, the crops people grow, and human blood. They hope to find genetic material with commercial value in agriculture and medicine. If they discover genes with commercial value, the company they work for patents the discovery. This gives them the exclusive legal right to manufacture and sell the genetic material without compensating the donors. For example, Indian farmers and then scientists worked for a hundred generations discovering, skillfully selecting, cultivating, and developing techniques for processing the neem tree, which has powerful antibacterial and pesticidal properties. However, a giant corporation based in a rich country is now the sole commercial beneficiary of their labor. Monsanto (United States), Novartis (Switzerland), Glaxo Wellcome (United Kingdom), and other prominent companies in the life sciences call this “protection of intellectual property.” Indigenous peoples and their advocates call it “biopiracy” (Rifkin, 1998: 37–66).

Finally, consider the possible consequences of people having their babies genetically engineered. This should be possible on a wide scale in 10 or 20 years. Free of inherited diseases and physical abnormalities, and perhaps genetically programmed to enjoy superior intellectual and athletic potential, these children would, in effect, speed up and improve the slow and imperfect process of natural evolution. That, at least, is the rosy picture sketched by proponents of the technology. In practice, because only the well to do are likely to be able to afford fully genetically engineered babies, the new technology could introduce an era of increased social inequality and low social mobility. Only the economically underprivileged would bear a substantial risk of genetic inferiority. This future was foreseen in the 1997 movie *Gattica.* The plot revolves around the tension between a society that genetically engineers all space pilots to perfection and a young man played by Ethan Hawke, who was born without the benefit of genetic engineering yet aspires to become a space pilot. Hawke’s character manages to overcome his genetic handicap. It is clear from the movie, however, that his success is both illegal and extremely rare. The norm is rigid genetic stratification, and it is strongly sanctioned by state and society.

BOX 18.2
IT’S YOUR CHOICE

WEB-BASED LEARNING AND HIGHER EDUCATION

“I love it,” says Carol Thibeault, a student at Central Connecticut State University. “With online classes, there’s no set time that I have to show up. Sometimes I lug a heavy laptop onto the commuter bus and work on course files I’ve downloaded while I ride along. I even take my computer to the beach” (quoted in Maloney 1999: 19). Carol is not alone in expressing her enthusiasm for the new information technology in higher education. E-mail and the World Wide Web are now about as exotic as the telephone in the United States and other rich countries. Some scholars see “online education” as the future of higher education.

The advantages of Web-based education are many. Parents with children, or students with jobs, can learn at their own speed, on their own schedule, and in their own style. This will make learning easier and more enjoyable. Potentially, many students can be taught efficiently and effectively. This will lower the cost of higher education.

Although few would argue for its elimination, many people think too much dependence on the “virtual classroom” has drawbacks. Some professors argue it is difficult to control the quality of online educational materials and instruction. That is why dropout rates for distance education courses tend to be significantly higher than rates in conventional classrooms (Merisotis, 1999). Others suggest that distance education will spread primarily among low-cost, low-status institutions. At elite institutions, they say, classroom contact and discussion will become even more important. So while one group of students will enjoy a great deal of personal attention from faculty members, another group will receive only cursory and impersonal attention.

What do you think the role of Web-based learning should be in higher education? Do you think distance learning is superior or inferior to traditional classroom learning? Is it better to learn from a professor and other students in a “real” classroom as opposed to a “virtual” classroom? Do you think online education will lead to an increase in social inequality?

(For other examples of how new technologies can contribute to social inequality, see the discussion of job polarization in Chapter 10, electronic democracy in Chapter 11, and Box 18.2).

What Is to Be Done?

