CHAPTER

1 Catalysts for Change

A tourist came in from Orbitville,
parked in the air, and said:

The creatures of this star
are made of metal and glass.

Through the transparent parts
you can see their guts.

Their feet are round and roll
on diagrams of long

measuring tapes, dark
with white lines.

They have four eyes.
The two in back are red.

Sometimes you can see a five-eyed
one, with a red eye turning

on the top of his head.
He must be special–

the others respect him
and go slow

when he passes, winding
among them from behind.

They all hiss as they glide,
like inches, down the marked
tapes. Those soft shapes,
shadowy inside
the hard bodies–are they
their guts or their brains?

–MAY SWENSON, "Southbound on the Freeway"[1]

1.1 Introduction

MOST OF US WHO LIVE IN WESTERN DEMOCRATIC NATIONS TAKE TECHNOLOGICAL change for granted. In the past two decades alone, we have witnessed the emergence of exciting new technologies, including cell phones, MP3 players, digital photography, email, and the World Wide Web. There is good reason to say we are living in the Information Age. Never before have so many people had such easy access to information. The two principal catalysts for the Information Age have been low-cost computers and high-speed communication networks (Figure 1.1). Even in a society accustomed to change, the rate at which computers and communication networks have transformed our lives is breathtaking.

In 1950 there were no more than a handful of electronic digital computers in the world. Today we are surrounded by devices containing embedded computers. We rely upon microprocessors to control our heating and cooling systems, microwaves, stereos, elevators, and a multitude of other devices we use every day. Thanks to microprocessors, our automobiles get better gas mileage and produce less pollution. On the other hand, the days of the do-it-yourself tune-up are gone. It takes a mechanic with computerized diagnostic equipment to work on a modern engine.

In 1990 few people other than college professors used email. Today more than 600 million people around the world have email accounts. We consider people without access to email as deprived, even though most of us also complain about the amount of spam we receive.

The World Wide Web was still being designed in 1990; today it contains billions of pages and makes possible extraordinarily valuable information retrieval systems. Teachers expect grade school children to use the Web when writing their reports. However, many parents worry that their Web-surfing children may be exposed to pornographic images or other inappropriate material.

May Swenson has vividly described our ambivalent feelings toward technology. In her poem "Southbound on the Freeway," an alien hovers above an expressway and watches the cars move along [1]. The alien notes "soft shapes" inside the automobiles

1. "Southbound on the Freeway" by May Swenson used with permission of the Literary Estate of May Swenson.

Figure 1.1 Low-cost computers and high-speed communication networks make possible the products of the Information Age, such as the Nokia E70. It functions as a phone, email client, camera, video recorder, MP3 player, game platform, alarm clock, calculator, notepad, and more. (Courtesy of Nokia)

and wonders, "are they their guts or their brains?" It's fair to ask: Do we drive technology, or does technology drive us?

Our relationship with technology is complicated. We create technology and choose to adopt it. However, once we have adopted a technological device, it can change us and how we relate to other people and our environment.

The choice to use a new technology can affect you physically. For example, anecdotal evidence from physicians and physical therapists reveals that the growing popularity of laptop computers is increasing the number of people suffering from wrist, neck, shoulder, and back pain. That's not surprising, given the awkward places many people use laptop computers, such as traditional college lecture halls with cramped seating and tiny writing surfaces. A chiropractor remarks, "Have you seen pictures of kids using computers? They lie on their stomachs on the floor and work on their elbows. That's a prescription for a lifetime of neck pain, back pain, and lower back pain" [2].

Use of a technology can also change the way you perceive the world. For example, more than 90 percent of cell phone users report that having a cell phone makes them feel safer. On the other hand, once people get used to carrying a cell phone, losing the phone may make them feel more vulnerable than they ever did before they began carrying one. A Rutgers University professor asked his students to go without their cell phones for 48 hours. Some students couldn't do it. A female student reported to the student newspaper, "I felt like I was going to get raped if I didn't have my cell phone in my hand." Some

FIGURE 1.2 The Amish carefully evaluate new technologies, choosing those that enhance family and community solidarity. (AP/Wideworld Photos)

parents purchase cell phones for their children so that a child may call a family member in an emergency. However, parents who provide a cell phone "lifeline" may be implicitly communicating to their children the idea that people in trouble cannot expect help from strangers [3].

The Amish understand that the adoption of a new technology can affect the way people relate to each other (Figure 1.2). Amish bishops meet twice a year to discuss matters of importance to the church, including whether any new technologies should be allowed. Their discussion about a new technology is driven by the question, "Does it bring us together, or draw us apart?" You can visit an "Old Order" Amish home and find a gas barbecue on the front porch, but no telephone inside, because they believe gas barbecues bring people together, while telephones interfere with face-to-face conversations [4].

New technologies are adopted to solve problems, but they often create problems, too. The automobile has given people the ability to travel where they want, when they want to. On the other hand, millions of people spend an hour or more each day stuck in traffic commuting between home and work. Refrigerators make it possible for us to keep food fresh for long periods of time. We save time because we don't have to go grocery shopping every day. Unfortunately, freon leaking from refrigerators has contributed to the depletion of the ozone layer that protects us from harmful ultraviolet rays. New communication technologies have made it possible for us to get access to news and entertainment from around the world. However, the same technologies have enabled major software companies to move thousands of jobs to India, China, and Vietnam, putting downward pressure on the salaries of computer programmers in the United States [5].

We may not be able to prevent a new technology from being invented, but we do have control over whether to adopt it. Nuclear power is a case in point. Nuclear power plants create electricity without producing carbon dioxide emissions, but they also produce radioactive waste products that must be safely stored for 100,000 years. Although nuclear power technology is available, no new nuclear power plants were built in the United States for more than 25 years after the accident at Three Mile Island in 1979 [6].

Finally, we *can* influence the rate at which new technologies are developed. Some societies, such as the United States, have a history of nurturing and exploiting new inventions. Congress has passed intellectual property laws that allow people to make money from their creative work, and the federal income tax structure allows individuals to accumulate great wealth.

Most of us appreciate the many beneficial changes that technology has brought into our lives. In health care alone, computed tomography (CT) and magnetic resonance imaging (MRI) scanners have greatly improved our ability to diagnose major illnesses; new vaccines and pharmaceuticals have eradicated some deadly diseases and brought others under control; and pacemakers, hearing aids, and artificial joints have improved the physical well-being of millions.

The point is that we should be making informed decisions about how to use technology to maximize its benefits and minimize its harms. To that end, this book will help you gain a better understanding of contemporary issues related to the use of information technology.

This chapter sets the stage for the remainder of the book. Electronic digital computers and high-performance communication networks are central to contemporary information technology. While the impact of these inventions has been dramatic in the past few decades, their roots go back hundreds of years. Section 1.2 tells the story of the development of computers, showing how they evolved from simple manual calculation aids to complex microprocessors. In Section 1.3 we describe two centuries of progress in networking technology, starting with the semaphore telegraph and culminating in the creation of an email system connecting hundreds of millions of users. Section 1.4 shows how information storage and retrieval evolved from the creation of the codex (paginated book) to the invention of the World Wide Web. Finally, Section 1.5 discusses some of the moral issues that have arisen from the deployment of information technology.

1.2 Milestones in Computing

1.2.1 Aids to Manual Calculating

Adding and subtracting are as old as commerce and taxes. Fingers and toes are handy calculation aids, but to manipulate numbers above 20, people need more than their own digits. The tablet, the abacus, and mathematical tables are three important aids to manual calculating [7].

Simply having a tablet to write down the numbers being manipulated is a great help. In ancient times, erasable clay and wax tablets served this purpose. By the late

FIGURE 1.3 This illustration from Gregor Reisch's *Margarita Philosophica*, published in 1503, shows two aids to manual calculating. The person on the left is adding numbers represented as Hindu-Arabic numerals. The person on the right is adding numbers using a counting board, a type of abacus. (© Science Museum Library/Science & Society Picture Library)

Middle Ages, Europeans often used erasable slates. Paper tablets became common in the nineteenth century, and they are still popular today.

An **abacus** is a computing aid in which a person performs arithmetic operations by sliding counters along rods, wires, or lines. The first abacus was probably developed in the Middle East more than two thousand years ago. In a Chinese, Japanese, or Russian abacus, counters move along rods or wires held in a rectangular frame. Beginning in medieval Europe, merchants performed their calculations by sliding wooden or metal counters along lines drawn in a wooden counting board (Figure 1.3). (Eventually the word "counter" came to mean not only the disk being manipulated but also the place in a store where transactions take place [7].)

Mathematical tables have been another important aid to manual computing for about two thousand years. A great breakthrough occurred in the early seventeenth century, when John Napier and Johannes Kepler published tables of logarithms. These tables were tremendous time savers to anyone doing complicated math because it allowed them to multiply two numbers by simply adding their logarithms. Many other useful tables were created as well. For example, businesspeople consulted tables to compute interest and convert between currencies. Today, people who compute their income taxes "by hand" make use of tax tables to determine how much they owe.

Even with tablets, abacuses, and mathematical tables, manual calculating is slow, tedious, and error-prone. To make matters worse, all mathematical tables prepared centuries ago contained errors. That's because somebody had to compute each table entry and somebody had to typeset each entry, and errors could occur in either of these steps. Advances in science, engineering, and business in the post-Renaissance period motivated European inventors to create new devices to make calculations faster and more reliable and to automate the printing of mathematical tables.

1.2.2 Mechanical Calculators

Blaise Pascal had a weak physique but a powerful mind. When he got tired of summing by hand long columns of numbers given him by his father, a French tax collector, he constructed a mechanical calculator to speed the chore. Pascal's calculator, built in 1640, was capable of adding whole numbers containing up to six digits. Inspired by Pascal's invention, the German Gottfried Leibniz constructed a more sophisticated calculator that could add, subtract, multiply, and divide whole numbers. The hand-cranked machine, which he called the Step Reckoner, performed multiplications and divisions through repeated additions and subtractions, respectively. The calculators of Pascal and Leibniz were not reliable, however, and did not enjoy commercial success.

In the nineteenth century, advances in machine tools and mass-production methods, combined with larger markets, made possible the creation of practical calculating machines. Frenchman Charles Thomas de Colmar utilized the stepped drum gear mechanism invented by Leibniz to create the Arithmometer, the first commercially successful calculator. Many insurance companies purchased Arithmometers to help their actuaries compute rate tables more rapidly [7].

Swedish publisher Georg Scheutz was intimately familiar with printing errors associated with the production of mathematical tables. He resolved to build a machine capable of automatically calculating and typesetting table values. Scheutz knew about the earlier work of English mathematician Charles Babbage, who had demonstrated how a machine could compute the values of polynomial functions through the method of differences. Despite promising early results, Babbage's efforts to construct a full-scale Difference Engine had been unsuccessful. In contrast, Georg Scheutz and his son Edvard, who developed their own designs, completed the world's first printing calculator: a machine capable of calculating mathematical tables and typesetting the values onto molds. The Dudley Observatory in Albany, New York, purchased the Scheutz difference engine in 1856. With support from the U.S. Nautical Almanac Office, astronomers used

the machine to help them compute the motion of Mars and the refraction of starlight. Difference engines were made obsolete by the emergence of simpler and less expensive calculating machines [7].

America in the late 1800s was a fertile ground for the development of new calculating technologies. This period of American history, commonly known as the Gilded Age, was characterized by rapid industrialization, economic expansion, and a concentration of corporate power. Corporations merged to increase efficiency and profits, but the new, larger corporate organizations had multiple layers of management and multiple locations, and in order for middle- and upper-level managers to monitor and improve performance, they needed access to up-to-date, comprehensive, reliable, and affordable information. All these requirements could not be met by bookkeepers and accountants using pen and paper to sum long columns of transactions by hand [8].

To meet this demand, many entrepreneurs began producing adding and calculating machines. One of these inventors was William Burroughs, a former bank clerk who had spent long days adding columns of figures. Burroughs devised a practical adding machine and offered it for sale. He found himself in a cut-throat market; companies competed fiercely to reduce the size of their machines and make them faster and easier to use. Burroughs distinguished himself from his competitors by putting together first-class manufacturing and marketing organizations, and by the 1890s the Burroughs Adding Machine Company led the industry. Calculating machines were entrenched in the offices of large American corporations by the turn of the century [8].

The adoption of mechanical calculators led to the "deskilling" and feminization of bookkeeping (Figure 1.4). Before the introduction of calculating machines, offices were

FIGURE 1.4 Bookkeepers using Comptometer calculators (1947). (Image from *Before the Computer* by James Cortada, Princeton University Press)

a male bastion, and men who could rapidly compute sums by hand were at a premium. Calculators leveled the playing field, making people of average ability quite productive. In fact, a 1909 Burroughs study concluded that a clerk using a calculator was six times faster than a clerk adding the same column of figures by hand [9]. As managers introduced mechanical calculators into offices, they replaced male bookkeepers with female bookkeepers and lowered wages. In 1880 only 5.7 percent of bookkeepers, cashiers, and accountants were women, but by 1910 the number of women in these jobs had risen to 38.5 percent [10].

1.2.3 Cash Register

Store owners in the late 1800s faced challenges related to accounting and embezzlement. Keeping accurate sales records was becoming more difficult as smaller stores evolved into "department stores" with several departments and many clerks. Preventing embezzlement was tricky when clerks could steal cash simply by not creating receipts for some sales.

While on a European holiday in 1878, Ohio restauranteur James Ritty saw a mechanical counter connected to the propeller shaft of his ship. A year later, he and his brother John used that concept to construct the first cash register, essentially an adding machine capable of expressing values in dollars and cents. Enhancements followed rapidly, and by the early 1900s the cash register had become an important information processing device (Figure 1.5). Cash registers created printed, itemized receipts for customers, maintained printed logs of transactions, and performed other accounting functions that provided store owners with the detailed sales records they needed.

Figure 1.5 An NCR cash register in Miller's Shoe Shine Parlor, Dayton, Ohio (1904). (The NCR Archive at Dayton History)

Cash registers also made embezzlement by clerks more difficult. The bell made it impossible for clerks to sneak money from the cash drawer and helped ensure that every sale was "rung up." Printed logs made it easy for department store owners to compare cash on hand against sales receipts [8].

1.2.4 Punched Card Tabulation

As corporations and governmental organizations grew larger in the late 1800s, they needed to handle greater volumes of information. One of these agencies was the U.S. Bureau of the Census, which collected and analyzed information on tens of millions of residents every decade. Aware of the tedium and errors associated with clerks manually copying and tallying figures, several Census Bureau employees developed mechanical tabulating machines. Herman Hollerith created the most successful device. Unlike a predecessor, who chose to record information on rolls of paper, Hollerith decided to record information on punched cards. The use of punched cards to store data was a much better approach, because cards could be sorted into groups, allowing the computation of subtotals by categories. Hollerith's equipment proved to be a great success when used in the 1890 census. In contrast to the 1880 census, which had required eight years to complete, the 1890 census was finished in only two years (Figure 1.6).

Other data-intensive organizations found applications for punched cards. Railroads used them to improve their accounting operations and send bills out more frequently. Retail organizations, such as Marshall Field's, used punched cards to perform more sophisticated analyses of information generated by the cash registers at its many stores. The Pennsylvania Steel Company and other heavy industries began to use use punched-card technology to do cost accounting on manufacturing processes.

The invention of sorters, tabulators, and other devices to manipulate the data on punched cards created a positive feedback loop. As organizations began using tabulating machines, they thought up new uses of information-processing equipment, stimulating further technological innovations.

International Business Machines (IBM) is the corporate descendent of Hollerith's company. Over a period of several decades, IBM and its principal competitor, Remington Rand, developed sophisticated machines based around punched cards: card punches, card verifiers, card sorters, and card tabulators. Users used these devices to create **data-processing systems** that received input data, performed one or more calculations, and produced output data. Within these systems, punched cards stored input data, intermediate results, and output data. In the most complicated systems, punched cards also stored the program—the steps of the computational process to be followed. Early systems relied on human operators to carry cards from one machine to the next. Later systems had electrical connections that allowed the output of one machine to be transmitted to the next machine without the use of punched cards or human intervention.

Organizations with large data-processing needs found punched-card tabulators and calculators to be valuable devices, and they continually clamored for new features that would improve the computational capabilities and speed of their systems [8].

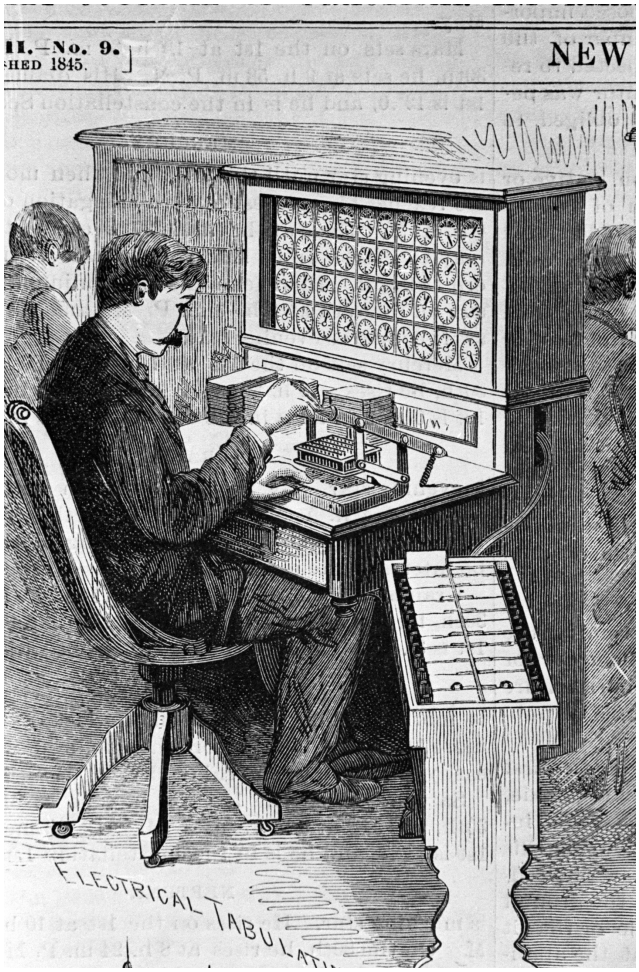


Figure 1.6 A U.S. Census Bureau employee uses a Hollerith electric tabulator (1890). (© Bettmann/CORBIS)

1.2.5 Precursors of Commercial Computers

Several computing devices developed during and immediately after World War II paved the way for the commercialization of electronic digital computers.

Between 1939 and 1941, Iowa State College professor John Atanasoff and his graduate student Clifford Berry constructed an electronic device for solving systems of linear equations. The Atanasoff-Berry Computer was the first computing device built with vacuum tubes, but it was not programmable.

