Technology Matters

Questions to Live With

David E. Nye

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6 Sustainable Abundance, or Ecological Crisis?

Does mastery of technology ensure abundance? Daniel Defoe's *Robinson Crusoe* (1719) answered unequivocally that it does. Based on actual experiences of a castaway British seaman, the novel describes its hero's 26 years on a deserted island off the coast of South America. Starting with nothing but a gun and a few tools salvaged from the wreck of his ship, the fictional Crusoe creates a comfortable though lonely life. In the eighteenth century, his story seemed a parable about the superiority of Western civilization. Crusoe's metal tools and weapons alone do not make him superior. Far more important, he has inherited generations of technical experience. He knows how to build a fortified shelter, and he does not have to invent the idea of a table, a chair, or other furniture. He catches fish, tames goats, weaves baskets, makes pottery, and in the course of several growing seasons patiently converts a few seeds of wheat into an annual crop. *Robinson Crusoe* became popular just as Britain began to industrialize. In subsequent generations, the steam engine promised radical increases in power and productivity, leading a late-eighteenth-century poet to declare: "Ingenious engines wondrous works perform, The hungry nourish and the naked warm!"[1]

For liberal political thinkers, the difference between Crusoe and the uneducated native whom he trained as his servant measured

the distance from primitive society to civilization.[2] From a liberal perspective, society may have had a rough equality in pre-history, but the extent of a society's possessions measures its advance. At the most primitive stage of existence, in other words, people are all equally impoverished. Progress requires the extraction of a surplus, and at times this has involved slavery or feudal bondage. Over millennia, however, society became more rational, as economic markets and laws, instead of naked power, became the basis for exchange. Technological liberals believe in humanity's ability to improve both production and distribution. Although social classes persist, they argue, the life of the average person continues to improve. The popular expression "a rising tide lifts all boats" expresses this optimism. The widespread liberal view has long been that advances in technology bring greater efficiency and prosperity for all in the form of higher wages, less expensive goods, better transportation, and shorter working hours. Most mainstream European and American politicians of the twentieth century embraced this view. Even Marxists expressed similar ideas, although they assumed that the full advantages of the machine would not be realized until a revolution had occurred. As late as 1970, Herbert Marcuse declared: "I believe that the potential liberating blessings of technology and industrialization will not even begin to be real and visible until capitalist industrialization and capitalist technology have been done away with."[3]

Visions of technological progress seem attractive in the abstract, but what do they mean in practice? The landscape provides a physical measure of technological change. One of the founders of landscape studies, J. B. Jackson, defines landscape as "a composition of man-made or man-modified spaces to serve as infrastructure or background for our collective existence."[4] Landscape is not natural; it is cultural. It is not static; it is part of an

evolving set of economic and social relationships. Landscapes are part of the infrastructure of existence, and they are inseparable from the technologies that people have used to shape land and to shape their vision. People continually put the land to new uses, and what appears to be natural to one generation is often the product of a struggle during a previous generation. Some of the apparently wild moors beloved of hikers in Britain were once thickly forested. In other parts of England and Scotland, landowners evicted small farmers during the period of enclosure, creating a countryside that visitors now take to be "natural." In Denmark, wheat-growing areas were converted to dairying during the nineteenth century because of pressure from inexpensive grain produced in the New World. The same pressure forced many New England farmers to give up agriculture. Most of the forested hillsides in New England were cleared pastures in 1840. Almost everywhere, the appearance of the land is the result of an interregional interplay between agriculture, industry, and leisure activities. Technologies also affect the air, which carries traces of smoke, microscopic particles, pollen, carbon monoxide, and the dust raised by travel. Even at national parks and in supposedly untouched wilderness areas, the intermingling of culture and nature continues, whether unintentionally (as in the cases of acid rain, pollution, and migration of plant species) or intentionally (trails, fire breaks, campsites, roads, scenic outlooks).

Landscapes express the technologies and land use of earlier generations. The farms in much of Europe and along the Atlantic coast of the United States are pastoral landscapes of irregularly shaped fields, pastures, and woodlots, each fitted into the form of the land. Their modest scale is attributable to their original use in family farming with draft animals. These pastoral landscapes proved reliably efficient for hundreds of years, though in many

areas they have now been abandoned (as a result of competition from more industrialized agriculture elsewhere) and gradually reforested. Yet this pastoral landscape is still productive enough to sustain the Amish or the Mennonites with a minimum of modern technology.

The landscapes that out-competed rural New England—the flatter and more fertile Middle West, the Canadian prairies, the pampas of Argentina—were farmed with new kinds of agricultural machinery. In 1890 a single US farmer could produce 380 bushels of wheat in the same time his grandfather needed to produce 20 bushels in 1830.[5] The productivity gains were greater for barley, less for other crops, but in all cases at least 200 percent. The new machines substituted horsepower for manpower, and worked best on large, flat, square fields. Productivity has increased just as dramatically since 1890, owing to gasoline motors, tractors, electrification, new fertilizers, and hybrid seeds.