The Market and High-Tech Solutions

Some people believe the environmental crisis will resolve itself. More precisely, they think we already have two weapons that will work together to end the crisis: the market and high technology. The case of oil illustrates how these weapons can combine forces. If oil reserves drop or oil is withheld from the market for political reasons, the price of oil goes up. This makes it worthwhile for oil exploration companies to develop new technologies to recover more oil. When they discover more oil and bring it to market, prices fall back to where they were. This is what happened following the oil crises of 1973 (when prices tripled) and 1978–9 (when prices tripled again). Reserves are higher now than they were in the 1970s and 1980s, and, at the time of this writing, oil is relatively inexpensive again. Similarly, if too little rice and wheat are grown to meet world demand, the price of these grains goes up. This prompts agrochemical companies to invent higher yield grains. Farmers use the new grain seed to grow more wheat and rice, and prices eventually fall. This is what happened during the so-called "green revolution" of the 1960s. Projecting these experiences into the future, optimists believe global warming, industrial pollution, and other forms of environmental degradation will be dealt with similarly. In their view, human inventiveness and the profit motive will combine to create the new technologies we need to survive and prosper in the 21st century.

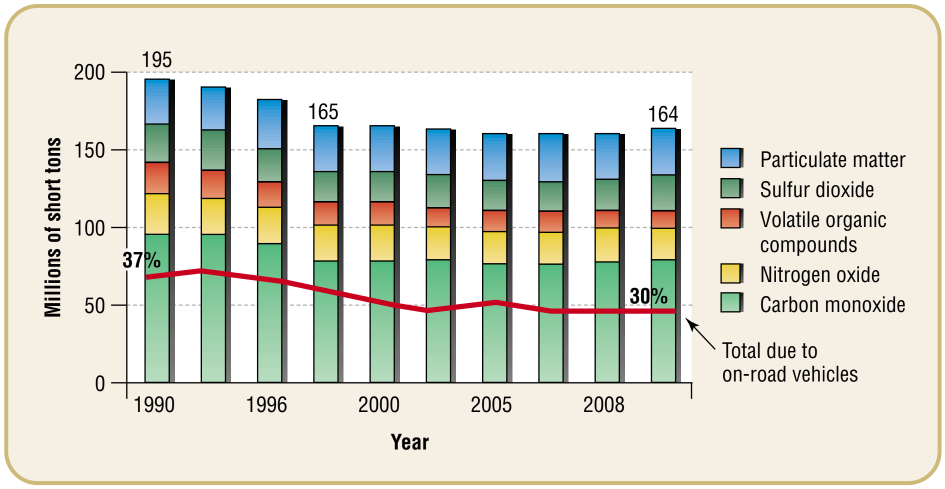
Some evidence supports this optimistic scenario. In recent years, we have adopted new technologies to combat some of the worst excesses of environmental degradation. For example, we have replaced brain-damaging leaded gas with unleaded gas. We have developed environmentally friendly refrigerants, allowing the production of ozone-destroying CFCs to plummet. In a model of international cooperation, rich countries have even subsidized the cost of replacing CFCs in the developing countries. Efficient windmills and solar panels are now common. More factories are equipped with high-tech pollution control devices, preventing dangerous chemicals from seeping into the air and water. We have introduced cost-effective ways to recycle metal, plastic, paper, and glass. New methods are being developed for eliminating carbon dioxide emissions from the burning of fossil fuels (Parson and Keith, 1998). In November 1999, Ford and General Motors took the wraps off their diesel–electric hybrid cars, five-passenger sedans that get as much as 108 miles to the gallon (see Figure 18.7). The widespread use of electric cars is perhaps only a decade

✦ **FIGURE 18.7** ✦
The Precept, General Motors' New Diesel–Electric Hybrid, Gets 108 Miles to the Gallon
General Motors Vice-Chairman Harry Pearce presents the Precept, a fuel-cell powered vehicle that gets 108 mpg and has a 500-mile range. High-tech inventions are one important part of the solution to the environmental crisis, but they are by no means sufficient.

SOURCE: General Motors (2000).

✦ **FIGURE 18.8** ✦
Air Pollutant Emission Projections, United States, 1990–2010 (in mil. short tons, projected)

SOURCE: Office of Air Quality Planning and Standards (1998: 5.4–5.8).