Dr. John W. Mauchly, a physics professor at the University of Pennsylvania, visited Iowa State College in 1941 to learn more about the Atanasoff-Berry Computer. After

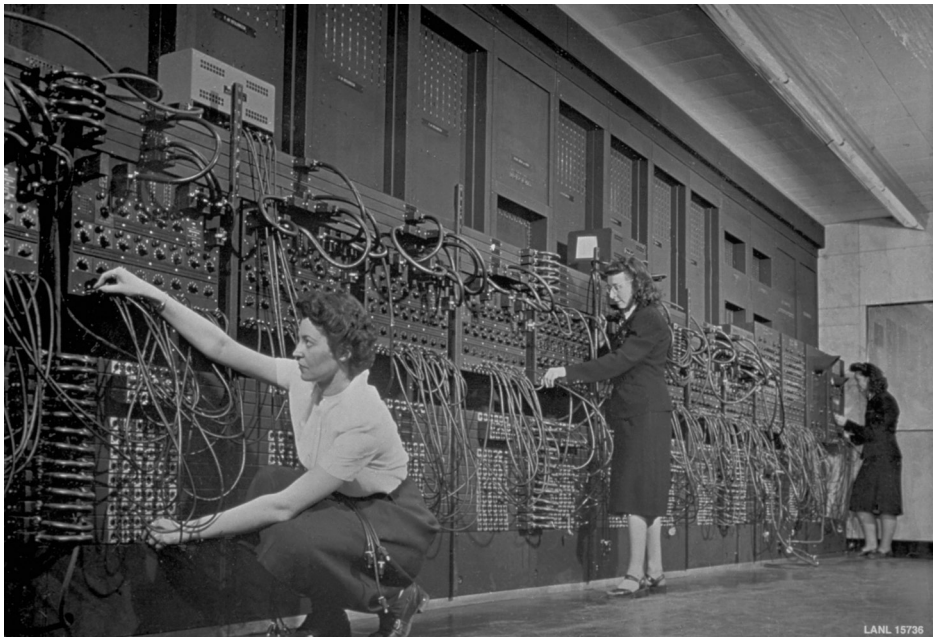


Figure 1.7 The ENIAC's first six programmers were women. Every instruction was programmed by connecting several wires into plugboards. (© CORBIS)

he returned to Penn, Mauchly worked with J. Presper Eckert to create a design for an electronic computer to speed the computation of artillery tables for the U.S. Army. They led a team that completed work on the ENIAC (Electronic Numerical Integrator and Computer) in 1946. As it turns out, the war ended before the ENIAC could provide the Army with any ballistics tables, but its speed was truly impressive. A person with a desk calculator could compute a 60-second trajectory in 20 hours. The ENIAC performed the computation in 30 seconds. In other words, the ENIAC was 2,400 times faster than a person with a desk calculator.

The ENIAC had many features of a modern computer. All of its internal components were electronic, and it could be programmed to perform a variety of computations. However, its program was not stored inside memory. Instead, it was "wired in" from the outside. Reprogramming the computer meant removing and reattaching many wires. This process could take many days (Figure 1.7).

Even before the ENIAC was completed, work began on a follow-on system called the EDVAC (Electronic Discrete Variable Automatic Computer). The design of the EDVAC incorporated many improvements over the ENIAC. The most important improvement was that the EDVAC would store the program in primary memory, along with the data manipulated by the program. In 1946 Eckert, Mauchly, and several other computer pioneers gave a series of 48 lectures at the Moore School. While some of the lectures discussed lessons learned from the ENIAC, others focused on the design of its successor,

the EDVAC. These lectures influenced the design of future machines built in the United States and the United Kingdom.

During World War II, British engineer F. C. Williams was actively involved in the development of cathode ray tubes (CRTs) used in radar systems. After the war, he decided to put his knowledge to use by figuring out how to use a CRT as a storage device for digital information. In early 1948 a team at the University of Manchester set out to build a small computer that would use a CRT storage device, now called the Williams Tube, to store the program and its data. They called their system the Small-Scale Experimental Machine. The computer successfully executed its first program in 1948. The Small-Scale Experimental Machine was the first operational, fully electronic computer system that had both program and data stored in its memory.

1.2.6 First Commercial Computers

In 1951 British corporation Ferranti, Ltd. introduced the Ferranti Mark 1, the world's first commercial computer. The computer was the direct descendent of research computers constructed at the University of Manchester. Ferranti delivered nine computers between 1951–1957, and later Ferranti models boasted a variety of technological breakthroughs, thanks to the company's close association with research undertaken at the University of Manchester and Cambridge University.

After completing work on the ENIAC, Eckert and Mauchly formed their own company to produce a commercial digital computer. The Eckert-Mauchly Computer Corporation signed a preliminary agreement with the National Bureau of Standards (representing the Census Bureau) in 1946 to develop a commercial computer, which they called the UNIVAC, for UNIVersal Automatic Computer. The project experienced huge cost overruns, and by 1950 the Eckert-Mauchly Computer Corporation was on the brink of bankruptcy. Remington Rand bailed them out and delivered the UNIVAC I to the U.S. Bureau of the Census in 1951 [11].

In a public relations coup, Remington Rand cooperated with CBS to use a UNIVAC computer to predict the outcome of the 1952 Presidential election (Figure 1.8). The events of election night illustrate the tough decisions people can face when computers produce unexpected results.

Adlai Stevenson had led Dwight Eisenhower in polls taken before the election, but less than an hour after the polls closed, with just 7 percent of the votes tabulated, the UNIVAC was predicting Dwight Eisenhower would win the election in a landslide. When CBS correspondent Charles Collingwood asked Remington Rand for the computer's prediction, however, he was given the run-around. The computer's engineers were convinced there was a programming error. For one thing, UNIVAC was predicting that Eisenhower would carry several Southern states, and everybody "knew" that Republican Presidential candidates never won in the South. Remington Rand's director of advanced research ordered the engineers to change the programming so the outcome would be closer to what the political pundits expected. An hour later, the reprogrammed computer predicted that Eisenhower would win by only nine electoral votes, and that's what CBS announced. As it turns out, the computer was right and the human "experts" were

FIGURE 1.8 Walter Cronkite (right) visits the UNIVAC computer at a Philadelphia factory to prepare for the 1952 Presidential election night coverage. The man standing to his right is J. Presper Eckert. The console operator is Harold Sweeney. (Courtesy of Unisys Corporation)

wrong. Before being reprogrammed, UNIVAC had predicted Eisenhower would win 438 electoral votes to 93 for Stevenson. The official result was a 442–89 victory for Eisenhower [11].

In America in the early 1950s the word "UNIVAC" was synonymous with "computer." Remington Rand sold a total of 46 UNIVACs to government agencies, such as the U.S. Air Force, the U.S. Army Map Service, the Atomic Energy Commission, and the U.S. Navy, as well as large corporations and public utilities such as General Electric, Metropolian Life, U.S. Steel, Du Pont, Franklin Life Insurance, Westinghouse, Pacific Mutual Life Insurance, Sylvania Electric, and Consolidated Edison.

Office automation leader IBM did not enter the commercial computer market until 1953, and its initial products were inferior to the UNIVAC. However, IBM quickly turned the tables on Remingon Rand, thanks to a larger base of existing customers, a far superior sales and marketing organization, and a much greater investment in research and development. In 1955 IBM held more than half the market, and by the mid-1960s

IBM dominated the computer industry with 65 percent of total sales, compared to 12 percent for number two computer maker Sperry Rand (the successor to Remington Rand) [11].

1.2.7 Programming Languages and Time–Sharing

In the earliest digital computers every instruction was coded as a long number. People immediately began looking for ways to make coding faster and less error-prone. One early improvement was the creation of assembly language, which allowed programmers to work with symbolic representations of the instruction codes. Still, one assembly language instruction was required for every machine instruction. Programmers wanted fewer, higher-level instructions to generate more machine instructions. In 1951 Frances Holberton, one of the six original ENIAC programmers, created a sort-merge generator for the UNIVAC that took a specification of files to be manipulated and automatically produced the machine program to do the sorting and merging. Building on this work, Grace Murray Hopper, also at Remington Rand, developed the A-0 system that automated the process of linking together subroutines to form the complete machine code [12].

Over at IBM, John Backus convinced his superiors of the need for a higher-level programming language for IBM computers. He led the effort to develop the IBM Mathematical Formula Translating System, or FORTRAN. Designed for scientific applications, the first system was completed in 1957. Many skeptics had believed that any "automatic programming" system would generate inefficient machine code compared to hand-coded assembly language, but they were proven wrong: the FORTRAN compiler generated high-quality code. What's more, programmers could write FORTRAN programs 5–20 times faster than the equivalent assembly language programs. Most programmers quickly shifted allegiance from assembly language to FORTRAN. Eventually other computer manufacturers developed their own FORTRAN compilers, and FORTRAN became an international standard [13].

Meanwhile, business-oriented programming languages were also being developed by several computer manufacturers. Grace Murray Hopper specified FLOW-MATIC, an English-like programming language for the UNIVAC. Other manufacturers began to develop their own languages. Customers didn't like incompatible languages, because it meant programs written for one brand of computer had to be rewritten before they could be run on another brand of computer. In 1959 an extremely important customer, the U.S. Department of Defense, brought together a committee to develop a common business-oriented programming language that all manufacturers would support. The committee wrote the specification for COBOL. By requiring manufacturers to support COBOL in order to get defense contracts, the U.S. Department of Defense helped ensure its widespread adoption [14].

In the early 1960s John Kemeny and Thomas Kurtz at Dartmouth College directed teams of undergraduate students who developed a time-sharing system and an easy-to-learn programming language. The Dartmouth Time-Sharing System (DTSS) gave

multiple people the ability to edit and run their programs simultaneously, by dividing the computer's time among all the users. Time-sharing made computers accessible to more people because it allowed the cost of owning and operating a computer system to be divided among a large pool of users who purchased the right to connect to the system [15].

The development of BASIC, a simple, easy-to-learn programming language, was another important step toward making computers accessible to a wider audience. Kemeny and Kurtz saw BASIC as a way to teach programming, and soon many other educational instutions began teaching students how to program using Dartmouth BASIC. The language's popularity led computer manufacturers to develop their own versions of BASIC [15].

1.2.8 Transistor and Integrated Circuit

Although the British had radar installations at the beginning of World War II, it became clear during the Battle of Britain that their systems were inadequate. The British and Americans worked together to develop microwave radar systems capable of locating enemy planes more precisely. Microwave radar required higher frequency receivers utilizing semiconductors, and in the process of manufacturing microwave radar systems for the war effort several American companies, including AT&T, greatly improved their ability to create semiconductors [16].

AT&T was on the lookout for a new technology to replace the vacuum tube. Its long distance network relied on vacuum tubes to amplify signals, but the tubes required a lot of power, generated a lot of heat, and burned out like lightbulbs. After the war, AT&T put together a team of Bell Labs scientists, led by Bill Shockley, to develop a semiconductor substitute for the vacuum tube. In 1948 Bell Labs announced the invention of such a device, which they called the **transistor** [17].

While most electronics companies ignored the invention of the transistor, Bill Shockley understood its potential. He left Bell Labs and moved to Palo Alto, California, where he founded Shockley Semiconductor in 1956. He hired an exceptional team of engineers and physicists, but many disliked his heavy-handed management style [17].

In September 1957 eight of Shockley's most talented employees, including Gordon Moore and Robert Noyce, walked out. The group, soon to be known as the "traitorous eight," founded Fairchild Semiconductor (Figure 1.9). By this time transistors were being used in a wide variety of devices, from transistor radios to computers. While transistors were far superior to vacuum tubes, they were still too big for some applications. Fairchild Semiconductor set out to produce a single semiconductor device containing transistors, capacitors, and resistors; in other words, an **integrated circuit.** Another firm, Texas Instruments, was on the same mission. Today, Robert Noyce of Fairchild Semiconductor and Jack Kilby of Texas Instruments are credited for independently inventing the integrated circuit [18].

The Cold War between the United States and the Soviet Union played an important role in advancing integrated circuit technology. American engineers developing the

Figure 1.9 The eight founders of Fairchild Semiconductor on the factory floor. Gordon Moore is second from the left and Robert Noyce is on the right. (Magnum Photos, Inc. © 1960 Wayne Miller)

Minuteman II ballistic missile in the early 1960s decided to use integrated circuits to improve the processing speed of its guidance computer. The Minuteman II program was the single largest consumer of integrated circuits in the United States between 1962 and 1965, representing about 20 percent of total sales. During these years companies learned how to make rugged, reliable integrated circuits [7]. They also continued to shrink the components within the integrated circuits, leading to an exponential increase in the power of integrated circuits. Gordon Moore noted this trend in a 1965 paper and predicted it would continue. Today, **Moore's Law** refers to the phenomenon of integrated circuits becoming twice as powerful roughly every two years.

1.2.9 IBM System/360

The integrated circuit made possible the construction of much more powerful and much more reliable computers. The 1960s was the era of mainframe computers, large computers designed to serve the data processing needs of large businesses. Mainframe computers enabled enterprises to centralize all of their data processing applications in a single system. As we have seen, by this time IBM dominated the mainframe market in the United States.

FIGURE 1.10 Engineers test processors for the System/60 Model 40, a medium-sized IBM mainframe introduced in 1964. (Courtesy of IBM Corporate Archives)

In 1964 IBM announced the System/360, a series of 19 compatible computers with varying levels of computing speed and memory capacity (Figure 1.10). Because the systems were software compatible, a business could upgrade its computer without having to rewrite its application programs. This feature was important because by the 1960s companies were making much larger investments in software.

1.2.10 Microprocessor

In 1968 Robert Noyce and Gordon Moore left Fairchild Semiconductor to found another semiconductor manufacturing company, which they named Intel. A year later Japanese calculator manufacturer Busicom approached Intel and asked it to design 12 custom chips for use in a new scientific calculator. Intel agreed to provide the chips and assigned responsibility for the project to Marcian "Ted" Hoff. After reviewing the project, Hoff suggested that it was not in Intel's best interests to manufacture a custom chip for every customer. As an alternative, he suggested that Intel create a general-purpose chip that could be programmed to perform a wide variety of tasks. Each customer could

program the chip to meet its particular needs. Intel and Busicom agreed to the plan, which reduced the required number of chips for Busicom's calculator from 12 to 4. A year of development by Ted Hoff, Stanley Mazor, and Federico Faggin led to the release of the Intel 4004, the world's first **microprocessor**. Inside the $1/8'' \times 1/6''$ chip were 2,300 transistors, giving the Intel 4004 the same computing power as the ENIAC, which had occupied 3,000 cubic feet.

Microprocessors made it possible to integrate computers into everyday devices. Today we're surrounded by devices containing microprocessors: cell phones, MP3 players, digital cameras, wristwatches, ATM machines, automobiles, microwave ovens, thermostats, traffic lights, and much more. The highest-profile use of microprocessors, however, is in personal computers.

1.2.11 Personal Computer

During the Vietnam conflict in the late 1960s and early 1970s, the area around San Francisco was home to a significant counterculture, including a large number of antiwar and antiestablishment activists. The do-it-yourself idealism of the power-to-the-people movement intersected with advances in computer technology in a variety of ways, including the *Whole Earth Catalog*, the People's Computer Company, and the Homebrew Computer Club [19].

The *Whole Earth Catalog*, first published in 1968, was "sort of like Google in paperback form" [20]—an effort to pull together in a single large volume lists of helpful tools for the creation of a more just and environmentally sensitive society. The definition of "tools" was broad; the catalog's lists included books, classes, garden tools, camping equipment, and (in later issues) early personal computers. "With the *Whole Earth Catalog*, Stewart Brand offered a generation of computer engineers and programmers an alternative vision of technology as a tool for individual and collective transformation" [21].

The People's Computer Company was a not-for-profit corporation dedicated to educating people on how to use computers. One of its activities was publishing a newspaper. The cover of the first issue read: "Computers are mostly used against people instead of for people, used to control people instead of to free them, time to change all that—we need a PEOPLE'S COMPUTER COMPANY" [22]. Typical issues contained programming tips and the source code to programs, particularly educational games written in BASIC. Newspaper publisher Bob Albrecht said, "I was heavily influenced by the *Whole Earth Catalog*. I wanted to give away ideas" [21]. The People's Computer Company also set up the People's Computer Center in a strip mall in Menlo Park. The People's Computer Center allowed people to rent teletype terminals connected to a time-shared computer. A large number of teenagers were drawn to computing through Friday evening game-playing sessions. Many users wrote their own programs, and the center promoted a culture in which computer enthusiasts freely shared software with each other.

In 1975 the Homebrew Computer Club, an outgrowth of the People's Computer Company, became a meeting place for hobbyists interested in building personal computers out of microprocessors. A company in Albuquerque, New Mexico, called MITS

had recently begun shipping the Altair 8800 personal computer, and during the first few Homebrew Computer Club meetings, members showed off various enhancements to the Altair 8800. Progress was frustratingly slow, however, due to the lack of a higher-level programming language.

Three months after the establishment of the Homebrew Computer Club, MITS representatives visited Palo Alto to demonstrate the Altair 8800 and the BASIC interpreter created by Paul Allen and Bill Gates, who had a tiny company called Micro-Soft. The audience in the hotel conference room was far larger than expected, and during the overcrowded and chaotic meeting somebody acquired a paper tape containing the source code to Altair BASIC. More than 70 copies of the tape were handed out at the next meeting of the Homebrew Computer Club. After that, free copies of the interpreter proliferated. Some hobbyists felt that the asking price of $500 for the BASIC interpreter was too high, considering that the Altair computer itself cost only $395 as a kit or $495 preassembled [19].

Bill Gates responded by writing "An Open Letter to Hobbyists" that was reprinted in a variety of publications. In the letter he asserted that less than 10 percent of all Altair owners had purchased BASIC, even though far more people than that were using it. According to Gates, the royalties Micro-Soft had received from Altair BASIC made the time spent on the software worth less than $2 an hour. He wrote, "Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software," but the theft of software created "very little incentive" for his company to release new products [19].

The controversy over Altair BASIC did not slow the pace of innovations. Hobbyists wanted to do more than flip the toggle switches and watch the lights blink on the Altair 8800. Steve Wozniak, a computer engineer at Hewlett-Packard, created a more powerful personal computer that supported keyboard input and television monitor output. Wozniak's goal was to make a machine for himself and to impress other members of the Homebrew Computer Club, but his friend Steve Jobs thought of a few improvements and convinced Wozniak they should go into business (Figure 1.11). They raised $1,300 by selling Job's Volkswagen van and Wozniak's Hewlett-Packard scientific calculator, launching Apple Computer. Although the company sold only 200 Apple I computers, its next product, the Apple II, became one of the most popular personal computers of all time.