Irrigated farms in California and Arizona take the rationalization of landscape further. Modern agribusiness relies on electric pumps that water fields when sensors say it is time. Airplanes spray the fields to keep down weeds and kill insects, and a combination of high-tech machines and migrant labor harvests the crop. The fields are enormous and laid out with mathematical precision, both to ensure proper irrigation and drainage and to let machines move efficiently over them. Such farming is profitable as long as energy and irrigation water remain inexpensive.

This succession of landscapes, from pastoral New England to industrialized family farming in the Middle West to irrigated agribusiness, traces an arc of increasing productivity made possible by increasing investment in mechanization. In the first half of the nineteenth century, many believed such agricultural development illustrated how industrialization creates more wealth,

more jobs, and more goods for all. In the United States, Daniel Webster and Edward Everett were particularly effective spokesmen for manufacturing. They argued that more technical skill and more mechanical power led to a higher level of civilization. By 1900 such views had become orthodox. Robert Thurston, a specialist in textile production who served as president of the American Society of Mechanical Engineers, quantified the argument.[6] Between 1870 and 1890 he saw factory productivity rise almost 30 percent, while working hours dropped and real wages rose 20 percent. Similar gains throughout the nineteenth century had radically improved daily life. People had more leisure time and more money to spend. Consumption of clothing, appliances, and home furnishings rose rapidly, and Thurston drew graphs to express "the trend of our modern progress in all material civilization." "Our mills, our factories, our workshops of every kind," he wrote, "are mainly engaged in supplying our people with the comforts and the luxuries of modern life, and in converting crudeness and barbarism into cultured civilization. Measured by this gauge, we are fifty percent more comfortable than in 1880, sixteen times as comfortable as were our parents in 1850, and our children, in 1900 to 1910, will have twice as many luxuries and live twice as easy and comfortable lives."[7]

Thurston exaggerated, but Americans had made considerable progress in acquiring material goods. When Werner Sombart visited America (preparing to write *Why Is There No Socialism in the United States?*), he observed that American workers had greater material well-being than their European counterparts.[8] Wages were two to three times higher than in Germany, yet food and clothing cost roughly the same.[9] American workers dressed better, ate better, and were more likely to own a home. They were far less likely to live in a tenement, and one- and two-family houses were

widespread. Sombart did not argue that the greater material well-being of American workers by itself explained the failure of socialist movements to achieve as much political power as in Europe. Ethnic and religious divisions, a modicum of upward mobility, and a different political system were also important. Furthermore, adults of that era were deeply impressed by inventions such as the telephone, the motion picture, the phonograph, the x-ray machine, the automobile, and the airplane. These inventions did not remain remote. They were not limited to the wealthy, but became democratically dispersed. In 1911 the president of MIT wrote: "Our grandfathers, looking down upon us, would feel that they observed a new heaven and a new earth."[10] The pace of technological change was undeniably quickening, and ordinary people acquired phonographs, electric lighting, and automobiles. In the early decades of the twentieth century, with such palpable evidence of change, Americans made engineers into cultural heroes in popular novels and films.[11]

In 1926, Henry Ford, whose factories had pioneered the assembly line and built more than half of the world's automobiles, declared (with the help of a ghost writer) that the machine was "the symbol of man's mastery of the environment."[12] For Ford, human history was about the development of power, from the "laborious hand culture of the soil" that he knew firsthand from a rural childhood to industrial society. His best-selling book declared that the modern mastery of power "would increase and cheapen production so that all of us may have more of this world's goods." This hardly seemed an empty promise coming from a man whose Model T cars got cheaper each year while improving in quality. For Ford's generation, nature was no longer outside human control; it was a source of raw materials to be exploited for human development.

Between 1851 (the year of London's Crystal Palace Exposition) and 1958 (the year of the World's Fair in Brussels), technological optimism found expression in a series of world's fairs on both sides of the Atlantic. All embodied the belief in material progress based on technology. In model homes, cities, and farms, fairgoers glimpsed an improved future not as an abstraction, but materialized in prototypes and demonstrations. Americans experienced their first telephone at the Philadelphia Centennial Exposition in 1876, their first electrified cityscape at the Chicago Columbian Exposition of 1893, their first full-size assembly line and first transcontinental telephone call at the San Francisco Panama Pacific Exposition in 1915, and their first television at the New York "World of Tomorrow" Exposition of 1939.[13] Europeans also celebrated these technologies, and in vast imperial pavilions showed how essential they were to their spreading empires.[14] Chicago's "Century of Progress" Exposition (1933) marked the growth of a small village into the second-largest city in the United States. Its exhibits were planned to "show you how Man has come up from the caves of half a hundred thousand years ago, adapting himself to, being molded by, his environments, responding to each new thing discovered and developed. You see man's march upward to the present day. . . ."[15] The Chicago fair's promoters announced the pre-eminence of the machine in the slogan "Science Finds—Industry Applies—Man Conforms."