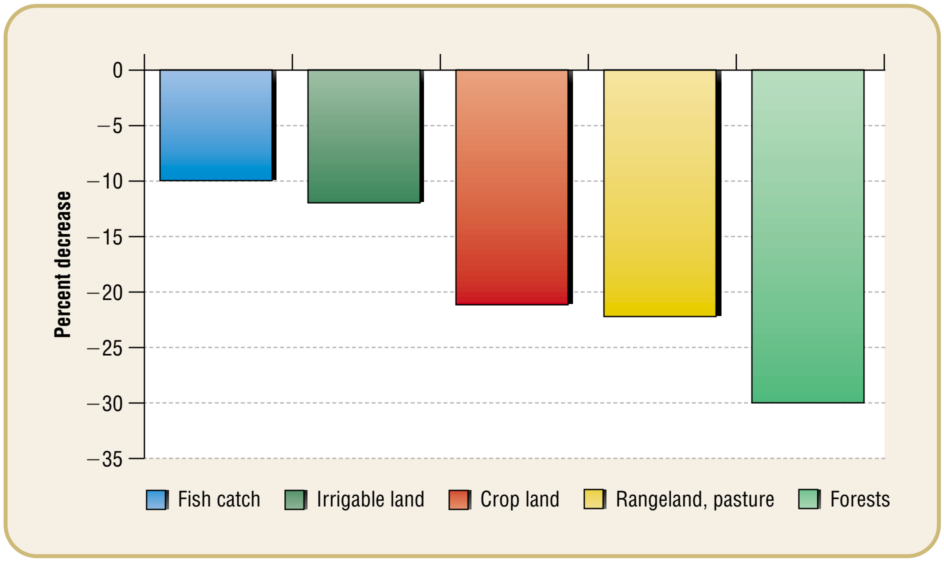
away. Figure 18.8 uses data from the United States Environmental Protection Agency to illustrate one consequence of these and related efforts. It shows actual production of five of the most common air pollutants in the United States between 1990 and 1998 and expected pollutant production between 1998 and 2010. Production of the five pollutants fell more than 15% between 1990 and 1999.

Clearly, market forces are helping to bring environmentally friendly technologies online. However, three factors suggest market forces cannot solve environmental problems on their own. First, price signals often operate imperfectly. Second, political pressure is often required to stimulate policy innovation. Third, markets and new technologies are not working quickly enough to deal adequately with the environmental crisis. Let us consider each of these issues in turn.

- *Imperfect price signals.* The price of many commodities does not reflect their actual cost to society. Gasoline in the United States costs about $1.40 a gallon on average at the time of this writing. But the *social* cost, including the cost of repairing the environmental damage caused by burning the gas, is $4 or more. In order to avoid popular unrest, the government of Mexico City charges consumers only about 10 cents a cubic meter for water. The actual cost to society is about 10 times that amount (Ehrlich, Daily, Daily, Myers, and Salzman, 1997). Due to these and many other price distortions, the market often fails to send signals that might result in the speedy adoption of technological and policy fixes.
- *Importance of political pressure.* Political pressure exerted by environmental social movement activists, community groups, and public opinion is often necessary to motivate corporate and government action on environmental issues. For instance, organizations like Greenpeace have successfully challenged the practices of logging companies, whalers, the nuclear industry, and other groups engaged in environmentally dangerous practices. Many less famous community associations have also played an important role in this regard (Brown, 1997). The antinuclear movement is an outstanding example of a movement that forced a substantial turnaround in government and corporate policy. For instance, in Germany, which obtains a third of its electricity from nuclear power, the antinuclear movement has had a major effect on public opinion, and in June 2000 the government decided to phase out all of the country's nuclear power plants within about 20 years. In the United States, no more nuclear power plants are planned. Again, the antinuclear movement must be credited with helping to change the public mood and bring about the halt in construction of new nuclear facilities.[1] All told, about 8% of Americans belong to groups committed

Web Research Projects
Who Are the Environmentalists?

[1]Recent statements by the Bush administration suggest this could change, however.



✦ **FIGURE 18.9** ✦
Renewable Resources, World, Percent Change, 1990–2010 (projected)

SOURCE: Postel (1994:11).

to protecting the environment. About 10% have contributed money to such organizations (National Opinion Research Center, 1999). Without the political efforts of pro-environment individuals, organizations, and social movements, it is doubtful many environmental issues would be defined as social problems by corporations and governments.