By the end of the 1970s many companies, including Apple Computer and Tandy, were producing personal computers. While hundreds of thousands of people bought personal computers for home use, businesses were reluctant to move to the new computer platform. Two significant developments made personal computers more attractive to businesses.

The first development was the computer spreadsheet program. For decades firms have used spreadsheets to perform financial predictions. Manually computing spreadsheets is monotonous and error-prone, since changing a value in a single cell can require updating many other cells. In the fall of 1979 Bob Frankston and Harvard MBA student Dan Bricklin released their program, called VisiCalc, for the Apple II. VisiCalc's labor-saving potential was obvious to businesses. After a slow start, it quickly became one of

Figure 1.11 Steve Jobs (right) convinced Steve Wozniak they should go into business selling the personal computer Wozniak designed. They named their company Apple Computer. (Apple Computer)

the most popular application programs for personal computers. Sales of the Apple II computer increased significantly after the introduction of VisiCalc.

The second development was the release of the IBM PC in 1981. The IBM name exuded reliability and respectability, making it easier for companies to make the move to desktop systems for their employees. As the saying went, "Nobody ever got fired for buying from IBM." In contrast to the approach taken by Apple Computer, IBM decided to make its PC an open architecture, meaning the system was built from off-the-shelf parts and other companies could manufacture "clones" with the same functionality. This decision helped to make the IBM PC the dominant personal computer architecture.

The success of IBM-compatible PCs fueled the growth of Microsoft. In 1980 IBM contracted with Microsoft to provide the DOS operating system for the IBM PC. Microsoft let IBM have DOS for practically nothing, but in return IBM gave Microsoft the right to collect royalties from other companies manufacturing PC-compatible computers. Microsoft profited handsomely from this arrangement when PC-compatibles manufactured by other companies gained more than 80 percent of the PC market [23].

1.3 Milestones in Networking

In the early nineteenth century the United States fell far behind Europe in networking technology. The French had begun constructing a network of telegraph towers in the

FIGURE 1.12 A semaphore telegraph tower on the first line from Paris to Lille (1794). (Coll. Musee de la Poste, Paris)

1790s, and forty years later there were towers all over the European continent (Figure 1.12). At the top of each tower was a pair of semaphores. Operators raised and lowered the semaphores; each pattern corresponded to a letter or symbol. A message initiated at one tower would be seen by another tower within viewing distance. The receiving tower would then repeat the message for the next tower in the network, and so on. This optical telegraph system could transmit messages at the impressive rate of about 350 miles per hour when the skies were clear.

In 1837 Congress asked for proposals to create a telegraph system between New York and New Orleans. It received one proposal based on proven European technology. Samuel Morse submitted a radically different proposal. He suggested constructing a telegraph system that used electricity to communicate the signals. Let's step back and review some of the key discoveries and inventions that enabled Morse to make his dramatic proposal.

1.3.1 Electricity and Electromagnetism

Amber is a hard, translucent, yellowish brown fossil resin often used to make beads and other ornamental items. About 2,600 years ago the Greeks discovered that if you rub amber, it becomes charged with a force enabling it to attract light objects such as feathers and dried leaves. The Greek word for amber is $\eta\lambda\epsilon\kappa\tau\rho\omega\nu$ (electron). Our word "electric" literally means "to be like amber."

For more than two thousand years amber's ability to attract other materials was seen as a curiosity with no practical value, but in the seventeenth and eighteenth centuries scientists began to study electricity in earnest. Alessandro Volta, a professor of physics at the University of Pavia, made a key breakthrough when he discovered that electricity could be generated chemically. He produced an electric current by submerging two different metals close to each other in an acid. In 1799 Volta used this principle to create the world's first battery. Volta's battery produced an electric charge more than 1,000 times as powerful as that produced by rubbing amber. Scientists soon put this power to practical use.

In 1820 Danish physicist Christian Oersted discovered that an electric current creates a magnetic field. Five years later, British electrician William Sturgeon constructed an electromagnet by coiling wire around a horseshoe-shaped piece of iron. When he ran an electric current through the coil, the iron became magnetized. Sturgeon showed how a single battery was capable of producing a charge strong enough to pick up a nine-pound metal object.

In 1830 American professor Joseph Henry rigged up an experiment that showed how a telegraph machine could work. He strung a mile of wire around the walls of his classroom at the Albany Academy. At one end he placed a battery; at the other end he connected an electromagnet, a pivoting metal bar, and a bell. When Henry connected the battery, the electromagnet attracted the metal bar, causing it to ring the bell. Disconnecting the battery allowed the bar to return to its original position. In this way he could produce a series of rings.

1.3.2 Telegraph

Samuel Morse, a professor of arts and design at New York University, worked on the idea of a telegraph during most of the 1830s, and in 1838 he patented his design of a telegraph machine. The U.S. Congress did not approve Morse's proposal to construct a New York–to–New Orleans telegraph system in 1837, but it did not fund any of the other proposals, either. Morse persisted with his lobbying, and in 1843 Congress appropriated $30,000 to Morse for the construction of a 40-mile telegraph line between Washington, D.C., and Baltimore, Maryland.

On May 1, 1844, the Whig party convention in Baltimore nominated Henry Clay for President. The telegraph line was only complete to Annapolis Junction at that time. A courier hand-carried a message about Clay's nomination from Baltimore to Annapolis Junction, where it was telegraphed to Washington. This was the first news reported via telegraph. The line officially opened on May 24. Morse, seated in the old Supreme Court chamber inside the U.S. Capitol, sent his partner in Baltimore a verse from the Bible: "What hath God wrought?"

The value of the telegraph was immediately apparent, and the number of telegraph lines quickly increased. By 1846 telegraph lines connected Washington, D.C., Baltimore, Philadelphia, New York, Buffalo, and Boston. In 1850 twenty different companies operated 12,000 miles of telegraph lines. The first transcontinental telegraph line was com-

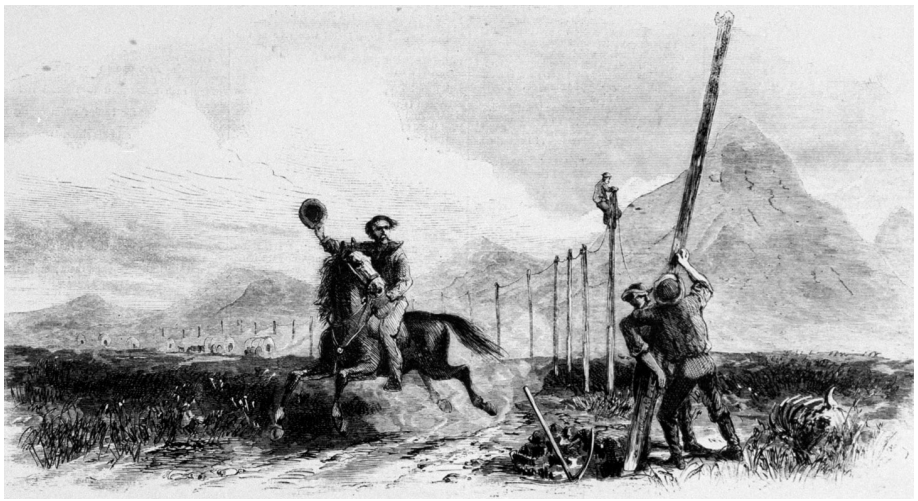


FIGURE 1.13 Pony Express riders lost their jobs when the U.S. transcontinental telegraph line was completed in 1861. (© Walter Daran/Getty Images)

pleted in 1861, putting the Pony Express out of business (Figure 1.13). The telegraph was the sole method of rapid long-distance communication until 1877. By this time the United States was networked by more than 200,000 miles of telegraph wire [24].

The telegraph was a versatile tool, and people kept finding new applications for it. For example, by 1870 fire alarm telegraphs were in use in 75 major cities in the United States. New York City alone had 600 fire alarm telegraphs. When a person pulled the lever of the alarm box, it automatically transmitted a message identifying its location to a fire station. These devices greatly improved the ability of fire departments to dispatch equipment quickly to the correct location [24].

1.3.3 Telephone

Alexander Graham Bell was born in Edinburgh, Scotland, into a family focused on impairments of speech and hearing. His father and grandfather were experts in elocution and the correction of speech. His mother was almost completely deaf. Bell was educated to follow in the same career path as his father and grandfather, and he became a teacher of deaf students. Later, he married a deaf woman.

Bell pursued inventing as a means of achieving financial independence. At first he focused on making improvements to the telegraph. A significant problem with early telegraph systems was that a single wire could transmit only one message at a time. If multiple messages could be sent simultaneously along the same wire, communication delays would be reduced, and the value of the entire system would increase.

Bell's solution to this problem is called a harmonic or musical telegraph. If you imagine hearing Morse code, it's obvious that all of the dots and dashes are the same

note played for a shorter or longer period of time. The harmonic telegraph assigned a different note (different sound frequency) to each message. At the receiving end different receivers could be tuned to respond to different notes, as you can tune your radio to hear only what is broadcast by a particular station.

Bell knew that the human voice is made up of sounds at many different frequencies. From his work on the harmonic telegraph, he speculated that it should be possible to capture and transmit human voice over a wire. He and Thomas A. Watson succeeded in transmitting speech electronically in 1876. Soon after, they commercialized their invention.

Nearly all early telephones were installed in businesses. Leasing a telephone was expensive, and most people focused on its commercial value rather than its social value. However, the number of phones placed in homes increased rapidly in the 1890s, after Bell's first patent expired.

Once telephones were placed in the home, the traditional boundaries between private, family life and public, business life became blurred. People enjoyed being able to conduct business transactions from the privacy of their home, but they also found that a ringing telephone could be an unwelcome interruption [25].

Another consequence of the telephone was that it eroded traditional social hierarchies. An 1897 issue of *Western Electrician* reports that Governor Chauncey Depew of New York was receiving unwanted phone calls from ordinary citizens: "Every time they see anything about him in the newspapers, they call and tell him what a 'fine letter he wrote' or 'what a lovely speech he made,' or ask if this or that report is true; and all this from people who, if they came to his office, would probably never say more than 'Good morning' " [26].

People also worried about the loss of privacy brought about by the telephone. In 1877 *The New York Times* reported that telephone men responsible for operating an early system in Providence, Rhode Island, overheard many confidential conversations. The writer fretted that telephone eavesdropping would make it dangerous for anyone in Providence to accept a nomination for public office [25].

The telephone enabled the creation of the first "online" communities. In rural areas the most common form of phone service was the party line: a single circuit connecting multiple phones to the telephone exchange. Party lines enabled farmers to gather by their phones every evening to talk about the weather and exchange gossip [27].

The power of this new medium was demonstrated in the Bryan/McKinley Presidential election of 1896. For the first time, Presidential election returns were transmitted directly into people's homes. "Thousands sat with their ear glued to the receiver the whole night long, hypnotized by the possibilities unfolding to them for the first time" [28].

The development of cell phone technology in the latter part of the twentieth century made telephone service much more widely available. Telephone service has now been extended to people living in areas never reached by wired telephone service, particularly those living in less developed countries. Today, the number of cell phones in use worldwide exceeds the number of traditional, wired telephones [29].

1.3.4 Typewriter and Teletype

For hundreds of years people dreamed of a device that would allow an individual to produce a document that looked as if it had been typeset, but the dream was not realized until 1867, when Americans Christopher Sholes, Carlos Glidden, and Samual Soule patented the first typewriter. In late 1873 Remington & Sons Company, famous for guns and sewing machines, produced the first commercial typewriter. It was difficult to use and was not well received; Remington & Co. sold only 5,000 machines in the first five years. However, the typewriter did get the attention of Mark Twain, who used it to produce *Tom Sawyer*, which may have been the world's first typewritten manuscript. By 1890, more reliable typewriters were being produced, and the typewriter became a common piece of office equipment [30].

In 1908 Charles and Howard Krum succeeded in testing an experimental machine that allowed a modified Oliver typewriter to print a message transmitted over a telegraph line. They called their invention the teletype. During the 1920s news organizations began using teletype machines to transmit stories between distant offices, and Wall Street firms began sending records of stock transactions over teletypes.

1.3.5 Radio

Earlier we described how the experiments of Oersted, Sturgeon, and Henry led to the development of the electromagnet and the telegraph. The connection between electricity and magnetism remained mysterious, however, until Scottish physicist James Clerk Maxwell published a mathematical theory demonstrating their relationship. This theory predicted the existence of an electromagnetic wave spreading with the velocity of light. It also predicted that light itself was an electromagnetic phenomenon. In 1885 Heinrich Hertz successfully generated electromagnetic waves, proving the correctness of Maxwell's theory.

Guglielmo Marconi put Hertz's discovery to practical use by successfully transmitting radio signals in the hills outside Bologna, Italy, in 1895. Unable to attract the attention of the Italian government, he took his invention to England, where he founded the Marconi Wireless Telegraph Company. The name of the company reflects Marconi's concept of how his invention would be used. To Marconi, radio, or "wireless," was a superior way to transmit telegraph messages.

David Sarnoff emigrated from Russia to the United States with his family when he was nine. When he had completed school, he landed a position with the Marconi Wireless Telegraph Company. In 1912 Sarnoff made a name for himself when he intercepted the first distress signal from the *Titanic* and spent the next three days relaying information about the rescue effort to the rest of the world. Four years later, Sarnoff suggested the use of radio as an entertainment device, writing: "I have in mind a plan of development which would make radio a household utility in the same sense as the piano or phonograph . . . The receiver can be designed in the form of a simple 'Radio Music Box' . . . (which) can be placed in the parlor or living room" [31]. In two decades, Sarnoff's vision had become a reality.

Figure 1.14 Orson Welles's radio adaption of *War of the Worlds* on the evening of October 30, 1938, convinced many Americans that Martians were attacking New Jersey. (© Bettmann/CORBIS)

The power of radio as a medium of mass communication was demonstrated on the evening of October 30, 1938 (the night before Halloween). From CBS Radio Studio One in New York, Orson Welles and the Mercury Theater put on a one-hour dramatization of H. G. Wells's *War of the Worlds* (Figure 1.14). To increase suspense, the play was performed as a series of news bulletins interrupting a concert of dance music. These bulletins described events occurring on a farm near Grovers Mill, New Jersey. Many listeners panicked. "People packed the roads, hid in cellars, loaded guns, even wrapped their heads in wet towels as protection from Martian poison gas, oblivious to the fact that they were acting out the role of the panic-stricken public that actually belonged in a radio play" [32].

1.3.6 Television

Broadcasting video over a wire began in 1884 with the invention of an electro-mechanical television by Paul Nipkow, but the first completely electronic television

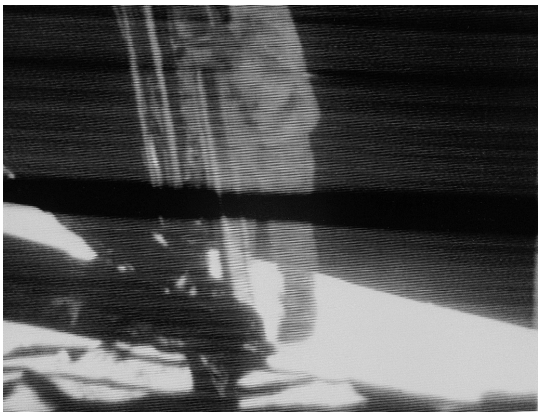


FIGURE 1.15 On July 20, 1969, television images of Neil Armstrong walking on the Moon were broadcast to hundreds of millions of viewers around the world. (Courtesy of NASA)

transmission was made in 1927 by Philo Farnsworth. Millions of Americans were formally introduced to the television at the 1939 World's Fair held in New York City, which had as its theme, "The World of Tomorrow." Since a television set cost about as much as an automobile, televisions remained a rarity in American households until the 1950s, when prices fell dramatically.

Television's ability to send a message around the world was demonstrated in July 1969. Hundreds of millions of people watched on live TV as astronaut Neil Armstrong stepped from the lunar module onto the surface of the Moon (Figure 1.15).

Television has created many opportunities for "news junkies" to get their fixes. The major commercial broadcast television networks have been supplemented by CNN and other cable news organizations and a myriad of Web sites. The various organizations compete with each other to be the first to break news stories. Increasingly, the media have turned to computer technology to help them provide information to the public. Sometimes this has led to embarrassing mistakes, as in the 2000 U.S. Presidential election.

About 7:50 P.M. on the evening of Tuesday, November 7, 2000, before the polls had even closed in the Florida panhandle, the major networks began announcing that Al Gore would be the winner in Florida. Based on the expected result of the Florida election, the networks went on to predict—while people were still voting in the Western states—that Al Gore would be the next President of the United States.

You might be wondering how it is possible to predict the outcome of an election before everyone has voted. In a practice known as exit polling, a company called Voter News Service questions people leaving polling places. It combines the information it collects with early returns to predict the outcome of elections. Since 1988 the television networks have relied upon the Voter News Service to provide them with exit polling results.

As it turns out, Voter News Service's prediction was wrong. More than a month after the election, after a series of recounts and court decisions, George W. Bush was declared the victor in Florida. With Florida's electoral votes in hand, Bush won the Presidency.

1.3.7 Remote Computing

Working at his kitchen table in 1937, Bell Labs researcher George Stibitz built a binary adder out of telephone relays, batteries, flashlight bulbs, tin strips, and wire. He took his invention back to Bell Labs and enlisted the help of Samuel Williams. Over the next two years they built the Complex Number Calculator, an electromechanical system that would add, subtract, multiply, and divide complex numbers.

Stibitz's next action is what sets him apart from other computer pioneers. He made a teletype machine the input/output device for the Complex Number Calculator. With this innovation, he did not have to be in the same room as the calculator to use it; he could operate it remotely.

In 1940 Stibitz demonstrated remote computing to members of the American Mathematical Society who were meeting at Dartmouth College in New Hampshire. He typed numbers into the teletype, which transmitted the data 250 miles to the calculator in New York City. After the calculator had computed the answer, it transmitted the data back to the teletype, which printed the result.

1.3.8 ARPANET

In reaction to the launch of Sputnik by the Soviet Union in 1957, the Department of Defense created the Advanced Research Projects Agency (ARPA). ARPA funded research and development at prominent universities. The agency's first director, J.C.R. Licklider, imagined a "Galactic Network"—a global computer network that would facilitate the exchange of programs and data.[2] This view of the computer as a device to improve communication was in stark contrast to the mindset of computer manufacturers, which continued to think of computers as number-crunching machines.