Technological optimism may have reached its peak in the middle of the twentieth century. The march of progress then seemed to lead to a work week of 30 hours or less, early retirement, and a life of leisure and comfort for all. In 1955 Congress was "told by union leaders that automation threatens mass unemployment and by business executives that it will bring unparalleled prosperity."[16] Most believed, however, that leisure

could be properly managed, and 1968 testimony before a Senate subcommittee "indicated that by 1985 people could be working just 22 hours a week, or 27 weeks a year, or they could retire at 38."[17] Some social scientists proclaimed that control of increasing amounts of energy was the measure of civilization. The anthropologist Leslie White posited four stages in human history: hunting and gathering, agriculture, industrial steam-power, and the atomic age.[18]

In the same years, Vannevar Bush urged Americans to see outer space as a new frontier that could be conquered through corporate research and development. In his vision, exploration and the search for new knowledge expressed the spirit of liberal capitalism. Profits, material progress, and science were inseparably joined. The march of science into the unknown would produce prosperity. In this "commodity scientism"[19] the space program was justified by improved commodities it "spun off" as by-products, such as new food concentrates, Teflon, and computer miniaturization. The *Los Angeles Herald-Examiner* editorialized: "America's moon program has benefited all mankind. It has brought better color television, water purification at less cost, new paints and plastics, improved weather forecasting, medicine, respirators, walkers for the handicapped, laser surgery, world-wide communications, new transportation systems, earthquake prediction systems and solar power."[20]

If during the 1960s the space program promised a technological cornucopia of goods, computer innovations played the same role in later decades. Full computerization appeared to promise a "new economy" that assured a permanent bull market on Wall Street. To some, the computer promised a virtual transcendence of not only economic law but of the natural world. In 1994, the Progress and Freedom Foundation declared: "The central event

of the 20th century is the overthrow of matter. In technology, economics, and the politics of nations, wealth—in the form of physical resources—has been losing value and significance. The powers of mind are everywhere ascendant over the brute force of things."[21] The Progress and Freedom Foundation's cyberlibertarians asserted that computerization signaled a fundamental shift in the relationship between people and the natural world, because cyberspace fostered a new set of relationships in a virtual ecological system. Calling cyberspace "a bioelectronic environment that is literally universal," they compared it to the unknown world that explorers faced during the Renaissance. "The bioelectronic 'frontier,'" they suggested, "is an appropriate metaphor for what is happening in cyberspace, calling to mind as it does the spirit of invention and discovery that led ancient mariners to explore the world, generations of pioneers to tame the American continent and, more recently, to man's first exploration of outer space."[22] To them, cyberspace was a dramatic new chapter in the history of technological progress. (They seemed unaware that the American West c. 1800 was not empty space and that its settlement by Europeans displaced native peoples and transformed an indigenous ecological system.[23] Similarly, investment in cyberspace might be regarded not only as pioneering in a new space, but also as the displacement of resources from people to machines.)

Technological liberals note that more people are alive today than ever before. The total possessions of this population have been increasing, because for several centuries industrialization has multiplied humanity's command of productive power. These trends seem likely to continue. More engineers and scientists than ever before in history are at work on new patents and applications. Several billion people still live in poverty, but technological liberals expect that wider adoption of new technologies will lift them

up. Though environmental mistakes have been made that needlessly destroyed much farmland and eliminated some species, they believe people can be more responsible without halting material progress. Most elected public officials share these liberal assumptions, which also underlie every corporation's statement of earnings.

Since the Renaissance, Western societies have been particularly adept at exploiting technologies to produce a surplus of food, goods, and services. They have used new forms of transportation to breach geographical barriers and integrate most of the world into a single market, collapsing space and time. In the long term, might this process lead to impoverishment? For example, building dams and irrigation systems in desert areas can increase food production, but after a few generations the land may become polluted and unproductive because of salts and chemicals left behind by evaporating water. Likewise, burning coal produces not only electricity but also smoke containing sulfur dioxide that falls to the earth as acid rain, destroying plants, fish, and wildlife. When such environmental effects are taken into account, the industrial revolution may only create temporary abundance. Another 100 years of intense use of fossil fuels will accelerate global warming, increase desertification, and cause many coastal areas to be flooded by rising seas.