✦ *Slow pace of change.* We saw above how price signals and new technologies have created pockets of environmental improvement, especially in the rich countries. However, it is unclear whether they can deal with the moral and political issues raised by biotechnology. Moreover, our efforts so far to clean up the planet are just not good enough. Returning to Figure 18.8, we observe that, after improving somewhat in the 1990s, United States air pollution is not expected to get any better between 1999 and 2010. Glancing back at Figure 18.4, we note that global warming continues to accelerate. Examining Figure 18.9, we see we can expect a substantial decrease in all of the world's renewable resources over the next decade. In 1993, 1,680 of the world's leading scientists, including 104 Nobel prize winners, signed the "World Scientists' Warning to Humanity." It stated: "A great change in our stewardship of the earth and the life on it is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated . . . Human beings and the natural world are on a collision course" (Union of Concerned Scientists, 1993). Evidence suggests we still are.

The Cooperative Alternative

The alternative to the market and high-tech approach involves people cooperating to greatly reduce their overconsumption of just about everything. This strategy includes investing heavily in energy-saving technologies, environmental cleanup, and subsidized, environmentally friendly industrialization in the developing countries. It would require renewed commitment to voluntary efforts, new laws and enforcement bodies to ensure compliance, increased environmentally related research and development by industry and government, more environmentally directed foreign aid, and hefty new taxes to pay for everything (Livernash and Rodenburg, 1998). In addition, a cooperative strategy entails careful assessment of all the risks associated with biotechnology projects and consultation with the public before such projects are allowed to go forward. Profits from genetic engineering would also have to be shared equitably with donors of genetic material.

Is the solution realistic? Certainly not, at least not in the short term. In fact, it would probably be political suicide for anyone in the rich countries to propose the drastic measures listed above. Few drivers would be happy paying $4 a gallon for gas, for example. To be politically acceptable, three conditions have to be met. The broad public in North America, Western Europe, and Japan would have to be:

- Aware of the gravity of the environmental problem;
- Confident in the capacity of people and their governments to solve the problem; and
- Willing to make substantial economic sacrifices to get the job done.

✦ TABLE 18.2 ✦

Public Opinion on Environmental Issues, United States, 1994 (in percent)

SOURCE: National Opinion Research Center (1999).

Proportion of Americans who think the following environmental problems are extremely/very/somewhat dangerous:	
1. Air pollution caused by cars	91
2. Air pollution caused by industry	94
3. Nuclear power stations	84
4. A rise in the world's temperature caused by the 'greenhouse effect'	82
5. Pollution of America's rivers, lakes, and streams	95
6. Pesticides and chemicals used in farming	84
7. "*It is just too difficult for someone like me to do much about the environment.*"	
Strongly agree/agree	27
Neither agree nor disagree	17
Disagree/strongly disagree	56
8. "*Government should let businesses decide for themselves how to protect the environment, even if it means they don't always do the right thing, or government should pass laws to make businesses protect the environment, even if it interferes with business' right to make their own decisions.*"	
Government should let businesses decide	11
Government should pass laws	89
9. *"We are faced with many problems in this country, none of which can be solved easily or inexpensively. I'm going to name some of these problems, and for each one I'd like you to tell me whether you think we're spending too much money on it, too little money, or about the right amount. Are we spending too much money, too little money, or about the right amount on improving and protecting the environment?"*	
Too little	61
About right	30
Too much	9
10. *"How willing would you be to pay much higher prices in order to protect the environment?"*	
Very/fairly willing	47
Neither willing nor unwilling	25
Not very/not at all willing	28
11. *"And how willing would you be to accept cuts in your standard of living in order to protect the environment?"*	
Very/fairly willing	32
Neither willing nor unwilling	23
Not very/not at all willing	45
12. *"And how willing would you be to pay much higher taxes in order to protect the environment?"*	
Very/fairly willing	34
Neither willing nor unwilling	21
Not very/not at all willing	45
13. *"How often do you make a special effort to sort glass or cans or plastic or papers and so on for recycling?"*	
Always/often/sometimes	87
Never	13
14. *"And how often do you cut back on driving a car for environmental reasons?"*	
Always/often/sometimes	36
Never	67