Conventional, circuit-switched telephone networks were not a good foundation upon which to build a global computer network (Figure 1.16a). Between 1961 and 1967 three research teams independently came up with an alternative to circuit-switched networks. These teams were led by Donald Davies and Roger Scantlebury at NPL in England, Paul Baran at RAND, and Leonard Kleinrock at MIT. Eventually the new design came to be called a packet-switched network (Figure 1.16b).

In 1967 ARPA initiated the design and construction of the ARPANET. Fear of a nuclear attack led to the crucially important design decision that the network should be decentralized. In other words, the loss of any single computer or communication link would not prevent the rest of the network from working. Every computer on the network

2. The primary source document for this description of the evolution of the Internet is "A Brief History of the Internet" by Barry M. Leiner et al. [33].

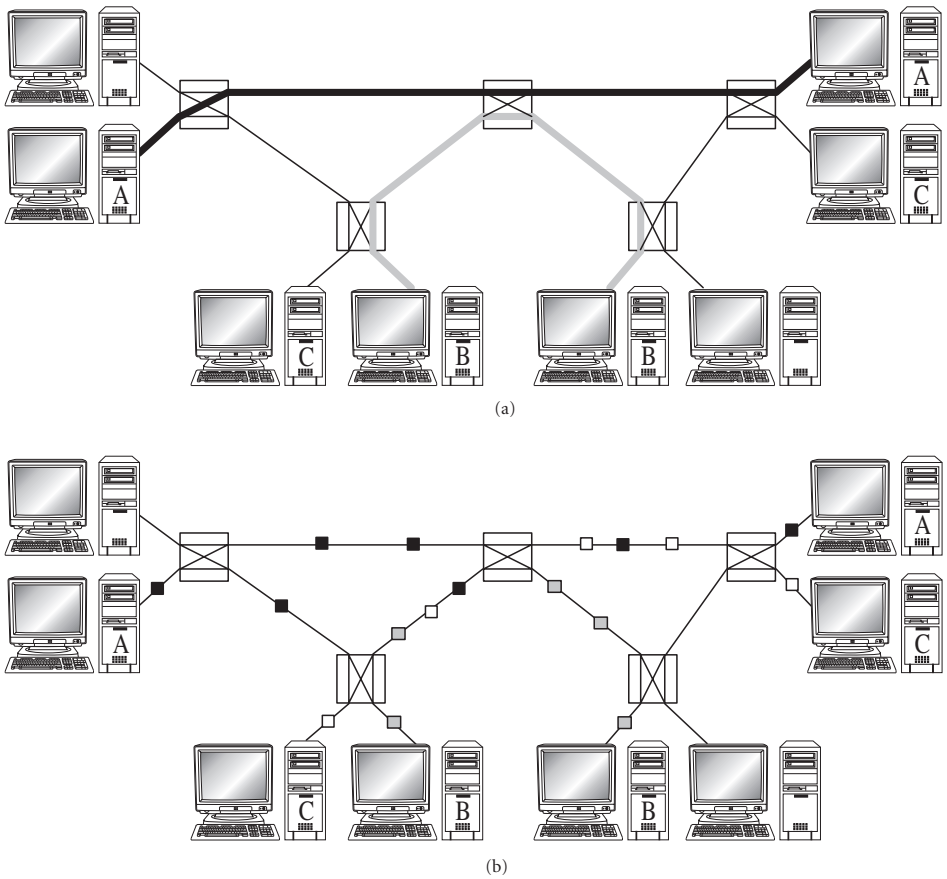


FIGURE 1.16 Comparison of circuit-switched networking and packet-switched networking. (a) In a **circuit-switched network**, a single physical connection is established between the two ends. The physical connection cannot be shared. In this illustration, one circuit links the two computers labeled A, and another circuit links the two computers labeled B. The computers labeled C may not communicate at this time, because no circuit can be established. (b) In a **packet-switched network**, a message is divided up into small bundles of data called packets. Every packet has the address of the computer where it should be routed. If there is more than one path from the message source to the message destination, different message packets may take different routes. Packets from different messages may share the same wire. In this illustration, three pairs of computers (labeled A, B, and C) are communicating simultaneously over a packet-switched network.

would have the ability to make decisions about how message traffic should be routed. Packet-switched networks met this condition; circuit-switched networks did not.

BBN in Boston was responsible for the Interface Message Processor (IMP) that connected a computer to the telephone network. In 1969 BBN delivered its first four

IMPs to UCLA, the Stanford Research Institute, the University of California at Santa Barbara, and the University of Utah.

1.3.9 Email

During the earliest years of ARPANET, the networked computers could transfer programs and data only. ARPANET users still relied upon the telephone for personal communications. In March 1972 Ray Tomlinson at BBN wrote the first software enabling email messages to be sent and received by ARPANET computers. A few months later, Lawrence Roberts created the first "killer app" for the network: an email utility that gave individuals the ability to list their email messages, selectively read them, reply to them, forward them to others, and save them. Email quickly became the most popular network application.

Today, email is one of the most important communication technologies on the planet. More than 60 billion email messages are sent each day.

1.3.10 Internet

ARPA researchers anticipated the need to connect the ARPANET with other networks based on different designs. Robert Kahn developed the concept of open architecture networking, which means individual networks could be quite different as long as they shared a common "internetworking architecture." Vinton Cerf and Robert Kahn designed the TCP/IP protocol that would support open architecture networking [34]. TCP (Transmission Control Protocol) is responsible for dividing a message into packets at the sending computer and reassembling the packets at the receiving computer. IP (Internet Protocol) is the set of rules used to route data from computer to computer. The **Internet** is the network of networks that communicate using TCP/IP. You could call January 1, 1983, the birth date of the Internet, because that was the date on which all ARPANET hosts converted to TCP/IP.

1.3.11 NSFNET

The National Science Foundation (NSF) in the United States saw the importance of networking to the academic community. It created a TCP/IP-based network called NSFNET, and it provided grants to universities to join the NSFNET. These grants encouraged broad participation by stipulating that universities would have to make their Internet connections available to all qualified users. The NSFNET consisted of regional networks connected by the NSFNET Backbone.

The NSF encouraged the universities participating in regional networks to reduce their network subscription costs by finding commercial customers for the networks. At the same time, the NSF banned commercial traffic on the NSFNET Backbone. These policies stimulated private companies to create commercial, long-distance Internet connections in the United States. In April 1995 the NSF ceased funding the NSFNET Backbone. Commercial network providers, well established by this time, took over the task of supplying long-distance Internet connections in the United States.

1.3.12 Broadband

The term **broadband** refers to a high-speed Internet connection, such as a cable modem or a DSL modem, that is at least 10 times faster than a dial-up Internet connection. The availability and speed of broadband connections continues to improve as fiber optic networks gradually replace networks based on copper wire. Fiber optic networks support high-capacity international broadband connections, such as those between the United States and India.

Broadband connections make feasible the transfer of large files, such as those containing images, music, and video. The growth of file-swapping among Internet users has paralleled the growth of broadband connections.

Today three-quarters of South Korean homes have high-speed Internet connections, making South Korea the world leader in broadband networking [35]. The typical new broadband connection in South Korea is 40 megabits per second, compared with 1.5 megabits per second or slower in the United States [36].

1.4 Milestones in Information Storage and Retrieval

1.4.1 Codex

Two thousand years ago, important information was recorded on papyrus scrolls wrapped around wooden rods. Papyrus had to be stored this way to keep from breaking apart. Even so, the ends of papyrus scrolls tended to fall off.

The development of the codex was a significant advance in information storage and retrieval technology. A codex was made up of rectangular pages sewn together on one side. These pages were made out of sheepskin (parchment) or calfskin (vellum). The codex was superior to papyrus in two ways. First, the codex was much more durable than a papyrus roll. Second, since it was divided into pages, the codex made it much easier for readers to find a particular passage: they could simply flip to the desired page.

Between the second and fourth centuries, the codex gradually replaced the scroll as the most popular method of recording important information. The Church accelerated the transition by insisting that all sacred texts be recorded in codices, to distinguish them from Hebrew scriptures kept on scrolls.

After the fall of the Roman Empire, Irish monks preserved Western culture by copying Greco-Roman and Judeo-Christian texts into codices [37]. Centuries later, most codices were produced using a process of wood engraving. A craftsman would take a block of wood and laboriously chisel away the background for a portion of a page, leaving the letters and illustrations raised. When all the wooden blocks for a page were carved, they would be fastened together. After the surface was inked, a blank page would be printed by pressing it down on the inked surface.

In the late Middle Ages explorers brought back from China the technology for manufacturing paper in mass quantities. By the fifteenth century paper gradually began to replace parchment in less expensive European codices.

1.4.2 Gutenberg's Printing Press

In 1436 Johannes Gutenberg began work on a printing press that would imprint pages using movable metal type rather than wood blocks, and in 1455 work was completed on Gutenberg's famous "42 Line Bible." Soon other printers were using the same technology to produce codices. The principal customer of these publishers was the Church. Hence most early publications were religious books and pamphlets.

The printing press proved itself to be a powerful tool for mass communication during the Reformation. Martin Luther did more than nail his 95 theses to the door of a church—he published them. Between 1517 and 1520, more than 300,000 copies of Martin Luther's publications were sold [38]. In the next 50 years, the number of religious tracts produced by Protestant reformers would outnumber those of their Catholic opponents by a factor of 10 to 1.

1.4.3 Newspapers

The printing press made possible the establishment of newspapers. Newspapers provided an important new way for private citizens to get their points of view heard. A free press serves as a powerful counterweight to government and its desire to manage the flow of information. It is not surprising, then, that there is a long history of government censorship or suppression of newspapers.

The first English-language newspaper appeared in Great Britain in the 1600s. Throughout most of the seventeenth century the government controlled the press by licensing approved newspapers and suppressing the rest. However, in 1695 Parliament declined to renew the Licensing Act, paving the way for a free press in England.

In America, newspapers helped to unify the colonies. As colonists read newspapers published in other colonies, they came to realize what values and concerns they shared with other colonists up and down the Atlantic seaboard. In this way newspapers played an important role in swaying American public opinion toward favoring independence from Great Britain (Figure 1.17).

1.4.4 Hypertext

The July 1945 issue of *The Atlantic Monthly* contained a visionary paper, "As We May Think," written by Vannevar Bush, who had served as Director of the Office of Scientific Research and Development in World War II. In the paper Bush notes, "The world has arrived at an age of cheap complex devices of great reliability; and something is bound to come of it" [39]. He describes many ways in which technology can solve important problems. One of the problems he focuses on is the problem of information retrieval. He points out how difficult it is for scientists to keep up with all the research results that are being published, especially when indexing systems do not lend themselves toward exposing the relationships among documents. Bush notes that the human mind doesn't work by indexing. Instead, our memories are associative. When we think of one thing, other related memories awaken in our minds. He suggests that a machine could simulate, to some degree, the mind's ability to make associations between pieces of information.

FIGURE 1.17 Newspaper accounts of "the Boston Massacre" of 1770 heightened revolutionary sentiment before the American War of Independence. (© 2007 Getty Images)

He gives a description for the Memex, an information retrieval system equipped with "a provision whereby any item may be caused at will to select immediately and automatically another" [39].

Ted Nelson was raised by his grandparents in Greenwich Village, New York. He was a graduate student studying sociology at Harvard when he took his first computer class. There he discovered that "everything everyone was saying about computers was a lie. It was up to me to design the literature of the future" [40]. In 1965 Nelson coined the word **hypertext,** which refers to a linked network of nodes containing information. The links allow readers to visit the nodes in a nonlinear fashion [41]. The proposed system had much in common with Bush's proposal for Memex. In 1967 Nelson proposed the creation of a system called Xanadu, a worldwide network of connected literature. Despite decades of work and a $5 million investment from Autodesk, the system was never completed [40].

1.4.5 Graphical User Interface

Douglas Engelbart grew up on a dairy farm in Oregon. After graduating from high school, he attended Oregon State College, but his electrical engineering studies were interrupted by World War II. While he was stationed in the Philippines he worked with radar and read "As We May Think," two events that influenced his views about the

potential of computing. When his military service ended, he completed his degree at OSC and took a job at Ames Laboratory, but soon began wondering, "How can my career maximize my contribution to mankind?" [42]. Engelbart decided to return to school and completed a Ph.D. in electrical engineering from the University of California at Berkeley in 1955. He joined the Stanford Research Institute, where he set out to use the power of the computer to augment human intellect.

In the 1950s and 1960s people submitted computer jobs in the form of decks of punch cards and often waited hours for them to run. Computer output was typically pages full of numbers that programmers would laboriously examine. Engelbart wondered why people couldn't interact directly with computers and view the output on a CRT, like radar images. He created a research lab called the Augmentation Research Center. This lab developed a hypermedia and groupware system called NLS (oNLine System). Engelbart invented several new input devices, including the computer mouse. In 1968, at the Fall Joint Computer Conference in San Francisco, he gave a 90-minute demonstration of NLS that included a screen divided into windows, email, use of a mouse to direct a cursor, and live videoconferencing with staff members 30 miles away (Figure 1.18). Engelbart's presentation is still called "the mother of all demos." Paul Saffo said, "It was like a UFO landing on the White House lawn." The presentation was so

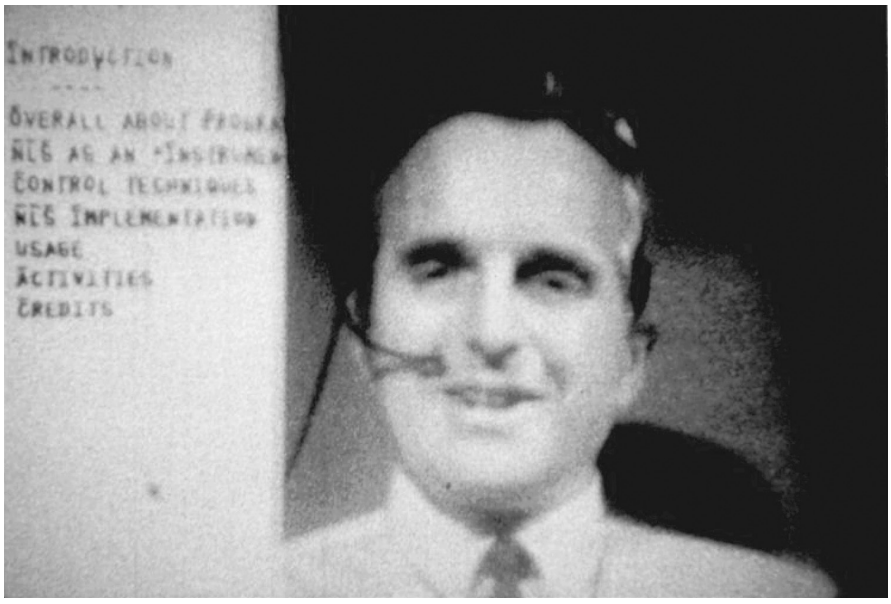


Figure 1.18 Douglas Engelbart gives the "mother of all demos" in December 1968 to 4,000 people at the Fall Joint Computer Conference. (Credit given by Douglas Engelbart and Bootstrap Institute)

far ahead of its time that some audience members thought it was a hoax [43]. Others thought Engelbart's ideas were completely impractical, noting that he was treating a computer as if it were for his personal use.

Alan Kay saw Engelbart's demo, understood the ramifications of the NLS, and was eager to take the next step. In 1970 he become one of the founding members of Xerox Palo Alto Research Center (PARC), a new facility dedicated to performing research into digital technology. The research team created the Alto, a small minicomputer designed to be used by a single person. The Alto incorporated a bit-mapped display, a keyboard, and a mouse. Kay played a leading role in developing the Alto's graphical user interface that responded to the point, click, and drag operations of a mouse. In order to link together the Altos, the Xerox PARC team also created **Ethernet**, which became a networking standard throughout the computer industry. Xerox failed in its attempt to market a commercial personal computer.

In 1979 Apple Computer sold 10 percent of its stock to Xerox. In return, Xerox let Jobs and some Apple engineers visit Xerox PARC and learn more about its research. Jobs returned from the visit committed to building a computer with a graphical user interface. A few years later Apple released the Lisa, a $10,000 personal computer with a graphical user interface. The price tag was too high, the processor was too slow, and the Lisa was not commercially successful. However, in January 1984 Apple released the Macintosh, a faster, $2,495 computer with a graphical user interface. The Macintosh was an instant hit: Apple sold 300,000 in the first year.

During the 1980s IBM, VisiCorp, and Microsoft all offered graphical user interfaces for IBM PC-compatible computers, but they could not compare in sophistication to the interface of the Apple Macintosh. Finally, in May 1990, Microsoft released Windows 3.0 for IBM PCs. Consumers eagerly bought 10 million copies of Windows, giving Microsoft a near monopoly in the graphical user interface market that it has maintained ever since.

1.4.6 Single–Computer Hypertext Systems

In 1982 Peter Brown at the University of Kent at Canterbury started a hypertext research project. He named the software Guide. Later, Office Workstations, Ltd. commercialized Guide, releasing versions for both the Apple Macintosh and the IBM PC.

In 1987 Apple Computer released HyperCard, a hypertext system that enabled programmers to create "stacks" of "cards." A card could contain text and images. The HyperCard programmer created links from one card to another with "buttons." Buttons could be visible to the user and labeled, or they could be transparent and associated with an image or an area of the card.

Users typically viewed one card at a time (Figure 1.19). They jumped from one card to another by using the computer's mouse to move a cursor over a button and then clicking the mouse. The best-selling computer games Myst and Riven are actually HyperCard stacks.

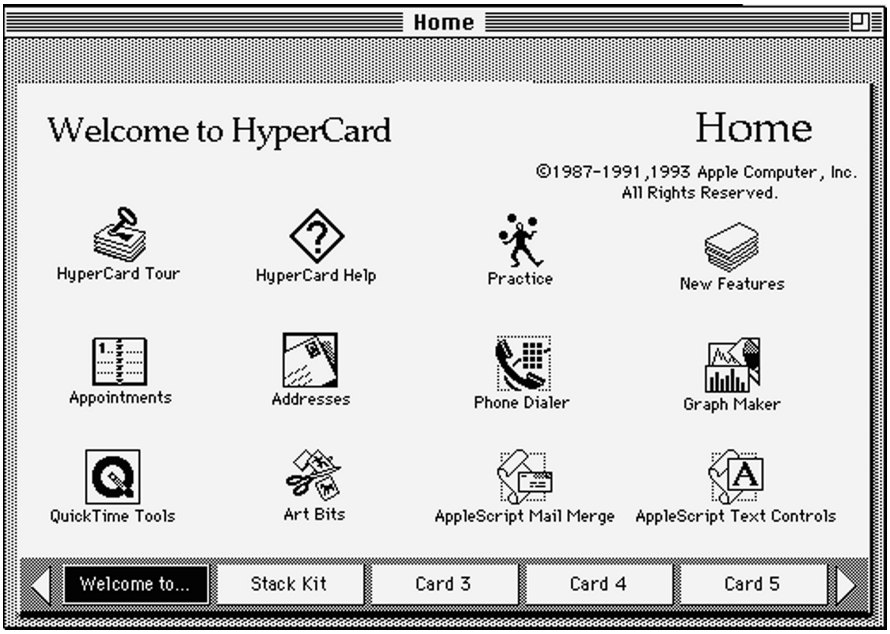


Figure 1.19 Apple's HyperCard is a notable example of a single-computer hypertext system.