From ancient times, some have regulated or even resisted technologies. A Byzantine city in the 530s had zoning laws that separated kilns, blacksmiths, and polluting activities from shops and houses.[24] Medieval French slaughterhouses and tanners polluted rivers and streams, leading to legislation in 1366 to prohibit such pollution of the Seine in Paris.[25] In the same years, demand for wood stripped much of England and France bare of forests. Firewood was burned for cooking and heating, and wood was also the primary building material. As early as 1140 the French had difficulty finding 35-foot beams for building, and architects worked out ingenious ways to use shorter pieces of wood to construct bridges and churches. Iron smelters consumed 25 cubic meters of wood to produce 50 kilograms of iron. A single furnace operating for just 40 days devoured an encircling forest for a one-kilometer radius. By 1230 the English were importing wood from Norway, and English coal was sold not only in London but also on the Continent. Mines became ever more extensive, and by the end of the thirteenth century air pollution was a problem. In 1307 London was the first city to prohibit coal burning, in a royal proclamation that was generally ignored. Many contemporary ecological problems—deforestation, fuel shortages, and both air and water pollution—can be traced back in European history at least 700 years.

As Europeans ran short of raw materials and expanded into the rest of the world, these problems recurred wherever they went. Their demand for wood, charcoal, and iron stripped colonies of forests. European demand for gold, silver, copper, zinc, lead, and nickel created extensive mines and open pits, immense slag heaps, and polluted groundwater. European industrial methods, whether exported to colonies (South Africa, India) or voluntarily adopted by other countries (Japan), led to extensive air and water pollution. Europeans' farming methods, exported to their colonies, brought new areas into production but also dramatically accelerated soil erosion. Plowing land and letting it lie fallow were not destructive practices when applied to the heavy soils of Northern Europe, but they often proved catastrophic in drier regions with lighter soils, such as the western plains of Canada and the United States. In Latin America, Europeans introduced new grazing animals whose hooves loosened the soil in hilly and

mountainous areas, accelerating erosion.[26] More recently, intensive use of pesticides and fertilizers has increased agricultural yields, but often at the cost of poisoning the soil and the groundwater. In short, Western technologies have been used to create abundance, but at a high environmental cost. In the twentieth century alone, the United States lost to erosion topsoil that took 1,000 years to form, and it continues to lose topsoil at a rate of 1.7 billion tons a year. In the world as a whole, agricultural land seven times the size of Texas has been destroyed through erosion and misuse. The UN estimates that between 0.3 and 0.5 percent of the world's cropland is destroyed each year, creating pressure to clear more forests, causing yet more erosion.[27] Clearly, these are grounds for pessimism.

Technological pessimism was prominent in Great Britain, where the industrial revolution began. William Blake denounced the "dark Satanic mills" of the English Midlands, and William Wordsworth complained about a railroad built into his beloved Lake District ("Is there no nook of English ground secure / From rash assault?"). And in *Frankenstein* (1818), a novel still resonant today, Mary Shelley evoked the possibility that scientists might create monsters that would escape their control. In contrast to today, during the nineteenth century, the attack often came from the political right. As Maxine Berg notes, the magazines *Fraser's* and *Blackwood's* published "the Tory theoretical attack on industrialisation and its social effects." Resistance to mechanization did not merely express a Tory "bias against the middle class" but was "a deep protest against the whole mechanism of industrial society."[28] Thomas Carlyle called the nineteenth century "the age of machinery." He declared that men had grown mechanical, and that steam had "fearfully accelerated a process which was going on already, but too fast."[29] Society had become "a

huge, dead, immeasurable steam engine, rolling on, in its dead indifference."[30] "Were we required to characterize this age of ours by any single epithet," Carlyle mused in 1829, "we should be tempted to call it, not an Heroical, Devotional, Philosophical, or Moral Age, but above all others, the Mechanical Age." Carlyle's critique also included the machine's psychological effects: "Men are grown mechanical in head and in heart, as well as in hand. They have lost faith in individual endeavour, and in natural force of any kind. Not for internal perfection, but for external combinations and arrangements, for institutions, constitutions—for Mechanism of one sort or other, do they hope and struggle."[31]

Critics on the right and on the left took up Carlyle's rhetoric. One can trace a tradition from such nineteenth-century pessimism to Henry Adams, who judged the automobile to be "a nightmare at one hundred kilometres an hour, almost as destructive as the electric tram which was only ten years older."[32] Adams concluded that technology as a whole had accelerated out of control.[33] After the appalling destruction of World War I, his autobiography sold briskly and helped convince intellectuals and writers of the 1920s that technological civilization had produced what T. S. Eliot called "the waste land." Eliot's generation had never heard of global warming, but by the year 2000 "waste land" was not a metaphor but a description. With half a billion automobiles on the world's highways, air pollution drove up the level of greenhouse gases. Furthermore, making cars requires enormous resources. Producing, gathering together, and assembling all the parts that go into a typical car—steel, plastic, aluminum, rubber, glass, and so forth—requires as much energy as it does to drive that car for a decade. Furthermore, roads, driveways, parking lots, and service stations have now expanded to cover more than 5 percent of the land in industrial countries. Nor are cars a particularly

safe form of transportation. At the end of the twentieth century, traffic accidents annually killed 400,000 people and maimed many more.[34]