Data from the 1994 General Social Survey allow us to see whether these three conditions are being met in the United States. They paint a good news/bad news scenario. Nearly all Americans are aware of the environmental problem. As Table 18.2 shows, between 82% and 95% consider pollution and other environmental problems to be dangerous. Moreover, a solid majority (56%) think they can do something about environmental issues themselves, while a huge majority (89%) believe the government should pass more laws to protect the environment. Most Americans (61%) even say too little is being spent on environmental cleanup. All this is encouraging.

However, expressing environmental awareness and agreeing on the need for action is one thing. Biting the bullet is another. Fewer than half of Americans (47%) are willing to pay much higher prices to protect the environment. Fewer than a third (32%) are willing to accept cuts in their standard of living. Barely a third (34%) are willing to pay much higher taxes. Most Americans are prepared to protect the environment if it does not inconvenience them too much. Thus, 87% say they sort glass, cans, plastic, or paper for recycling. But when it is inconvenient, the numbers drop sharply. Only 36% say they have ever cut back on driving for environmental reasons.

Other surveys conducted in the United States and elsewhere reveal much the same pattern. Most people know about the environmental crisis. They want it dealt with. But they are unwilling to pay much of the cost themselves. The situation is reminiscent of American attitudes toward involvement in World War II. In 1939, when Britain and France went to war with Germany, most Americans considered the Nazi threat remote and abstract. They did not want to go to war. As German and Japanese aggression expanded, however, more Americans were willing to help their allies. Eventually, when it seemed Germany and Japan posed a real threat to the United States, the United States began providing supplies on favorable terms to Britain, Russia, and China. But the United States did not go to war until the Japanese attacked Pearl Harbor, crippling United States naval power in the Pacific and making it clear America had to fight to survive. This episode of American history teaches us that people are not usually prepared to make big personal sacrifices for seemingly remote and abstract goals. They are, however, prepared to sacrifice a great deal if the goals become much less remote and abstract. By extension, more and bigger environmental catastrophes may have to occur before more people are willing to take remedial action. Realistically speaking, it may well take one, two, or many environmental Pearl Harbors to get most Americans to make the necessary commitment to help save the planet. The good news is that there may still be time to act.

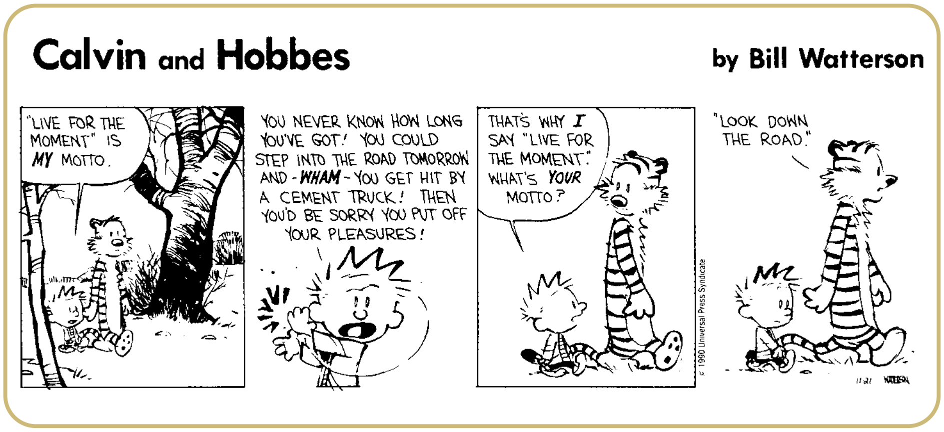
Evolution and Sociology

For many thousands of years, humans have done well on this planet. That is because we have created cultural practices, including technologies, that allowed us to adapt to and thrive in our environment. Nonetheless, there have been some failures along the way. Many tribes and civilizations are extinct. And our success to date as a species is no warrant for the future. If we persist in using technologies that create an inhospitable environment, Nature will deal with us in the same way it always deals with species that cannot adapt.