1.4.7 Networked Hypertext: World Wide Web

Tim Berners-Lee is the son of two mathematicians, both of whom were programmers for the Ferranti Mark 1 computer in the 1950s. From them, Berners-Lee learned that, "in principle, a person could program a computer to do most anything" [44]. He also learned that it is easy to get a computer to keep information in lists or tables, but much more difficult to get it to remember arbitrary relationships.

When Berners-Lee was in high school, his father read some books about the brain; the two of them talked about how a computer might be able to make neural-like connections the way a brain does. This idea stuck with Berners-Lee, and in 1980, while working for CERN in Switzerland, he wrote a program called Enquire that incorporated links between information. Berners-Lee was not familiar with the work of Vannevar Bush, Ted Nelson, or Doug Engelbart, but he was heading in the same direction.

In late 1989 Berners-Lee wrote a memo to a management team at CERN, proposing the development of a networked hypertext system that could be used for documentation purposes. When they didn't respond, he tried again in the spring of 1990. Again, no response. However, an intriguing new personal computer called the NeXT had just been released. Berners-Lee asked his boss if he could purchase a NeXT to check out its operating system and programming environment. His boss okayed the purchase, then puckishly suggested that maybe Berners-Lee ought to try implementing his proposed hypertext system on it [44].

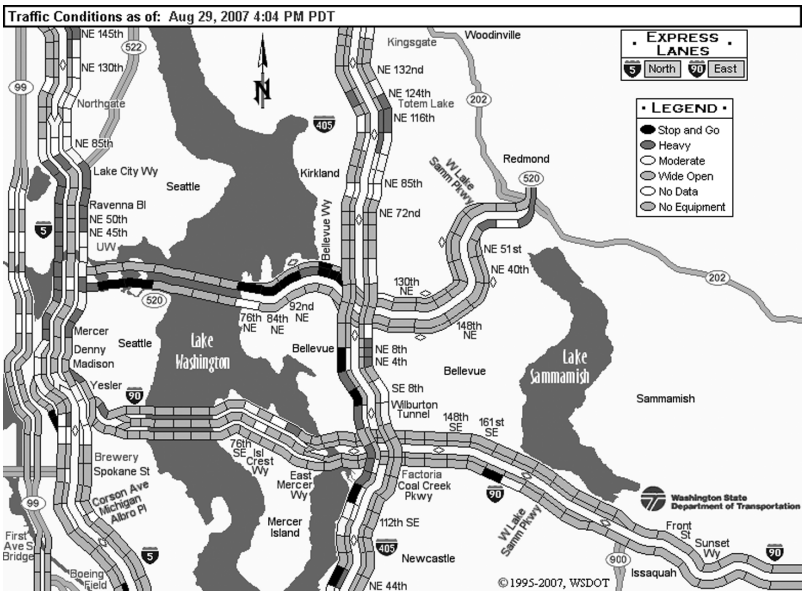


FIGURE 1.20 Using the Web, you can access up-to-date traffic information from many major cities. (Courtesy Washington State Department of Transportation)

Unlike earlier commercial hypertext systems, Berners-Lee's system allowed links between information stored on different computers connected by a network. Because it is built on top of the TCP/IP protocol, links can connect any two computers on the Internet, even if they have different hardware or are running different operating systems.

A **Web browser** is a program that allows a user to view Web pages and traverse hyperlinks between pages. Berners-Lee completed the first Web browser on the NeXT Computer on Christmas Day, 1990. He called his browser WorldWideWeb. In March 1991 he released the browser to some computer users at CERN.

The first widely used Web browser was Mosaic, developed at the National Center for Supercomputer Applications at the University of Illinois, Urbana-Champaign. Other well-known Web browsers are Netscape Navigator, Mozilla Firefox, and Microsoft Internet Explorer. Since 1999 Internet Explorer has been the most widely used Web browser.

Today, you can use the Web to retrieve text, still images, movies, songs, computer programs—in theory, anything that can be digitized. The Web has also become a convenient way for organizations to provide people access to news updates and dynamically changing information (Figure 1.20).

1.4.8 Search Engines

A **search engine** is a program that accepts a list of keywords from a user, searches a database of documents, and returns those documents most closely matching the specified keywords. Today, the term search engine is most frequently used to describe programs

that search databases of Web pages. Web search engines are the most powerful information retrieval devices ever invented. The most popular Web search engine, Google, has indexed more than 8 billion Web pages.

There are two types of Web search engines. Crawler-based search engines, such as Google and AltaVista, automatically create the database of information about Web pages. In a process similar to Web surfing, programs called spiders follow hyperlinks, eventually visiting millions of different Web pages. Summary information about these pages is collected into massive databases. When you perform a query, the search engine consults its database to find the closest matches.

The second type of Web search engine relies upon humans to build the database of information about various Web pages. People who develop a Web site can submit a summary of their site to the keepers of the search engine. Alternatively, those responsible for the search engine may create their own reviews of Web sites. The advantage of this kind of search engine is that humans can create more accurate summaries of a Web page than a spider program. The disadvantage of this approach is that only a small fraction of the Web can be catalogued. Open Directory is an example of this kind of search engine.

1.5 Information Technology Issues

Information technology (IT) refers to devices used in the creation, storage, manipulation, exchange, and dissemination of data, including text, sound, and images. Computers, telephones, and video cameras are examples of IT. The cost of IT devices continues to fall, while their capabilities continue to increase. As a result, people are making greater use of IT in their everyday lives. Some of these uses create new issues that need to be resolved. In this section we describe a few of the issues raised by the growth of IT.

The great power of email is that it allows (at least in principle) anyone to send email to anyone else with an email address. Now that just about everyone has an email account, it is easier than ever to contact friends and family. Parents who used to complain because they never got letters from their children at college found out that it was much easier to keep in touch via email. On the other hand, most email traffic is spam: unsolicited, bulk, commercial email. Is spam destroying the value of email?

Thanks to the Web, it is easier than ever to share information with people all over the world. Imagine I live in Canada and post some controversial files on my Web site. Some Americans visit my Web site and download the files, an action that violates U.S. laws. Should I be prevented from posting material that is legal in Canada but illegal in the United States?

For many items of value, making the original copy is expensive, but making copies of the original is inexpensive. For example, an entertainment company may spend hundreds of thousands of dollars to produce a CD, but copies can be burned for just a few cents each. Once CDs have been ripped into MP3 files, the Internet provides a fast and efficient way to distribute them. As a result, unauthorized copies of songs, movies, and computer programs are proliferating. Should we continue to give ownership rights to

creators of intellectual property, or is it hopeless? If we no longer give ownership rights to creators of intellectual property, will creativity suffer?

If I use a credit card to purchase an item, the credit card company now has information about my spending habits. Who has a right to that information? For example, if I buy a pair of water skis with my credit card, does the credit card company have a right to sell my name, address, and phone number to other companies that may want to sell me related products?

The use of IT has changed the way that banks process loan applications. Rather than make a local decision regarding my creditworthiness, the bank will check a national credit bureau and ask for my credit rating. What are the advantage and disadvantages of this alternative approach to lending money?

Computers are now embedded in many devices on which we depend, from traffic signals to pacemakers. Software errors have resulted in injury and even death. When bugs result in harm to humans, what should the liability be for the people or corporations that produced the software?

When employees use IT devices in their work, companies can monitor their actions closely. For example, a company can track the number of calls per minute each of its telephone operators is handling. It can document the number of keystrokes per minute of its data entry operators. It can log all of the Web sites its employees visit, and it can read the email they send and receive at work. How does such monitoring affect the workplace? Does it create an unacceptable level of stress among employees?

IT is allowing more people than ever to telecommute; in other words, work from home. What are the advantages and disadvantages of telecommuting?

IT capabilities are leading to changes in the IT industry itself. Silicon Valley used to be the epicenter of the IT industry, but improvements in the speed and reliability of communication networks have led to a more decentralized landscape. New hot spots of innovation include Redmond, Washington (Microsoft), Austin, Texas (Dell Computer), Armonk, New York (IBM), Walldorf, Germany (SAP), and Bangalore, India (Wipro Technologies). U.S.-based software companies are doing more development in countries where salaries are much lower, such as India, China, and Vietnam [5]. Will this trend continue? How many software jobs in the United States will be lost to countries where labor is significantly cheaper?

Finally, the World Wide Web has provided an unprecedented opportunity for individuals and nongovernmental organizations to have their points of view made available to millions. This could bring about new levels of citizen involvement and democratic reform. On the other hand, some countries are making large portions of the Web unavailable to its citizens. Will the Web prove to be a tool for democracy, or will it be muzzled by repressive regimes?

Summary

We are living in the Information Age, an era characterized by ubiquitous computing and communication devices that have made information much easier to collect, trans-

mit, store, and retrieve. These devices are the culmination of centuries of technological progress.

The first mechanical adding machines date back to the seventeenth century, but real progress in mechanical calculator technology did not occur until the end of the nineteenth century. Advances in machine tools and mass production methods, combined with market demand, made possible the emergence of practical mechanical calculators during the second half of the nineteenth century. During America's Gilded Age, corporations and governmental organizations grew larger and needed to generate and handle greater volumes of information in a shorter amount of time. Calculators, cash registers, and punched-card tabulators were developed to meet these needs. Eventually IBM and Remington Rand began to produce systems capable of performing lengthy calculations. These systems used stacks of punched cards to store input data, output data, intermediate results, and even series of instructions, called programs.

Military-funded research and development projects during World War II, particularly the construction of the ENIAC and the development of microwave radar systems, accelerated the emergence of electronic digital computers in the United States and the United Kingdom. The Small-Scale Experimental Machine constructed at the University of Manchester in England was the first operational, fully electronic digital computer to store both its program and data in memory. Soon after, computers were commercially available.

Higher-level programming languages made it practical for more people to learn computer programming, greatly improved programmer productivity, and allowed organizations to change computer vendors without having to rewrite all their programs. Time-sharing made computers more accessible by allowing the costs of purchasing and operating a computer to be divided among several organizations.

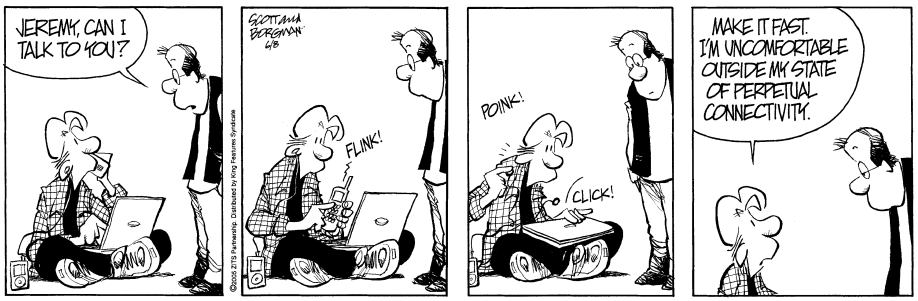
The invention of the transistor and the integrated circuit paved the way for the creation of the microprocessor, or computer on a chip, and the subsequent growth of the personal computer industry. The rapid decline in the cost of manufacturing microprocessors has made possible the use of computers in items as mundane as electric mixers and door locks, as well as solar-powered calculators selling for less than $5, a far cry from the first rudimentary mechanical adders.

Advances in computing technology have been accompanied by equally dramatic improvements in communications networks. Two centuries ago mechanical semaphore telegraph systems could transmit messages at about 350 miles per hour. The discovery of electromagnetism led to the invention of the modern telegraph that could transmit messages at the speed of electricity. Alexander Graham Bell worked on improving the telegraph. He ended up inventing the telephone, which enabled the creation of the first "online" communities. Radio and television made it possible for millions of people around the planet to receive the same message simultaneously. Today's Internet binds hundreds of millions of computers across the globe, creating new opportunities for sending as well as receiving messages.

The codex represented a significant improvement over the scroll as a way of storing information. The codex was more durable than the papyrus scroll, and it was much easier for readers to find a particular passage they were looking for. The availability of

paper and printing presses based on movable metal type made it possible for ordinary people to afford codices. Even today, books and magazines are typically produced using this technology.

Vannevar Bush, Ted Nelson, and Douglas Engelbart all envisioned more powerful ways of storing and retrieving information. Bush suggested that a machine be used to mimic the associative memory of the brain. Nelson invented the word "hypertext," meaning a linked network of nodes containing information. Engelbart conceived of a computing system built around a graphical display device. His investigations led to many innovations, including the computer mouse and a video display divided into windows. Engelbart's concepts became practical with the availability of low-cost systems with bit-mapped displays, such as the Apple Macintosh. Single-user hypertext systems were available for the Macintosh a couple of years after its initial release, but the true power of hypertext was revealed when Tim Berners-Lee created the World Wide Web, which allowed links between information stored on different computers. The Web has become a popular and powerful information storage and retrieval mechanism.



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What conclusions can we draw from our study of the development of computers, communication networks, and information storage and retrieval devices? First, revolutionary discoveries are rare. Rather, most innovations represent simply the next step in a long staircase of evolutionary changes. Each inventor, or team of inventors, relies upon prior work. In many cases different inventors come up with the same "original" idea at the same time.

A second conclusion we can draw from these stories is that information technology did not begin with the personal computer and the World Wide Web. Many other inventions, including the telegraph, the telephone, the mechanical calculator, the radio, and the television, led to significant social changes when they were adopted.

Nevertheless, in the past two decades the rate of technological change has accelerated, thanks to low-cost computers and high-speed communication networks. The pace of technological progress is so rapid that we may feel hard-pressed to keep up. It's good to reflect on Seymour Papert's observation:

> So we are entering this computer future; but what will it be like? What sort of a world will it be? There is no shortage of experts, futurists, and prophets who are

ready to tell us, but they don't agree. The Utopians promise us a new millennium, a wonderful world in which the computer will solve all our problems. The computer critics warn us of the dehumanizing effect of too much exposure to machinery, and of disruption of employment in the workplace and the economy.

Who is right? Well, both are wrong—because they are asking the wrong question. The question is not "What will the computer do to us?" The question is "What will we make of the computer?" The point is not to predict the computer future. The point is to make it. [45]

Review Questions

1. According to the author, why is there good reason to say we are living in the Information Age?
2. What can the Amish teach us about our relationship with technology?
3. Name three aids to manual calculating.
4. Why did commercial mechanical calculators become practical in the nineteenth century?
5. Why did the market for mechanical calculators grow significantly in the late nineteenth century?
6. What factors helped the Burroughs Adding Machine Company to surpass a large number of competitors to become the most successful calculator company by the 1890s?
7. How did the widespread adoption of the mechanical calculator change the office environment?
8. What needs motivated the invention of the cash register?
9. Give four examples of how punched cards were used by large organizations in the early twentieth century.
10. What are the three principal components of a data-processing system?
11. Name three ways the development of radar in World War II stimulated advances in computing.
12. Why did IBM quickly overtake Remington Rand as the leading computer manufacturer in the United States in the 1950s?
13. What was the motivation for the creation of higher-level programming languages? How did the introduction of higher-level programming languages change computing?
14. How did time-sharing give more organizations access to electronic digital computers in the 1960s?
15. In what way did the Cold War accelerate the development of technology needed for the personal computer?
16. What was the principal innovation of the IBM System/360?
17. Can you think of a practical reason why the semaphore telegraph was adopted more rapidly on the continent of Europe than in the British Isles?

18. Give two examples of how the introduction of Morse's telegraph changed life in America.
19. Briefly describe three ways in which society changed by adopting the telephone.
20. What is the difference between a circuit-switched network and a packet-switched network?
21. Why does the Internet have a decentralized structure?
22. How did the National Science Foundation stimulate the creation of commercial, long-distance data networks in the United States?
23. Describe two ways in which the codex represented an improvement over the scroll.
24. What is hypertext?
25. How is a hypertext link similar to a citation in a book? How is it different?
26. Who invented the computer mouse?
27. The Apple Macintosh succeeded in the marketplace, while the Apple Lisa failed. Give two reasons why this happened.
28. In what fundamental way is an Apple HyperCard stack different from the World Wide Web?
29. Berners-Lee decided to build the World Wide Web on top of the TCP/IP protocol. Why did this decision help ensure the success of the Web?
30. What was the first widely used Web browser? What is the most popular browser in use today?
31. Use four different search engines (www.altavista.com, www.google.com, www.msn.com, www.yahoo.com) to perform a search on the phrase "Information Technology." Create a table that compares the top 10 Web pages returned by each search engine. Which engines were the most similar?
32. What is a search engine? Describe the two types of search engines.
33. What is information technology?
34. Name three inventions described in this chapter that were created for a military application.
35. This chapter names the two most popular applications of the Internet. What are they?
36. Give four examples from the book of how a social condition influenced the development of a new technology.
37. Give four examples from the book of a social change brought about by the adoption of a new technology.

Discussion Questions

38. Think about the last piece of consumer electronics you purchased. How did you first learn about it? What factors (features, price, ease of use, etc.) did you weigh before you purchased it? Which of these factors were most influential in your purchase decision? Are you still happy with your purchase?

39. Do you tend to acquire new technological devices before or after the majority of your friends? What are the pros and cons of being an early adopter of a new technology? What are the pros and cons of being a late adopter of a new technology?

40. Have you ever gone camping or had another experience where you went for at least a few days without access to a phone, radio, television, or computer? (In other words, there was no communication between you and the outside world.) What did you learn from your experience?

41. Are there any technologies that you wish had never been adopted? If so, which ones?

42. Some say that no technology is inherently good or evil; rather, any technology can be used for either good or evil purposes. Do you share this view?

43. Is the cell phone changing our views about polite and impolite behavior? For example, is it polite for someone to be talking on their cell phone while ordering a drink at Starbuck's?

44. Martin Carnoy writes, "Thanks to a communications and software revolution, we are more 'connected' than ever before—by cell phone, email, and video conferencing—yet more disconnected than in the past from social interaction" [46]. Do you agree?

45. Should the Altair 8800 owners have used Altair BASIC on their computers without paying Micro-Soft?

46. The story of Altair BASIC highlights a clash between those who see software as something to be developed and freely shared among computer enthusiasts and those who see software development as an entrepreneurial activity. Give some contemporary examples that illustrate these contrasting views of software.