There were other, less visible problems. In *Silent Spring* (1962), Rachel Carson warned that the abuse of pesticides such as DDT had poisoned many areas and undermined their ecological systems. An ever-larger chorus of critics identified advanced technology not only with increasing numbers of automobiles and air pollution but also with atomic bombs, chemical pollution, biological mutants, malfunctioning computers, and out-of-control technical systems. These dystopian fears recurred in science fiction, which often depicted a devastated future, where the remnants of humanity struggled to survive the wreckage of a technological disaster. At the beginning of the twenty-first century, people could use new technologies to increase production, but a growing minority doubted the wisdom of the goal.

Even if, despite pollution and overuse of resources, people have increased abundance for all, are they happier as a result? According to some polls, even though the gross national product had doubled, Americans of the 1990s were no happier than they had been in 1957.[35] Their work hours had increased, while time spent with friends and family had declined. Bombarded with thousands of advertisements a day, they overconsumed in a throwaway economy.

Should desire for more and more things drive human development? In conceiving the first modern utopia, Thomas More rejected high consumption. His Utopia increased leisure by drastically reducing human wants and adopting a modest style of life.[36] Utopia's citizens rejected luxury on principle. They wore simple, long-lasting clothing, and lived in small, sturdy houses. More had

"little confidence in tools or practical arts either as emancipators or as promoters of social equality."[37] Likewise, Defoe's Robinson Crusoe soon realized that there was no point to killing more animals or growing more food than he could consume: "I had enough to eat and to supply my wants, and what was all the rest to me?"[38] Indeed, when Crusoe salvages bars of gold from a shipwreck, they are of far less value to him than a fire shovel and tongs.[39]

In contrast to More and Defoe, however, many utopian writers of the nineteenth and twentieth centuries projected a future world with ever-increasing levels of luxury. In Edward Bellamy's *Looking Backward*, which sold more than a million copies in the 1880s and which remains in print today, a centralized state controls a disciplined "Industrial Army" that mass-produces a cornucopia of goods. Each citizen has the right to an ample supply from the large warehouses that have replaced wasteful, individual stores.

Western societies embraced the ideal of technological abundance, but a small, articulate minority called for simplicity. Henry David Thoreau argued that, rather than constantly expand one's desires, it was better to simplify material life to make time for reading, reflection, and close study of nature. In *Walden* (1854) he ridiculed the farmer who spent his life acquiring more possessions, arguing that such a man had lost control over his life. More generally, Thoreau questioned the value of slicing life into segments governed by clock time and suggested that the railway rode mankind rather than the reverse. He concluded that "men have become the tools of their tools," and feared that "our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end.[40] . . . We are in great haste to construct a magnetic telegraph from Maine to Texas; but Maine and Texas, it may be, have nothing

important to communicate."[41] Though these remarks on the telegraph may seem quaint today, in point of fact Americans did not immediately know what they might use the telegraph for, and it took the better part of a decade before the first intercity line was completed (from Washington to Baltimore, in 1844). At first this line had few customers; in 1845 it operated at only 15 percent of its capacity.[42] To stimulate public interest, the promoters staged long-distance chess games.

Even people who have never read Thoreau's *Walden* know that it is based on his experience of building and then living in a simple one-room house in the Massachusetts woods. Thoreau sought to reduce his needs to a minimum, but he was by no means anti-technology. Beginning in the 1820s, Thoreau's family manufactured pencils, a process that involved the careful adjustment and use of machinery. Thoreau invented a machine to grind plumbago (graphite) into a uniformly fine powder. He then discovered how to combine this powder with a particular clay to make a "pencil lead" that wrote with an even, smooth line.[43] The Thoreau family also sold finely ground plumbago to printing companies. Thoreau was skilled enough in the use of the axe and the hammer to construct his modest house. He was interested in how sawmills and gristmills operated, and his journals contain descriptions of work of many kinds, including the harvesting of ice from Walden Pond. He made a small cash income practicing as a surveyor, measuring the land scientifically by means of repeatable processes that were subject to verification. Far from being a technophobe, Thoreau had many of the traits of the Yankee mechanic. In Concord, he got along better with skilled workers than with the gentry.[44] He described himself to his former Harvard classmates as follows in 1847: "I am a Schoolmaster—a Private Tutor, a Surveyor—a Gardener, a Farmer—a Painter, I mean a House Painter, a Carpenter, a Mason, a Day-Laborer, a Pencil-Maker, a Glass-paper Maker, a Writer, and sometimes a Poetaster."[45]