Broadly speaking, we have two survival strategies to cope with the challenges that lie ahead: competition and cooperation. Charles Darwin wrote famously about competition in *The Origin of Species* (1859). He observed that members of each species struggle against each other and against other species in their struggle to survive. Most of the quickest, the strongest, the best camouflaged, and the smartest live long enough to bear offspring. Most of the rest are killed off. Thus, the traits passed on to offspring are those most valuable for survival. Ruthless competition, it turns out, is a key survival strategy of all species, including humans.

In *The Descent of Man,* Darwin mentioned our second important survival strategy: cooperation. In some species mutual assistance is common. The species members that flourish are those that best learn to help each other (Darwin, 1871: 163). The Russian geographer and naturalist Petr Kropotkin (1908 [1902]) elaborated this idea. After spending 5 years studying animal life in Siberia, he concluded that "mutual aid" is at least as

✦ **FIGURE 18.10** ✦
The Advantage of Sociological Knowledge



important a survival strategy as competition. Competition takes place when members of the same species compete for limited resources, said Kropotkin. Cooperation occurs when species members struggle against adverse environmental circumstances. According to Kropotkin, survival in the face of environmental threat is best assured if species members help each other. Kropotkin also showed that the most advanced species in any group—ants among insects, mammals among vertebrates, humans among mammals—are the most cooperative. Many evolutionary biologists now accept Kropotkin's ideas (Gould, 1988). Recently, based on computer simulations involving competitive and cooperative strategies, mathematicians concluded that "cooperation [is] as essential for evolution as . . . competition" (Nowak, May, and Sigmund, 1995: 81).

As we have seen, a strictly competitive approach to dealing with the environmental crisis—relying on the market alone to solve our problems—now seems inadequate. Instead, it appears we require more cooperation and self-sacrifice. This involves substantially reducing consumption, paying higher taxes for environmental cleanup and energy-efficient industrial processes, subsidizing the developing countries to industrialize in an environmentally friendly way, and so forth. Previously, we outlined some grave consequences of relying too little on a cooperative survival strategy at this historical juncture. But which strategy you emphasize in your own life is, of course, your choice.

Similarly, throughout this book—when we discussed families, gender inequality, crime, race, population, and many other topics—we raised social issues lying at the intersection point of history and biography—yours and ours. We set out alternative courses of action and outlined their consequences. We thus followed our disciplinary mandate: helping people make informed choices based on sound sociological knowledge (Wilensky, 1997; see Figure 18.10). In the context of the present chapter, however, we can make an even bolder claim for the discipline. Conceived at its broadest, sociology promises to help in the rational and equitable evolution of humankind.

SUMMARY

1. Technology is not beyond human control. For while technologies routinely transform societies, they are adopted only when there is a social need for them.
2. Since the last third of the 19th century, technological development has increasingly come under the control of multinational corporations and the military establishments of the major world powers.
3. Research scientists and engineers who work for these organizations must normally adhere to their research priorities.
4. A substantial and growing minority of Americans is skeptical about the benefits of technology.
5. Four important negative consequences of technology are global warming, industrial pollution, the decline of biodiversity, and genetic pollution.
6. Disadvantaged classes, racial minorities, and developing countries are exposed to a disproportionately large share of the risks associated with environmental degradation.

7. Most Americans are unwilling to undergo the personal sacrifices required to deal with environmental degradation. However, that could easily change in the face of repeated environmental catastrophes.
8. Some analysts think the market and high technology will solve the environmental problem. However, three issues suggest these are insufficient solutions: imperfect price signals, the importance of political pressure, and the slow pace of change.
9. Sociology can play an important role sensitizing the public to the social issues and choices humanity faces in the 21st century. For example, sociology poses the choice between more competition and more cooperation as ways of solving the environmental crisis.