47. More than 90 percent of personal computers run a version of the Microsoft Windows operating system. In what ways is this situation beneficial to computer users? In what ways does this situation harm computer users?

In–Class Exercises

48. Many cell phones now come equipped with cameras. Managers of health clubs are concerned that people in locker rooms may be secretly photographed by other members carrying small cell phones. Debate the following proposition: "Health clubs should ban all cell phone use within their premises."

49. In the 1984 Presidential election, all the major television networks used computers to predict that Republican Ronald Reagan would defeat Democrat Walter Mondale, even before the polls closed on the West Coast. When they heard this news, some Mondale supporters who had been waiting in line to vote simply went home without voting. This may have influenced the results of some statewide and local elections. Debate the following proposition: "In Presidential elections polls should close at the same time everywhere in the United States."

50. Honda Motor Company has begun offering a collision mitigation brake system on its new Inspire sedan sold in Japan. The system uses a radar hidden behind the H logo in the grill to detect vehicles within 100 meters. When a vehicle is detected, the system warns

the driver by sounding a buzzer, flashing a light, tightening the seat belt, and braking slightly. If the driver fails to respond, the system brakes more and tightens the seat belt further to reduce the impact of the collision.

Discuss possible benefits and risks associated with Honda's collision detection system.

51. IBM's T. J. Watson Laboratory is working on software called the Artificial Passenger. Suppose you're driving alone to a faraway destination. The Artificial Passenger will engage you in conversation and analyze your responses. For example, the program may ask you, "Who was the first person you ever dated?" If your response is mumbled, incorrect, or even just too slow in coming, the program may sound an alarm, roll down a window, or start music playing. It may even suggest you pull over or find a hotel at which to spend the night.

Discuss possible benefits and risks associated with IBM's Artificial Passenger.

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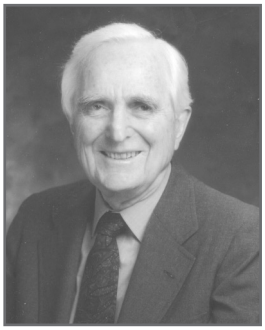
AN INTERVIEW WITH



Douglas Engelbart

Raised on a small farm near Portland, Oregon, Douglas C. Engelbart earned a B.S. in electrical engineering from Oregon State College in 1948. After working three years at NASA's Ames Research Lab, he went to the University of California at Berkeley and earned a Ph.D. in electrical engineering in 1955. A few years later he began the Augmentation Research Center at the Stanford Research Institute. He and his research team are credited with prototyping the computer mouse, multi–window displays, shared–screen teleconferencing, a working hypermedia system, and dozens of other inventions.

Dr. Engelbart has won many prizes and awards, including the National Medal of Technology and the world's largest prize for invention and innovation, the Lemelson–MIT Prize of $500,000. In 1998 he was inducted into the National Inventors Hall of Fame.

He is currently the Director of his own company, Bootstrap Alliance, which uses speaking engagements, consulting, development projects, management seminars, and strategic alliances to help organizations achieve peak performance by improving their processes of improvement.

What thinkers influenced you the most?

When I was stationed in The Philippines after World War II, I ran across an issue of *Life* magazine that reprinted Vannevar Bush's *Atlantic Monthly* article "As We May Think." At the time, I didn't think about it that much, but 13 years later I remembered his description of links that would take you from one microfiche frame to another.

Another person who influenced my thinking was S. I. Hayakawa, who wrote a book called *Language in Thought and Action*. It talks about how perception converts sensory stimuli into recognition in particular concept terms. When you are learning how to read, you first learn how to convert letters into a word. After a while, you just perceive the word, not the individual letters. As you mature, you don't even say the word, the meaning just flows. It got me thinking about how the human brain, which was created for survival, was adapted for reading. The current paradigm says the way you are meant to read is on a book page. But wait—that's just the current technology. A computer can present new options, and our perception can adapt. I'm still waiting for the paradigms to come around.

Your laboratory, the Augmentation Research Center, is credited with dozens of innovations. In your opinion, which of them have had the most impact on society?

Boy, a lot of them were just rejected! But not all. We were the first ones to have a system that was using hyperlinks. We had email by 1970 and spreadsheets by the mid-1970s. We also had distance collaboration with shared screens. Two widely separated people could be talking on the phone, looking at exactly the same working display and passing its control back and forth between them.

I started using the word "augmentation" because I didn't think the phrase "office automation" was accurate. An electronic typewriter doesn't really automate writing. It augments the human by neatly printing characters on the page. The word "augmentation" suggests that a significant new artifact can create a whole bunch of new capabilities. You can't predict all the changes that a new technology will bring. The best thing you can do is facilitate these changes.

How can organizational improvements "boost mankind's collective IQ," as it says on your Web site?

The world is getting so much more complex, and there is a mindlessness in our approach to many issues. If we don't raise our collective IQ, things will just collapse. For example, the United States is collectively very stupid about global warming. The everyday populace doesn't have a realization of what's going on. How can we boost the collective IQ of American citizens? If we improve the collective ability of people to digest information, they can make better decisions. We need to create a capability infrastructure that gives people the best understanding of the current situation, the best understanding of the possible solutions, and the best understanding of the resources available. A higher collective IQ means being alert to a situation, understanding it, and having a plan.

What do you mean by bootstrapping collective IQ?

If we'd like to get collectively smarter, how fast and in what corners can we start making progress toward it? When we make headway, let's fix it so that we are that much more effective in making more headway. Strategically, we must consider how to invest resources to boost collective IQ on broad scale.

For the past five decades, your visions for the future of computing have been often ignored and frequently ridiculed. Did you ever lose heart?

No, but I certainly got dented. Many of the things for which I got prizes and awards thirty years later were ridiculed when I thought them up. I was fortunate to have reflected on this paradigm thing enough to understand that when someone criticized me, it's because in their paradigm I was talking nonsense. When I got my big idea in the 1950s, there were only about three working computers in the country. When I talked about people interacting with a computer, it was equivalent to saying someday people will have their own private helicopters. I got terribly frustrated waiting for the paradigms to change.

Do you have a prediction for the next big information-technology breakthrough?

There are going to be computer displays incorporated into glasses or contact lenses. Our interactions with computers will become more subtle. They will respond to our twitches or facial expressions. We'll have cell phones in our ears. Cranial implants will provide amazing extensions to our senses. These implants will speed our perceptions. On the other hand, you won't have to get out of bed to interact with a computer. If you don't move, imagine what kind of a deplorable physical life you will have.

We will have a dynamic knowledge repository. That's a prime thing to pursue. It's one thing to Google something, to find instances of a fact or concept—but, what is the current understanding? What is the upshot? What does it all mean? What does it add up to be? It's a little understood process by which all of this activity evolves into a common picture. Accountants can look at each person's entry and come up with an overall financial picture, but we don't know how to do this "integration" effectively for general knowledge.

Imagine what would happen if artificial intelligence gave machines more intelligence than humans. Why keep us around? We need to improve our collective IQ.

CHAPTER

2 Introduction to Ethics

No man is an island, entire of itself; every man is a piece of the continent, a part of the main. If a clod be washed away by the sea, Europe is the less, as well as if a promontory were, as well as if a manor of thy friend's or of thine own were. Any man's death diminishes me, because I am involved in mankind; and therefore never send to know for whom the bell tolls; it tolls for thee.

–John Donne, *Meditation XVII*

2.1 Introduction

Imagine hovering above the Earth in a spacecraft on a cloudless night. Looking down upon our planet, you see beautiful constellations of artificial light (Figure 2.1). The stars in these incandescent galaxies are our communities.

Forming communities allows us to enjoy better lives than if we lived in isolation. Communities facilitate the exchange of goods and services. Instead of each family assuming responsibility for all of its needs, such as food, housing, clothing, education, and health care, individuals can focus on particular activities. Specialization results in higher productivity that increases everyone's quality of life. Communities also make people more secure against external dangers.

There is a price associated with being part of a community. Communities prohibit certain actions and make other actions obligatory. Those who do not conform with these prohibitions and obligations can be punished. Still, the fact that people *do* live

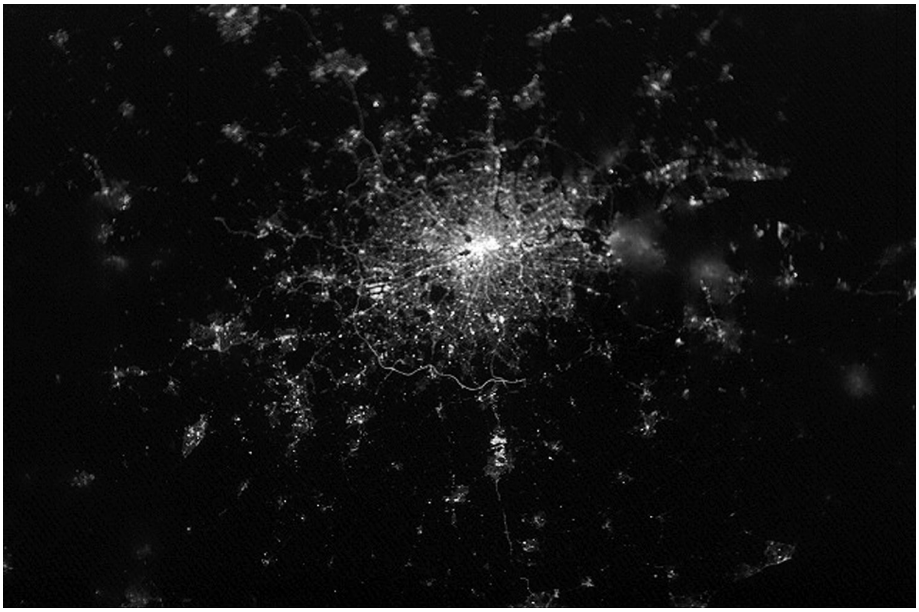


FIGURE 2.1 Looking down on London, England, at night from space. (Courtesy of NASA)

in communities is strong evidence that the advantages of community life outweigh the disadvantages.

Responsible community members take the needs and desires of other people into account when they make decisions. They recognize that virtually everybody shares the "core values" of life, happiness, and the ability to accomplish goals. People who respect only their own needs and desires are taking the selfish point of view. Moving to the "ethical point of view" requires a decision that other people and their core values are also worthy of respect [1].

People who take the ethical point of view may still disagree over what is the proper course of action to take in a particular situation. Sometimes the facts of the matters are disputable. At other times, different value judgments arising from competing ethical theories lead people to opposite conclusions. For this reason, it is worthwhile to have a basic understanding of some of the most popular ethical theories. In this chapter we will describe the difference between morality and ethics, discuss a variety of ethical theories, evaluate their pros and cons, and show how to use the more viable ethical theories to solve moral problems.

2.1.1 Defining Terms

A **society** is an association of people organized under a system of rules designed to advance the good of its members over time [2]. Cooperation among individuals helps promote the common good. However, people in a society also compete with each other;

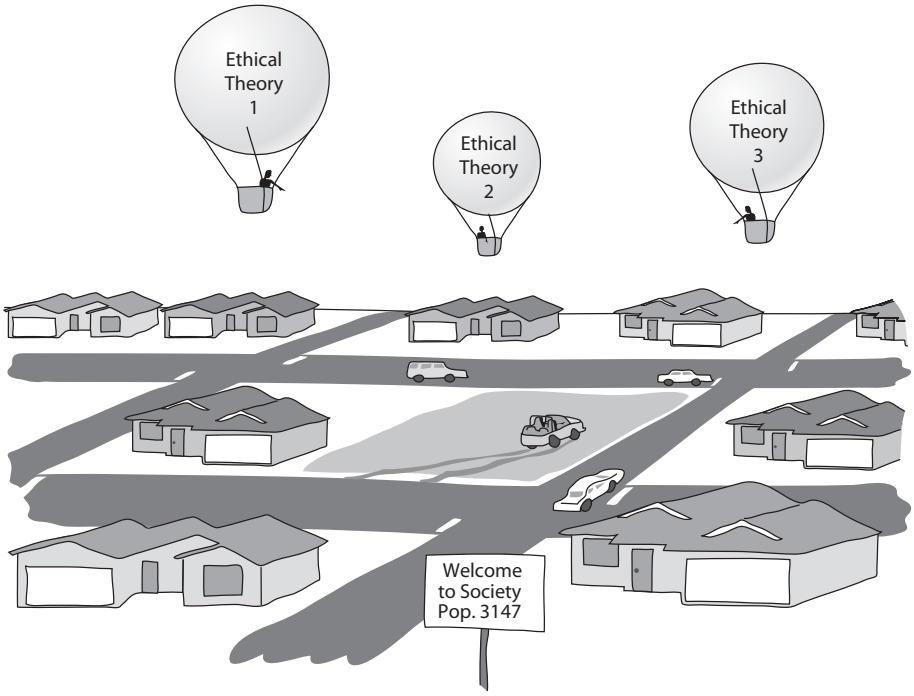


Figure 2.2 An analogy explaining the difference between ethics and morality. Imagine society as a town. Morality is the road network within the town. People doing ethics are in balloons floating above the town.

for example, when deciding how to divide limited benefits among themselves. Sometimes the competition is relatively trivial, such as when many people vie for tickets to a movie premiere. At other times the competition is much more significant, such as when two start-up companies seek control of an emerging market. Every society has rules of conduct describing what people ought and ought not to do in various situations. We call these rules **morality.**

A person may simultaneously belong to multiple societies, which can lead to moral dilemmas. For example, what happens when a pacifist (according to the rules of his religion) is drafted to serve in the armed forces (according to the laws of his nation)?

Ethics is the philosophical study of morality, a rational examination into people's moral beliefs and behavior. Consider the following analogy (Figure 2.2). Society is like a town full of people driving cars. Morality is the road network within the town. People ought to keep their cars on the roads. Those who choose to "do ethics" are in balloons floating above the town. From this perspective, an observer can evaluate individual roads (particular moral guidelines) as well as the quality of the entire road network (moral system). The observer can also judge whether individual drivers are staying on the roads (acting morally) or taking shortcuts (acting immorally). Finally, the observer

can propose and evaluate various ways of constructing road networks (alternative moral systems). While there may in fact be a definite answer regarding the best way to construct and operate a road network, it may be difficult for the observers to identify and agree upon this answer, because each observer has a different viewpoint.

The study of ethics is particularly important right now. Our society is changing rapidly as it incorporates the latest advances in information technology. Just think about how cell phones, portable digital music players, laptop computers, and the World Wide Web have changed how we spend our time and interact with others! These inventions have brought us many benefits. However, some people selfishly exploit new technologies for personal gain, even if that reduces their overall benefit for the rest of us. Here are two examples. While most of us are happy to have the ability to send email to people all over the world, we are dismayed at the amount of spam—unsolicited bulk email—we receive. Access to the World Wide Web provides libraries with an important new information resource for its patrons, but should children be exposed to pop-up advertisements for pornographic Web sites?

When we encounter new problems such as spam or pornographic Web sites, we need to decide which activities are "good," which are "neutral," and which are "bad." Unfortunately, existing moral guidelines sometimes seem old-fashioned or unclear. If we can't always count on "common wisdom" to help us answer these questions, we need to learn how to work through these problems ourselves.

2.1.2 Four Scenarios

As an initiation into the study of ethics, carefully read each of the following scenarios. After reflection, come up with your answer to each question.

~ SCENARIO 1

Alexis, a gifted high school student, wants to become a doctor. Because she comes from a poor family, she will need a scholarship in order to attend college. Some of her classes require extra research projects in order to get an A. Her high school has a few, older PCs, but there are always long lines of students waiting to use them during the school day. After school, she usually works at a part-time job to help support her family.

On some evenings Alexis goes to the library of a private college a few miles from her family's apartment, where she always finds plenty of unused PCs connected to the Internet. On the few occasions when a librarian asks her if she is a student at the college, she says "Yes," and the librarian leaves her alone. Using the resources of this library, Alexis efficiently completes the extra research projects, graduates from high school with straight As, and gets a full-ride scholarship to attend a prestigious university.

Questions

1. Did Alexis do anything wrong?
2. Who benefited from Alexis's course of action?

3. Who was hurt by Alexis's course of action?
4. Did Alexis have an unfair advantage over her high school classmates?
5. Would any of your answers change if it turns out Alexis did not win a college scholarship after all and is now working at the Burger Barn?
6. Are there better ways Alexis could have accomplished her objective?
7. What additional information, if any, would help you answer the previous questions?

Scenario 2

An organization dedicated to reducing spam tries to get Internet service providers (ISPs) in an East Asian country to stop the spammers by protecting their mail servers. When this effort is unsuccessful, the anti-spam organization puts the addresses of these ISPs on its "black list." Many ISPs in the United States consult the black list and refuse to accept email from the blacklisted ISPs. This action has two results. First, the amount of spam received by the typical email user in the United States drops by 25 percent. Second, tens of thousands of innocent computer users in the East Asian country are unable to send email to friends and business associates in the United States.

Questions

1. Did the anti-spam organization do anything wrong?
2. Did the ISPs that refused to accept email from the blacklisted ISPs do anything wrong?
3. Who benefited from the organization's action?
4. Who was hurt by the organization's action?
5. Could the organization have achieved its goals through a better course of action?
6. What additional information, if any, would help you answer the previous questions?

Scenario 3

In an attempt to deter speeders, the East Dakota State Police (EDSP) installs video cameras on all of its freeway overpasses. The cameras are connected to computers that can reliably detect cars traveling more than five miles per hour above the speed limit. These computers have sophisticated image recognition software that enables them to read license plate numbers and capture high-resolution pictures of vehicle drivers. If the picture of the driver matches the driver's license photo of one of the registered owners of the car, the system issues a speeding ticket to the driver, complete with photo evidence. Six months after

the system is put into operation, the number of people speeding on East Dakota freeways is reduced by 90 percent.

The FBI asks the EDSP for real-time access to the information collected by the video cameras. The EDSP complies with this request. Three months later, the FBI uses this information to arrest five members of a terrorist organization.

Questions

1. Did the East Dakota State Police do anything wrong?
2. Who benefited from the actions of the EDSP?
3. Who was harmed by the actions of the EDSP?
4. What other courses of action could the EDSP have taken to achieve its objectives? Examine the advantages and disadvantages of these alternative courses of action.
5. What additional information, if any, would help you answer the previous questions?

SCENARIO 4

You are the senior software engineer at a start-up company developing an exciting new product for handheld computers that will revolutionize the way nurses keep track of their hospitalized patients. Your company's sales force has led hospital administrators to believe your product will be available next week. Unfortunately, at this point the package still contains quite a few bugs. The leader of the testing group has reported that all of the known bugs appear to be minor, but it will take another month of testing for his team to be confident the product contains no catastrophic errors.