Once Thoreau had completed his little house, he selected furnishings, including a bed, a table, and so forth. Initially, he had a little rug for a doormat. He soon found that this small rug had to be taken up and shaken, and that the floor beneath still needed cleaning in any case. The rug was merely a small nuisance, and he got rid of it, because he wanted to eliminate, rather than accumulate, such possessions and the little tasks they entailed. He realized that people can easily become slaves to what they own. Likewise, he concluded that it was often faster to walk than to ride a stage or a train, if one took into account not just travel time but also the number of hours one had to work to earn money for the fare. By Thoreauvian logic, a good many conveniences not only prove unnecessary; they create debt and force us to work long hours so that we can pay for them.

Thoreau's life and writings inspired other early environmentalists. John Muir advocated simple living arrangements and questioned the value of a clutter of technological gadgets. Others who have retreated from civilization into remote places to practice simple living include Helen and Scott Nearing, who left New York to take up subsistence farming in the 1920s. For several generations they proved that one might have a good life with a minimum of technology. During the twentieth century, thousands of others also quietly rejected technological abundance, as documented in David Shi's book *The Simple Life*.[46] Not all of them retreated into the countryside. Lewis Mumford advocated a simple life in the city, sought to establish planned communities, and attacked the consumer culture as "the opulence of carefully packaged emptiness." In the last three decades of the twentieth century, inspired by such individuals and by books such as *The Poverty of Affluence*,[47]

non-profit political organizations such as World Watch and Friends of the Earth lobbied against the ideology of growth. They raised questions about scale and appropriateness that seemed urgent once the energy crises of the 1970s revealed the vulnerability of Western economies to oil and gas shortages. In *Small Is Beautiful* (1972), E. F. Schumacher advocated that developing countries solve their problems with simple machines and small-scale workshops rather than complex, high-tech "solutions" that made them dependent upon foreign aid and imperial suppliers.[48] Such "low-tech" ideas also seemed appealing in industrial nations, because they empowered individuals to select and construct their own technological systems. The counterculture found such ideas especially appealing and codified them in *The Whole Earth Catalogue* (1968), which provided detailed information on where to buy and how to use a host of small-scale technologies to preserve food, generate power, build and insulate new forms of shelter such as geodesic domes, and otherwise escape from conventional consumption.

With the energy crisis of the early 1970s, people other than counterculturists became interested in such things as passive solar heat and electricity-generating windmills. Suddenly it seemed self-evident that oil, gas, and coal were limited resources that would run out within a few generations. Nor was the use of nuclear reactors to generated electricity considered a comfortable alternative. Even before the accidents at Three Mile Island and Chernobyl demonstrated the dangers of nuclear plants, Amory Lovins attacked nuclear power generation as a brittle, centralized system that was costly, created long-term pollution, and was vulnerable to terrorism. In contrast, wind and solar power were flexible, de-centralized, non-polluting, safe, and probably less expensive in the long term.[49] In the short term, however, alternative energy sources could not begin to supply the electricity demands of Western economies. Furthermore, so much energy was needed to produce some of the early solar panels and windmills that they represented little net gain.

Beginning in the 1980s, World Watch issued yearly "State of the World" reports. Conventional economic theory assumes that the gross national product must continually grow, but such groups were convinced that technological abundance both destroyed the environment and distracted people from helping one another.[50] Such reports and the ideal of sustainability based on alternate energies did not transform the habits of most people, however. Once the energy shortages of the 1970s receded, consumers reverted to automobiles for transportation and continued to increase domestic per-capita energy use. After 1980, automakers found that Americans did not want small, fuel-efficient cars; they wanted pickup trucks and so-called sport-utility vehicles. Just as Henry Ford discovered in the 1920s that the public would not buy the Model T in perpetuity but demanded annual restyling, in the last two decades of the twentieth century manufacturers acceded to consumers' demands for bigger vehicles.

In contrast, Europeans have long been accustomed to smaller automobiles and higher taxes on gasoline, which encourage alternative forms of transport. Many rely primarily on mass transit and bicycles and live in compact cities with many row houses and apartments. Such countries have a standard of living as high as in the United States, but use only half as much energy per capita. Their economies may prove more sustainable than those of Australia, the United States, and Canada. The Netherlands is a particularly interesting example of a highly technological nation that decided to limit development. For centuries, the Dutch approached the natural world as a reservoir of raw materials to

be exploited to the maximum. They drained low-lying areas and made them into fields. They transformed rivers into canals. They built dikes that pushed back the ocean, and today much of the population lives below sea level. However, in the twentieth century the Dutch began to recognize limits to this exploitation. After cutting off the Zuider Zee from the North Sea, they decided not to drain all the water away. They recovered some land for settlement and agriculture, but allowed much of the area to remain under water. They had prevented North Sea storms from flooding the heart of their nation, but long experience had shown that pumping out an entire area provoked land subsidence, so that the new fields sank below the original seabed. Simultaneously, the Dutch learned to see the tamed Zuider Zee as the equivalent of a giant lung in the middle of the country, providing moisture, cleaner air, fishing, ecological diversity, and recreation areas.