GLOSSARY

Acid rain is precipitation whose acidity destroys forests and the ecosystems of lakes. It is formed by sulfur dioxide and other gases emitted by coal-burning power plants, pulp and paper mills, and motor-vehicle exhaust.

Biodiversity refers to the enormous variety of plant and animal species inhabiting the earth.

Environmental racism is the tendency to heap environmental dangers on the disadvantaged, especially on disadvantaged racial minorities.

Genetic pollution refers to the potential dangers of mixing the genes of one species with those of another.

Global warming is the gradual worldwide increase in average surface temperature.

The **greenhouse effect** is the accumulation of carbon dioxide in the atmosphere that allows more solar radiation to enter the atmosphere and less solar radiation to escape.

Normal accidents are accidents that occur inevitably though unpredictably due to the very complexity of modern technologies.

The **ozone layer** is 5–25 miles above the earth's surface. It is depleted by CFCs. The depletion of the ozone layer allows more ultraviolet light to enter the earth's atmosphere. This increases the rate of skin cancer and crop damage.

Recombinant DNA involves taking a piece of DNA from one living species and inserting it into the DNA of another living species, where it grows along with the host DNA.

A **risk society** is a postmodern society defined by the way risk is distributed as a side effect of technology.

Social constructionism is a sociological approach to studying social problems such as environmental degradation. It emphasizes that social problems do not emerge spontaneously. Instead, they are contested phenomena whose prominence depends on the ability of supporters and detractors to make the public aware of them.

Technological determinism is the belief that technology is the main factor shaping human history.

Technology is the practical application of scientific principles.

Technopoly is a form of social organization in which technology compels people to try to solve all problems using technical rather than moral criteria, even though technology is often the source of the problems.

QUESTIONS TO CONSIDER

1. What are the main environmental problems in your community? How are they connected to global environmental issues? (See "Recommended Web Sites," below, for useful leads.)
2. Take an inventory of your environmentally friendly and environmentally dangerous habits. In what ways can you act in a more environmentally friendly way?

WEB RESOURCES

Companion Web Site for This Book

http://sociology.wadsworth.com

Begin by clicking on the Student Resources section of the Web site. Choose "Introduction to Sociology" and finally the Brym and Lie book cover. Next, select the chapter you are currently studying from the pull-down menu. From the Student Resources page you will have easy access to InfoTrac College Edition®, MicroCase Online exercises, additional Web links, and many other resources to aid you in your study of sociology, including practice tests for each chapter.

InfoTrac Search Terms

These search terms are provided to assist you in beginning to conduct research on this topic by visiting http://www.infotraccollege.com/wadsworth.

Environmental problems
Environmental racism
Global warming
Human Genome Project
Technology

Recommended Web Sites

The Web site of the United States Environmental Protection Agency at http://www.epa.gov is a valuable educational tool. Of particular interest is the search engine at http://www.epa.gov/epahome/comm.htm. It allows you to discover the environmental issues in your community.

The Web sites of 54 environmental movements are listed at http://www.uccs.edu/socges/env-cl12.html.

Against All Reason is a provocative electronic journal devoted to "the radical nature of science as a route to knowledge and the radical critique of the social, political, and economic roles of science and technology." Go to http://www.human-nature.com/reason/index.html.

Good lists of Sociology of Science and Technology Web links can be found http://WWW.Trinity.Edu/mkearl/science.html and http://www.ualberta.ca/slis/guides/scitech/kmc.htm.

SUGGESTED READINGS

Lester R. Brown, Janet N. Abramovitz, Linda Starke et al. *State of the World 2001* (New York: Norton, 2001). This popular annual contains a rich compendium of facts and interpretations about the environmental condition of the planet. It also proposes workable solutions.

Robert Pool. *Beyond Engineering: How Society Shapes Technology* (New York: Oxford University Press, 1997). A lucid analysis of how social factors influence technological development, with particular emphasis on nuclear power.

Jeremy Rifkin. *The Biotech Century: Harnessing the Gene and Remaking the World* (New York: Jeremy P. Tarcher/Putnam, 1998). An alarming account of the potential and problems of the technology that promises to change humanity more than any other.