Because of the fierce competition in the medical software industry, it is critical that your company be the "first to market." To the best of your knowledge, a well-established company will release a similar product in a few weeks. If its product appears first, your start-up company will probably go out of business.

Questions

1. Should you recommend release of the product next week?
2. Who will benefit if the company follows your recommendation?
3. Who will be harmed if the company follows your recommendation?
4. Do you have an obligation to any group of people that may be affected by your decision?
5. What additional information, if any, would help you answer the previous questions?

Reflect on the process you used in each scenario to come up with your answers. How did you decide if particular actions or decisions were right or wrong? Were your reasons consistent from one case to the next? Did you use the same methodology in more than one scenario? If someone disagreed with you on the answer to one of these questions, how would you try to convince that person that your position makes more sense?

Ethics is the rational, systematic analysis of conduct that can cause benefit or harm to other people. Because ethics is based in reason, people are required to explain *why* they hold the opinions they do. This gives us the opportunity to compare ethical evaluations. When two people reach different conclusions, we can weigh the facts and the reasoning process behind their conclusions to determine the stronger line of thinking.

It's important to note that ethics is focused on the *voluntary, moral* choices people make because they have decided they ought to take one course of action rather than an alternative. Ethics is not concerned about involuntary choices or choices outside the moral realm.

For example, if I am ordering a new car, I may get to choose whether it is red, white, green, or blue. This choice is not in the moral realm.

Now, suppose I'm driving my new, red car down a city street. A pedestrian, obscured from my view by a parked car, runs out into traffic. In an attempt to miss the pedestrian, I swerve, lose control of my car, and kill another pedestrian walking along the sidewalk. While my action caused harm to another person, this is not an example of ethical decision-making, because my decision was a reflex action rather than a reasoned choice.

However, suppose I did not have full control of the car because I had been driving while intoxicated. In that case the consequences of my voluntary choice to drink affected another moral being (the innocent pedestrian). Now the problem has entered the realm of ethics.

2.1.3 Overview of Ethical Theories

The formal study of ethics goes back at least 2,400 years, to the Greek philosopher Socrates. Socrates did not put any of his philosophy in writing, but his student Plato did. In Plato's dialogue called the *Crito*, imprisoned Socrates uses ethical reasoning to explain why he ought to face an unjust death penalty rather than take advantage of an opportunity to flee into exile with his family [3].

In the past two millennia, philosophers have proposed many ethical theories. In this chapter we review some of them. How do we decide if a particular theory is useful? A useful theory allows its proponents to examine moral problems, reach conclusions, and defend these conclusions in front of a skeptical, yet open-minded audience (Figure 2.3).

Suppose you and I are debating a moral problem in front of a nonpartisan crowd. You have concluded that a particular course of action is right, while I believe it is wrong. It is only natural for me to ask you, "Why do you think doing such-and-such is right?" If you are unable to give any logical reasons why your position is correct, you are unlikely to persuade anyone. On the other hand, if you can explain the chain of reasoning that led you to your conclusion, you will be more likely to convince the audience that your

FIGURE 2.3 A good ethical theory should enable you to make a persuasive, logical argument to a diverse audience.

position is correct. At the very least you will help reveal where there are disputed facts or values. Hence we will reject proposed ethical theories that are not based on reasoning from facts or commonly accepted values.

In the following sections we will consider seven ethical theories—seven frameworks for moral decision-making. We will present the motivation or insight underlying each theory, explain how it can be used to determine whether an action is right or wrong, and give the "case for" and the "case against" the theory. The workable theories will be those that make it possible for a person to present a persuasive, logical argument to a diverse audience of skeptical, yet open-minded people.

The principal sources for these brief introductions to ethical theories are *Ethical Insights: A Brief Introduction, Second Edition* by Douglas Birsch [4] and *The Elements of Moral Philosophy, Fourth Edition* by James Rachels [5]. Consult one or both of these books if you'd like to explore any of these theories in greater depth.

2.2 Subjective Relativism

Relativism is the theory that there are no universal moral norms of right and wrong. Different individuals or groups of people can have completely opposite views of a moral problem, and both can be right. Two particular kinds of relativism we'll discuss are subjective relativism and cultural relativism.

Subjective relativism holds that each person decides right and wrong for himself or herself. This notion is captured in the popular expression "What's right for you may not be right for me."

2.2.1 The Case for Subjective Relativism

1. *Well-meaning and intelligent people can have totally opposite opinions about moral issues.*

   For example, consider the issue of legalized abortion in the United States. There are a significant number of rational people on each side of the issue. The reason people cannot reach the same conclusion is that morality is not like gravity; it is not something "out there" that rational people can discover and try to understand. Instead, each of us creates his or her own morality.

2. *Ethical debates are disagreeable and pointless.*

   Going back to the example of abortion, the debate in the United States has been going on for more than 30 years. An agreement about whether abortion is right or wrong may never be reached. Nobody is all-knowing. When faced with a difficult moral problem, who is to say which side is correct? If morality is relative, we do not have to try to reconcile opposing views. Both sides are right.

2.2.2 The Case against Subjective Relativism

1. *With subjective relativism the line between doing what you think is right and doing what you want to do is not sharply drawn.*

   People are good at rationalizing their bad behavior. Subjective relativism provides an ideal last line of defense for someone whose conduct is being questioned. When pressed to explain a decision or action, a subjective relativist can reply, "Who are *you* to tell *me* what I should and should not do?" If morality means doing whatever you want to do, it doesn't mean much, if it means anything at all.

2. *By allowing each person to decide right and wrong for himself or herself, subjective relativism makes no moral distinction between the actions of different people.*

   The fact is that some people have caused millions to suffer, while others have led lives of great service to humanity. Suppose both Adolf Hitler and Mother Teresa spent their entire lives doing what they thought was the right thing to do. Do you want to give both of them credit for living good lives?

   A modification of the original formulation of subjective relativism might be: "I can decide what's right for me, as long as my actions don't hurt anybody else." That solves the problem of Adolf Hitler versus Mother Teresa. However, as soon as you introduce the idea that you shouldn't harm others, you must come to an agreement with others about what it means to harm someone. At this point the process is no longer subjective or completely up to the individual. In other words, a statement of the form "I can decide what's right for me, as long as my actions don't hurt anyone else" is inconsistent with subjective relativism.

3. *Subjective relativism and tolerance are two different things.*

   Some people may be attracted to relativism because they believe in tolerance. There is a lot to be said for tolerance. It allows individuals in a pluralistic society like the

United States to live in harmony. However, tolerance is not the same thing as subjective relativism. Subjective relativism holds that individuals decide for themselves what is right and what is wrong. If you are a tolerant person, is it okay with you if some people decide they want to be intolerant? What if a person decides that he will only deal fairly with people of his own racial group? Note that any statement of the form "People ought to be tolerant" is an example of a universal moral **norm,** or rule. Relativism is based on the idea that there are no universal moral norms, so a blanket statement about the need for tolerance is incompatible with subjective relativism.

4. *We should not give legitimacy to an ethical theory that allows people to make decisions based on something other than reason.*

   If individuals decide for themselves what is right and what is wrong, they can reach their conclusions by any means they see fit. They may choose to base their decisions on something other than logic and reason, such as the rolling of dice or the turning of Tarot cards. This path is contrary to using logic and reason.

If your goal is to persuade others that your solutions to actual moral problems are correct, adopting subjective relativism is self-defeating because it is based on the idea that each person decides for himself or herself what is right and what is wrong. According to ethical relativism, nobody's conclusions are any more valid than anyone else's, no matter how these conclusions are drawn. Therefore, we reject subjective relativism as a workable ethical theory.

2.3 Cultural Relativism

If subjective relativism is unworkable, what about different views of right and wrong held by different societies at the same point in time, or those held by the same society at different points in time?

In the modern era, anthropologists have collected evidence of societies with moral codes markedly different from those of the societies of Europe and North America. William Graham Sumner described the evolution of *folkways*, which he argues eventually become institutionalized into the moral guidelines of a society:

> The first task of life is to live . . . The struggle to maintain existence was not carried on individually but in groups. Each profited by the other's experience; hence there was concurrence towards that which proved to be the most expedient. All at last adopted the same way for the same purpose; hence the ways turned into customs and became mass phenomena. Instincts were learned in connection with them. In this way folkways arise. The young learn by tradition, imitation, and authority. The folkways, at a time, provide for all the needs of life then and there. They are uniform, universal in the group, imperative, and invariable. As time goes on, the folkways become more and more arbitrary, positive, and imperative. If asked why they act in a certain way in certain cases, primitive people always answer that it is because they and their ancestors always have done so . . . The morality of a

> group at a time is the sum of the taboos and prescriptions in the folkways by which right conduct is defined . . . 'Good' mores are those which are well adapted to the situation. 'Bad' mores are those which are not so well adapted [6].

Cultural relativism is the ethical theory that the meaning of "right" and "wrong" rests with a society's actual moral guidelines. These guidelines vary from place to place and from time to time.

Charles Hampden-Turner and Fons Trompenaars conducted a modern study that reveals how notions of right and wrong vary widely from one society to another. Here is a dilemma they posed to people from 46 different countries:

> You are riding in a car driven by a close friend. He hits a pedestrian. You know he was going at least 35 miles per hour in an area of the city where the maximum allowed speed is 20 miles per hour. There are no witnesses other than you. His lawyer says that if you testify under oath that he was driving only 20 miles per hour, you will save him from serious consequences.
>
> What right has your friend to expect you to protect him?
>
> - My friend has a definite right as a friend to expect me to testify to the lower speed.
> - He has some right as a friend to expect me to testify to the lower speed.
> - He has no right as a friend to expect me to testify to the lower speed.
>
> What do you think you would do in view of the obligations of a sworn witness and the obligation to your friend?
>
> - Testify that he was going 20 miles per hour.
> - Not testify that he was going 20 miles per hour [7].

About 90 percent of Norwegians would not testify to the lower speed and do not believe that the person's friend has a definite right to expect help. In contrast, only about 10 percent of Yugoslavians feel the same way. About three-quarters of Americans and Canadians agree with the dominant Norwegian view, but Mexicans are fairly evenly divided [7]. Cultural relativists say we ought to pay attention to these differences.

2.3.1 The Case for Cultural Relativism

1. *Different social contexts demand different moral guidelines.*

   It's unrealistic to assume that the same set of moral guidelines can be expected to work for all human societies in every part of the world for all ages. Just think about how our relationship with our environment has changed. For most of the past 10,000 years, human beings have spent most of their time trying to produce enough food to survive. Thanks to science and technology, the human population of the Earth has increased exponentially in the past century. The struggle for survival has shifted away from people to the rest of Nature. Overpopulation has created a host of environmental problems, such as the extinction of many species, the destruction

of fisheries in the world's oceans, and the accumulation of greenhouse gases. People must change their ideas about what is acceptable conduct and what is not, or they will destroy the planet.

2. *It is arrogant for one society to judge another.*

   Anthropologists have documented many important differences among societies with respect to what they consider proper and improper moral conduct. We may have more technology than people in other societies, but we are no more intelligent than they are. It is arrogant for a person living in twenty-first-century America to judge the actions of another person who lived in Peru in the fifteenth century.

3. *Morality is reflected in actual behavior.*

   We often find people saying that certain actions are wrong, but then they do them anyway. Some parents tell their children, "Do as I say, not as I do." Looking at the actual behavior of people (their *de facto* values) gives a truer picture of what a society believes is right and wrong than listening to their hypothetical discussions about how they ought to behave.

2.3.2 The Case against Cultural Relativism

1. *Just because two societies do have different views about right and wrong doesn't imply that they ought to have different views.*

   Perhaps one society has good guidelines and another has bad guidelines. Perhaps neither society has good guidelines.

   Suppose two societies are suffering from a severe drought. The first society constructs an aqueduct to carry water to the affected cities. The second society makes human sacrifices to appease the rain god. Are both "solutions" equally acceptable? No, they are not. Yet, if we accept cultural relativism, we cannot speak out against this wrongdoing, because no person in one society can make any statements about the morality of another society.

2. *Cultural relativism does not explain how an individual determines the moral guidelines of a particular society.*

   Suppose I am new to a society and I understand I am supposed to abide by its moral guidelines. How do I determine what those guidelines are?

   One approach would be to poll other people, but this begs the question. Here's why. Suppose I ask other people whether the society considers a particular action to be morally acceptable. I'm not interested in knowing whether they personally feel the action is right or wrong. I want them to tell me whether the society as a whole thinks the action is moral. That puts the people I poll in the same position I'm in—trying to determine the moral guidelines of a society. How are *they* to know whether the action is right or wrong?

   Perhaps the guidelines are summarized in the society's laws, but laws take time to enact. Hence the legal code reflects at best the moral guidelines of the same society at some point in the past, but that's not the same society I am living in

today, because the morals of any society change over time. That leads us to our next objection.

3. *Cultural relativism does not do a good job of characterizing actions when moral guidelines evolve.*

   Until the 1960s many southern American states had segregated universities. Today these universities are integrated. This change in attitudes was accelerated by the actions of a few brave people of color who challenged the status quo and enrolled in universities that had been the exclusive preserve of white students. At the time these students were doing what they "ought not" to have done; they were doing something wrong according to the moral guidelines of the time. By today's standards, they did nothing wrong, and many people view them as heroic figures. Doesn't it make more sense to believe that their actions were the right thing to do all along?

4. *Cultural relativism provides no framework for reconciliation between cultures in conflict.*

   Think about the culture of the poverty-stricken Palestinians who have been crowded into refugee camps in the Gaza Strip for the past 50 years. Many of these people are completely committed to an armed struggle against Israel. Meanwhile, many people in Israel believe the Jewish state ought to be larger and are completely committed to the expansion of settlements into the Gaza Strip. The values of each society lead to actions that harm the other, yet cultural relativism says each society's moral guidelines are right. Cultural relativism provides no way out—no way for the two sides to find common ground.

5. *The existence of many acceptable cultural practices does not imply that any cultural practice would be acceptable.*

   Judging *many* options to be acceptable and then reaching the conclusion that *any* option is acceptable is called the **many/any fallacy**. To illustrate this fallacy, consider documentation styles for computer programs. There are many good ways to add comments to a program; that does not mean that any commenting style is good.

   It is false that all possible cultural practices have equal legitimacy. Certain practices must be forbidden and others must be mandated if a society is to survive [1]. This observation leads us directly to our next point.

6. *Societies do, in fact, share certain core values.*

   While a superficial observation of the cultural practices of different societies may lead you to believe they are quite different, a closer examination often reveals similar values underlying these practices. James Rachels argues that all societies, in order to maintain their existence, must have a set of core values [5]. For example, newborn babies are helpless. A society must care for its infants if it wishes to continue on. Hence a core value of every society is that babies must be cared for. Communities rely upon people being able to believe each other. Hence telling the truth is another core value. Finally, in order to live together, people must not constantly be on guard against attack from their community members. For this reason a prohibition against murder is a core value of any society.

Because societies do share certain core values, there is reason to believe we could use these values as a starting point in the creation of a universal ethical theory that would not have the deficiencies of cultural relativism.

7. *Cultural relativism is only indirectly based on reason.*

   As Sumner observed, many moral guidelines are a result of tradition. You behave in a certain way because it's what you're supposed to do, not because it makes sense.

Cultural relativism has significant weaknesses as a tool for ethical persuasion. According to cultural relativism, the ethical evaluation of a moral problem made by a person in one society may be meaningless when applied to the same moral problem in another society. Cultural relativism suggests there are no universal moral guidelines. It gives tradition more weight in ethical evaluations than facts and reason. For these reasons cultural relativism is not a powerful tool for constructing ethical evaluations persuasive to a diverse audience, and we consider it no further.

2.4 Divine Command Theory

The three great religious traditions that arose in the Middle East—Judaism, Christianity, and Islam—teach that a single God is the creator of the universe and that human beings are part of God's creation. Each of these religions has sacred writings containing God's revelation. If you are a religious person, living your life aligned with the will of God may be very important to you.

Jews, Christians, and Muslims all believe that God inspired the Torah. Here is a selection of verses from Chapter 19 of the third book of the Torah, called Leviticus:

> You shall each revere his mother and his father, and keep My sabbaths. When you reap the harvest of your land, you shall not reap all the way to the edges of your field, or gather the gleanings of your harvest. You shall not pick your vineyard bare, or gather the fallen fruit of your vineyard; you shall leave them for the poor and the stranger. You shall not steal; you shall not deal deceitfully or falsely with one another. You shall not swear falsely by My name. You shall not defraud your neighbor. You shall not commit robbery. The wages of a laborer shall not remain with you until morning. You shall not insult the deaf, or place a stumbling block before the blind. You shall not take vengeance or bear a grudge against your kinsfolk. Love your neighbor as yourself [8].

The **divine command theory** is based on the idea that good actions are those aligned with the will of God and bad actions are those contrary to the will of God. Since the holy books contain God's directions, we can use the holy books as moral decision-making guides. God says we should revere our mothers and fathers, so revering our parents is good. God says do not lie or steal, so lying and stealing are bad (Figure 2.4).

Figure 2.4 The divine command theory of ethics is based on two premises: good actions are those actions aligned with the will of God, and God's will has been revealed to us.

2.4.1 The Case for the Divine Command Theory

1. *We owe obedience to our Creator.*

   God is the creator of the universe. God created each one of us. We are dependent upon God for our lives. Hence we are obligated to follow God's rules.

2. *God is all-good and all-knowing.*

   God loves us and wants the best for us. God is omniscient; we are not. Hence God knows better than we do what we must do to be happy. For this reason we should align ourselves with the will of God.

3. *God is the ultimate authority.*

   Since most people are religious, they are more likely to submit to God's law than to a law made by people. Our goal is to create a society where everyone obeys the moral laws. Hence our moral laws should be based on God's directions to us.

2.4.2 The Case against the Divine Command Theory

1. *There are many holy books, and some of their teachings disagree with each other.*

   There is no single holy book that is recognized by people of all faiths, and it is unrealistic to assume everyone in a society will adopt the same religion. Even among Christians there are different versions of the Bible. The Catholic Bible has six books

not found in the Protestant Bible. Some Protestant denominations rely upon the King James version, but others use more modern translations. Every translation has significant differences. Even when people read the same translation, they often interpret the same verse in different ways.

2. *It is unrealistic to assume a multicultural society will adopt a religion-based morality.*

   An obvious example is the United States. In the past two centuries, immigrants representing virtually every race, creed, and culture have made America their home. Some Americans are atheists. When a society is made up of people with different religious beliefs, the society's moral guidelines should emerge from a secular authority, not a religious authority.