But during the centuries when European cultures conquered much of the rest of the world, often with destructive results, they imposed few checks on development. North American passenger pigeons, once so numerous that they seemed to blot out the sky, were extinct by the late nineteenth century. These migrating birds had once eaten billions of insects each year and fertilized the landscape with tons of droppings containing phosphorous. Their extinction broke an important part of an ecological cycle.[51] Restrictions on hunting the carrier pigeon and preservation of its habitat could have saved it, but no one realized the bird's importance until too late. More recently, some European nations have reversed a destructive policy of eliminating hedgerows to create larger fields as part of the "rationalization" of farming. Many bird species live and prosper in hedgerows, and as they diminished local ecologies were upset. By the end of the twentieth century, hedgerows were being re-established to protect against wind

erosion and to readjust the balance between wild nature and agriculture.

The refusal to drain the Zuider Zee and the reestablishment of hedgerows suggest that humanity can move beyond seeing technology and nature as irreconcilable opposites. Richard White has written of the Columbia River Valley as an "organic machine" whose energies include not only the flow of the water, but also the salmon, the Native Americans, and the Anglo-Americans, with their steamboats, dams, and electrical systems. White rejects the man/nature dichotomy, and sees an intermingling. "Dams, hatcheries, channels, pumps, cities, and ranches are all products of human work, and it is our labor that ultimately links us to the river. Our labor, our energy, is the nature in us. And we harness it, just as we harness nature, to social purposes."[52] Many environmental scholars now see people as part of nature, and nature as part of culture. If instead one views nature as something separate from humans, it creates a misleading perception of "an 'us vs. them' posture that creates opposition within environmental movements as well as outside them."[53] An office worker may feel quite independent of the natural world, forgetting that the electricity driving the computer and lighting the building comes from a dam in the mountains or from coal mined and burned hundreds of miles away.[54] In larger perspective, human and natural processes are inseparable.

Joel Cohen confronted the fundamental question in his 1995 book *How Many People Can the Earth Support?* For more than 300 years, analysts have argued there must be a limit to the earth's long-term "carrying capacity," but they have disagreed about what it is. Estimates have ranged from 1 billion persons to over 100 billion. The medians for low and high estimates suggest a maximum population of between 7.7 billion and 12 billion.[55] Earth's

population is now moving into this range, and theories about its carrying capacity will be tested. Aside from different statistical assumptions and varying estimates of the available arable land and potable water, "how many people the Earth can support depends on what people want from life."[56] If people in dry areas want green lawns and chlorinated swimming pools, there will be less water for irrigation. Not only will farmers produce less food, but chlorinated water will be unavailable to other species. If people want to eat meat every day and wear natural fibers, the world can support fewer people than it can support if people are vegetarians and buy synthetic clothing. Ultimately, the world's carrying capacity is not a scientific fact but a social construction. Nature is not outside us, and it does not have fixed limits. Rather, its limits are our own.

Does technology assure abundance? The example of Robinson Crusoe creating a comfortable life on a remote island is more complex than it first appears. When he is leaving his island, he contrives to settle several sailors there, and he sends them cattle, hogs, and additional settlers. Crusoe transforms himself from a castaway into the owner of a colony. Using European agriculture, metal tools, and weapons, the settlers increase the island's carrying capacity and link it to the Atlantic economy. Its limits depend on how much its inhabitants want. That island's story, like humanity's, is open-ended, depending on human choices.

7 | Work: More, or Less? Better, or Worse?

Much hard physical labor has disappeared, as workers use machines to dig canals and ditches, pump water, carry materials from place to place, and lift loads in factories and warehouses. Today, in the industrial nations, few field workers swelter in the sun; agriculture has been mechanized. But some jobs are numbingly repetitive: the supermarket cashier endlessly scanning foods at the checkout counter, the fast-food cook frying identical hamburgers, the toll-booth attendant collecting small sums from hundreds of passing motorists. Such work is boring, it isolates workers from sustained contact with other people, and it does not lead to new opportunities. Some of these jobs are being automated. Many motorists no longer need to stop to pay tolls, as scanners read the codes on their vehicles. Tedious and dangerous factory work has been replaced by robots or automatic machines, while millions of people hold jobs that did not exist 150 years ago in industries created around new technologies, such as computing, musical recording, broadcasting, design, advertising, and research and development. As recently as 150 years ago, most people in Europe and the United States were farmers. Today, less than 5 percent remain on farms, and industrial work occupies only about 25 percent of workers. In agriculture and industry,

10. Roszak 1969, p. 12.

11. This paragraph relies on pp. 234–238 of Jackson 1985.

12. Riesman 1958, pp. 375–402.

13. The information on the transformation of the original suburb assembled by Peter Bacon Hales can be seen at http://tigger.uic.edu.

14. "Behind the Region's Run-up in Prices," *New York Times* Sunday Late Edition, July 13, 2003.

15. Rae 1965, p. 61.

16. Ibid., pp. 95–99; Tedlow 1990, pp. 158–181.

17. Source: www.smartmoney.com.

18. This paragraph is based on an excellent paper presented by Kenneth Lepartito at the 1996 annual meeting of the Society for the History of Technology in London.

19. Blaszczyk 2000, p. 13.

20. Ibid., p. 93.

21. Ibid., p. 229.

22. Scranton 1997, p. 17.

23. Ibid., p. 99.

24. See e.g. Lederer 1961. For a Marxist version of this argument, see Ewen 1975.

25. Lyotard 1984, p. 4.

26. Castells 2001, p. 249.

27. Ibid., p. 250.

28. Ibid., p. 252.

29. Ibid., p. 261.

30. Miller and Slater 2001.

31. Ritzer 1993.

32. Barber 1996.

33. Fukuyama 2001. For a related argument, see Friedman 2000.

34. Robertson 1992. See also Appadurai 1996.

35. Kroes 1996, p. 164.

36. Durning 1992, pp. 69, 74, 68, 45.

37. Hobsbawm and Ranger 1983, p. 6.

38. Ibid., p. 4.

Chapter 6

1. David Humphreys, cited on p. 28 of Kasson 1976.

2. By "liberal thinkers" I mean those who embraced the idea of progress in the nineteenth and twentieth centuries, including utilitarians and advocates of free markets.

3. Marcuse 1970, p. 68.

4. Jackson 1984, p. 8.

5. See p. 114 of Nye 1998a.

6. Thurston 1881, pp. 7–8.

7. Thurston 1895, p. 310.

8. Sombart 1976, pp. 102–106.

9. Ibid., pp. 74, 87, 92.

10. Cited on p. 122 of Tichi 1987.

11. Tichi 1987, pp. 118–131.

12. Henry Ford, cited on p. 87 of Rhodes 1999.

13. Nye 1998b.

14. Greenhalgh 1988, pp. 52–81.

15. *Official Guide: Book of the Fair, 1933* (Chicago: A Century of Progress, 1933), p. 12.

16. Raskin 1955, p. 17.

17. Gibbs 1989, pp. 59–60.

18. White 1949, pp. 363–368.

19. Smith 1983.

20. *Los Angeles Herald-Examiner,* July 20, 1969.

21. Dyson et al. 1994.

22. Ibid., p. 3.

23. See e.g. Limerick 1988.

24. See pp. 12–13 of Long 2003.

25. The remaining examples in this paragraph are from pp. 75–85 of Gimpel 1988.

26. McNeill 2000, pp. 38–39.

27. Ibid., p. 48.

28. Berg 1980, p. 261.

29. Carlyle 1829, p. 266.

30. Ibid., p. 265.

31. Ibid.

32. Adams 1931, p. 380.

33. See chapter 11 of Nye 2003.

34. McNeill 2000, pp. 310–311.

35. Durning 1992, p. 82 and passim.

36. Sibley 1973, p. 267

37. Ibid., p. 261.

38. Defoe 1719, p. 127.

39. Ibid., p. 187.

40. In view of the inanity of many mobile phone conversations, it may be that people still seek improved means to unimproved ends.

41. Thoreau 1854, pp. 29, 42.

42. Blonheim 1994, pp. 32, 36.

43. Petroski 1989.

44. Gross 2000, pp. 181–196.

45. Elizabeth Hall Witherell, with Elizabeth Dubrulle, "The Life and Times of Henry D. Thoreau," at www.niulib.niu.edu.

46. Shi 1985.

47. Wachtel 1983.

48. Schumacher 1973.

49. Lovins 1976.

50. See e.g. World Watch Institute 2004.

51. Merchant 1989, p. 36.

52. White 1995, p. 112.

53. Cronon 1996, p. 455.

54. White 1996, p. 184.

55. Cohen 1995, pp. 368–369.

56. Ibid., p. 283.

Chapter 7

1. For a useful discussion of this point, see pp. 114–120 of Staudenmaier 1985.

2. Pacey 1999, pp. 18–20.