3. *Some moral problems are not addressed directly in scripture.*

   For example, there are no verses in the Bible mentioning the Internet. When we discuss moral problems arising from information technology, a proponent of the divine command theory must resort to analogy. At this point the conclusion is based not simply on what appears in the sacred text but also on the insight of the person who invented the analogy. The holy book alone is not sufficient to solve the moral problem.

4. *It is fallacious to equate "the good" with "God."*

   Religious people are likely to agree with the statement "God is good." That does not mean, however, that God and "the good" are exactly the same thing. Trying to equate two related but distinct things is called the **equivalence fallacy.** Instead, the statement "God is good" means there is an objective standard of goodness that God meets perfectly.

   Here's another way to put the question. Is an action good because God commands it, or does God command it because it's good? This is an ancient question: Plato raised it about 2,400 years ago in the Socratic dialogue *Euthyphro*. In this dialogue Socrates concludes, "The gods love piety because it is pious, and it is not pious because they love it" [9]. In other words, "the good" is something that exists outside of God.

   We can reason our way to the same conclusion. If good means "commanded by God," then good is arbitrary. Why should we praise God for being good if good is whatever God wills? According to this view of the good, it doesn't matter whether God commanded, "Thou shalt not commit adultery" or "Thou shalt commit adultery." Either way, the command would have been good by definition. If you object that there is no way God would command us to commit adultery, because marital fidelity is good and adultery is bad, then you are arguing that there is a standard of right and wrong separate from God. In that case, we can talk about the good without talking about God. That opens the door to a rational discussion of the good, which we will pursue in the next section.

5. *The divine command theory is based on obedience, not reason.*

   If good means "willed by God," and if religious texts contain everything we need to know about what God wills, then there is no room left for collecting and an-

alyzing facts. Hence the divine command theory is not based on reaching sound conclusions from premises through logical reasoning. There is no need for a person to question a commandment. The instruction is right because it's commanded by God, period.

Consider the story of Abraham in the book of Genesis. God commands Abraham to take his only son, Isaac, up on a mountain, kill him, and make of him a burnt offering. Abraham obeys God's command and is ready to kill Isaac with his knife when an angel calls down and tells him not to harm the boy. Because he does not withhold his only son from God, God blesses Abraham [10]. Earlier in Genesis God condemns Cain for killing Abel [11]. How, then, can Abraham's sacrifice of Isaac be considered good? To devout readers, the logic of God's command is irrelevant to this story. Abraham is a good person, a heroic model of faith, because he demonstrated his obedience to the will of God.

The fact that moral guidelines are not the result of a logical progression from a set of underlying principles is a significant obstacle. While you may choose to align your personal actions with the Divine will, the divine command theory often fails to produce arguments that can persuade skeptical listeners whose religious beliefs are different. Hence we conclude the divine command theory is not a powerful weapon for ethical debate in a secular society, and we reject it as a workable theory for the purposes of this book.

2.5 Kantianism

Kantianism is the name given to the ethical theory of the German philosopher Immanuel Kant (1724–1804). Kant spent his entire life in or near Königsberg in East Prussia, where he was a professor at the university. Kant believed that people's actions ought to be guided by moral laws, and that these moral laws were universal. He held that in order to apply to all rational beings, any supreme principle of morality must itself be based on reason. Hence, while many of the moral laws Kant describes can also be found in the Bible, Kant's methodology allows these laws to be derived through a reasoning process. A Kantian is able to go beyond simply stating *that* an action is right or wrong by citing chapter and verse; a Kantian can explain *why* it is right or wrong.

2.5.1 Good Will and the Categorical Imperative

Kant begins his inquiry by asking, "What is always good without qualification?" Many things, such as intelligence and courage, can be good, but they can also be used in a way that is harmful. For example, a group of gangsters may use intelligence and courage to rob a bank. Kant's conclusion is that the only thing in the world that can be called good without qualification is *a good will*. People with good will often accomplish good deeds, but producing beneficial outcomes is not what makes a good will good. A good will is good in and of itself. Even if a person's best efforts at doing good should fall short and cause harm, the good will behind the efforts is still good. Since a good will is the only

thing that is universally good, the proper function of reason is to cultivate a will that is good in itself.

Most of us have probably had many experiences when we've been torn between *what we want to do* and *what we ought to do*. According to Kant, what we want to do is of no importance. Our focus should be on what we ought to do. Our sense of "ought to" is called **dutifulness** [12]. A dutiful person feels compelled to act in a certain way out of respect for some moral rule. Our will, then, should be grounded in a conception of moral rules. The moral value of an action depends upon the underlying moral rule. It is critical, therefore, that we be able to determine if our actions are grounded in an appropriate moral rule.

What makes a moral rule appropriate? To enable us to answer this question, Kant proposes the Categorical Imperative.

Categorical Imperative (First Formulation)

Act only from moral rules that you can at the same time will to be universal moral laws.

To illustrate the Categorical Imperative, Kant poses the problem of an individual in a difficult situation who must decide if he will make a promise with the intention of later breaking it. The translation of this moral rule could be: "A person may make a false promise when that is the only way to escape a difficult situation."

To evaluate this moral rule, we universalize it. What would happen if everybody in extreme circumstances made false promises? If that were the case, nobody would believe promises, and it would be impossible for our individual in distress to make a promise that anyone believed. The moral rule self-destructs when we try to make it a universal law. Therefore, it is wrong for a person in distress to make a promise with the intention of breaking it.

It is important to see that Kant is *not* arguing that the consequences of everybody breaking promises would be to undermine interpersonal relationships, increase violence, and make people miserable, and that is why we cannot imagine turning our hypothetical moral rule into a universal law. Rather, Kant is saying that simply willing that our moral rule become a universal law produces a logical contradiction.

Let's see how. Suppose I am the person who can escape from a difficult situation by making a promise I intend to break later on. On the one hand, it is my will that I be able to make a promise that is believed. After all, that's what promises are for. If my promise isn't believed, I won't be able to get out of the difficult situation I am in. But when I universalize the moral rule, I am willing that everybody be able to break promises. If that were a reality, then promises would not be believable, which means there would be no such thing as a promise [13]. If there were no such thing as a promise, I would not be able to make a promise to get myself out of a difficult situation. Trying to universalize our proposed moral rule leads to a contradiction.

Figure 2.5 The second formulation of the Categorical Imperative states that it is wrong for one person to use himself or another person solely as a means to an end.

Here's another way to see why the proposed action is wrong. In order for my false promise to be believed, I want everyone *except* myself to be truthful all the time. Because there is a contradiction between what I wish to do and how I expect others in a similar situation to act, I know that what I am considering doing is wrong.

Kant also presents a second formulation of the Categorical Imperative, which many find more useful.

Categorical Imperative (Second Formulation)

Act so that you always treat both yourself and other people as ends in themselves, and never only as a means to an end.

To use popular terminology, the second formulation of the Categorical Imperative says it is wrong for one person to "use" another (Figure 2.5). Instead, every interaction with other people must respect them as rational beings.

Here is an example that illustrates how we can apply the second formulation. Suppose I manage a semiconductor fabrication plant for a large corporation. The plant manufactures integrated circuits on 8-inch wafers. I know that in one year the corporation is going to shut down the plant and move all of its production to other sites capable of producing 12-inch wafers. In the meantime, I need new employees to work in the clean room. Many of the best applicants are from out of state. I am afraid that if they knew the plant was going to shut down next year, they would not want to go through the hassle and expense of moving to this area. If that happens, I'll have to hire less-qualified local workers. Should I disclose this information to the job applicants?

According to the second formulation of the Categorical Imperative, I have an obligation to inform the applicants, since I know this information is likely to influence their decision. If I deny them this information, I am treating them as a means to an end (a way to get wafers produced), not as ends in themselves (rational beings).

2.5.2 Evaluating a Scenario Using Kantianism

SCENARIO

Carla is a single mother who is working hard to complete her college education while taking care of her daughter. Carla has a full-time job and is taking two evening courses per semester. If she can pass both courses this semester, she will graduate. She knows her child will benefit if she can spend more time at home.

One of her required classes is modern European history. In addition to the midterm and final examinations, the professor assigns four lengthy reports, which is far more than the usual amount of work required for a single class. Students must submit all four reports in order to pass the class.

Carla earns an "A" on each of her first three reports. At the end of the term, she is required to put in a lot of overtime where she works. She simply does not have time to research and write the final report. Carla uses the Web to identify a company that sells term papers. She purchases a report from the company and submits it as her own work.

Was Carla's action morally justifiable?

Analysis

Many times it is easier to use the second formulation of the Categorical Imperative to analyze a moral problem from a Kantian point of view, so that's where we begin. By submitting another person's work as her own, Carla treated her professor as a means to an end. She deceived her professor with the goal of getting credit for someone else's work. It was wrong for Carla to treat the professor as a grade-generating machine rather than a rational agent with whom she could have communicated her unusual circumstances.

We can also look at this problem using the first formulation of the Categorical Imperative. Carla wants to be able to get credit for turning in a report she has purchased. A proposed moral rule might be: "I may claim credit for a report written by someone else." However, if everyone followed this rule, reports would cease to be credible indicators of the students' knowledge, and professors would not give academic credit for reports. Her proposed moral rule is self-defeating. Therefore, it is wrong for Carla to purchase a report and turn it in as her own work.

Commentary

Note that the Kantian analysis of the moral problem focuses on the will behind the action. It asks the question: "What was Carla trying to do when she submitted under her own name a term paper written by someone else?" The analysis ignores extenuating circumstances that non-Kantians may cite to justify her action.

2.5.3 The Case for Kantianism

1. *Kantianism is rational*.

   Unlike the moral theories we have already described, Kantianism is based on the premise that rational beings can use logic to explain the "why" behind their solutions to ethical problems.

2. *Kantianism produces universal moral guidelines.*

   Kantianism aligns with the intuition of many people that the same morality ought to apply to all people for all of history. These guidelines allow us to make clear moral judgments. For example, one such judgment might be, "Sacrificing living human beings to appease the gods is wrong." It is wrong in North America in the twenty-first century, and it was wrong in South America in the fifteenth century.

3. *All persons are treated as moral equals.*

   A popular belief is that "all people are created equal." Because it holds that people in similar situations should be treated in similar ways, Kantianism provides an ethical framework to combat discrimination.

2.5.4 The Case against Kantianism

1. *Sometimes no single rule fully characterizes an action.*

   Kant holds that every action is motivated from a rule. The appropriate rule depends upon how we characterize the action. Once we know the rule, we can test its value using the Categorical Imperative. What happens when no single rule fully explains the situation? Douglas Birsch gives this example: Suppose I'm considering stealing food from a grocery store to feed my starving children [4]. How should I characterize this action? Am I stealing? Am I caring for my children? Am I trying to save the lives of innocent people? Until I characterize my action, I cannot determine the rule and test it against the Categorical Imperative. Yet no single one of these ways of characterizing the action seems to capture the ethical problem in its fullness.

2. *There is no way to resolve a conflict between rules.*

   We may try to address the previous problem by allowing multiple rules to be relevant to a particular action. In the previous example, we might say that the relevant rules are (1) You should not steal, and (2) You should try to protect the lives of innocent persons. Unfortunately, Kantianism does not provide us a way to put moral laws in order of importance. Even if we could rank moral laws in order of importance, how would we compare a minor infraction of a more important law against a major infraction of a less important law? One conclusion is that Kantianism does not provide a practical way to solve ethical problems when there is a conflict between moral rules.

3. *Kantianism allows no exceptions to moral laws.*

   Common sense tells us that sometimes we ought to "bend" the rules a bit if we want to get along with other people. For example, suppose your mother asks you if

you like her new haircut, and you think it is the ugliest haircut you have ever seen. What should you say? Common sense dictates that there is no point in criticizing your mother's hair. She certainly isn't going to get her hair un-cut, no matter what you say. If you compliment her, she will be happy, and if you criticize her looks, she will be angry and hurt. She expects you to say something complimentary, even if you don't mean it. There just seems to be no downside to lying. Yet a Kantian would argue that lying is wrong because it goes against the moral law. Many people hold that any ethical theory so unbending is not going to be useful for solving "real world" problems.

While these objections point out weaknesses with Kantianism, the theory does support moral decision-making based on logical reasoning from facts and commonly held values. It is culture neutral and treats all humans as equals. Hence it meets our criteria for a workable ethical theory, and we will use it as a way of evaluating moral problems in the rest of the book.

2.6 Act Utilitarianism

2.6.1 Principle of Utility

The English philosophers Jeremy Bentham (1748–1832) and John Stuart Mill (1806–1873) proposed a theory that is in sharp contrast to Kantianism. According to Bentham and Mill, an action is good if it benefits someone; an action is bad if it harms someone. Their ethical theory, called **utilitarianism,** is based upon the Principle of Utility, also called the Greatest Happiness Principle.

PRINCIPLE OF UTILITY (GREATEST HAPPINESS PRINCIPLE)

An action is right (or wrong) to the extent that it increases (or decreases) the total happiness of the affected parties.

Utility is the tendency of an object to produce happiness or prevent unhappiness for an individual or a community. Depending on the circumstances, you may think of "happiness" as advantage, benefit, good, or pleasure, and "unhappiness" as disadvantage, cost, evil, or pain.

We can use the Principle of Utility as a yardstick to judge all actions in the moral realm. To evaluate the morality of an action, we must determine, for each affected person, the increase or decrease in that person's happiness, and then add up all of these values to reach a grand total. If the total is positive (meaning the total increase in happiness is greater than the total decrease in happiness), the action is moral; if the total is negative (meaning the total decrease in happiness is greater than the total increase in happiness), the action is immoral. The Principle of Utility is illustrated in Figure 2.6.

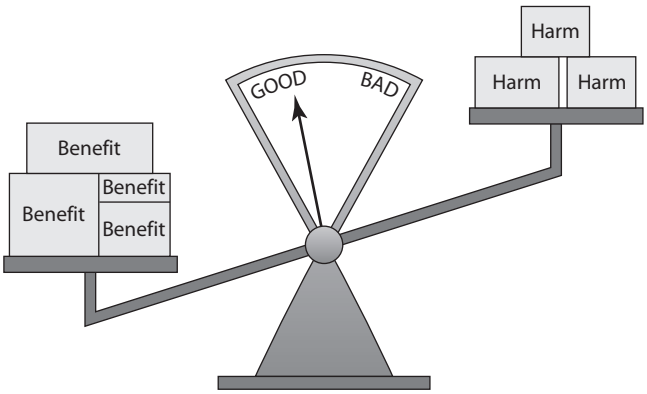


Figure 2.6 Utilitarianism is based on the Principle of Utility, which states that an action is good (or bad) to the extent that it increases (or decreases) the total happiness of the affected parties.

Note that the morality of an action has nothing to do with the attitude behind the action. Bentham writes: "There is no such thing as any sort of motive that is in itself a bad one. If [motives] are good or bad, it is only on account of their effects" [14]. We call utilitarianism a **consequentialist** theory, because the focus is on the consequences of an action.

Act utilitarianism is the ethical theory that an action is good if its net effect (over all affected beings) is to produce more happiness than unhappiness. Suppose we measure pleasure as a positive number and pain as a negative number. To make a moral evaluation of an action, we simply add up, over all affected beings, the change in their happiness. If the sum is positive, the action is good. If the sum is negative, the action is bad.

Did you notice that I used the word "beings" rather than "persons" in the previous paragraph? An important decision an act utilitarian must make is determining which beings are considered to be morally significant. Bentham noted that at one time only adult white males were considered morally significant beings. Bentham felt that any being that can experience pain and pleasure ought to be seen as morally significant. Certainly women and people of color are morally significant beings by this definition, but in addition all mammals (and perhaps other animals) are morally significant beings, because they, too, can experience pain and pleasure. Of course, as the number of morally significant beings increases, the difficulty of evaluating the consequences of an action also increases. It means, for example, that the environmental impacts of decisions must often be included when performing the utilitarian calculus.

2.6.2 Evaluating a Scenario Using Act Utilitarianism

~ Scenario

A state is considering replacing a curvy stretch of highway that passes along the outskirts of a large city. Would building the highway be a good action?

Analysis

To perform the analysis of this problem, we must determine who is affected and the effects of the highway construction on them. Our analysis is in terms of dollars and cents. For this reason we'll use the terms "benefit" and "cost" instead of "happiness" and "unhappiness."

About 150 houses lie on or very near the proposed path of the new, straighter section of highway. Using its power of eminent domain, the state can condemn these properties. It would cost the state $20 million to provide fair compensation to the homeowners. Constructing the new highway, which is three miles long, would cost the taxpayers of the state another $10 million. Suppose the environmental impact of the new highway in terms of lost habitat for morally significant animal species is valued at $1 million.

Every weekday 15,000 cars are expected to travel on this section of highway, which is one mile shorter than the curvy highway it replaces. Assuming it costs 40 cents per mile to operate a motor vehicle, construction of the new highway will save drivers $6,000 per weekday in operating costs. The highway has an expected operating lifetime of 25 years. Over a 25-year period, the expected total savings to drivers will be $39 million.

We'll assume the highway project will have no positive or negative effects on any other people. Since the overall cost of the new highway is $31 million and the benefit of the new highway is $39 million, building the highway would be a good action.

Commentary

Performing the benefit/cost (or happiness/unhappiness) calculations is crucial to the utilitarian approach, yet it can be controversial. In our example, we translated everything into dollars and cents. Was that reasonable? Neighborhoods are the site of many important relationships. We did not assign a value to the harm the proposed highway would do to these neighborhoods. There is a good chance that many of the homeowners will be angry about being forced out of their houses, even if they are paid a fair price for their properties. How do we put a dollar value on their emotional distress? On the other hand, we can't add apples and oranges. Translating everything into dollars and cents is the only way we can do the calculation. ≈

Bentham acknowledged that a complete analysis must look beyond simple benefits and harms. Not all benefits have equal weight. To measure them, he proposed seven attributes that can be used to increase or decrease the weight of a particular pleasure or pain:

- *intensity:* magnitude of the experience
- *duration:* how long the experience lasts
- *certainty:* probability it will actually happen
- *propinquity:* how close the experience is in space and time
- *fecundity:* its ability to produce more experiences of the same kind

- *purity:* extent to which pleasure is not diluted by pain, or vice versa
- *extent:* number of people affected

As you can see, performing a complete calculation for a particular moral problem can be a daunting prospect!

2.6.3 The Case for Act Utilitarianism

1. *It focuses on happiness.*

   By relying upon the Greatest Happiness Principle as the yardstick for measuring moral behavior, utilitarianism fits the intuition of many people that the purpose of life is to be happy.

2. *It is down-to-earth.*

   The utilitarian calculus provides a straightforward way to determine whether a particular action is good or bad. By grounding everything in terms of happiness and unhappiness resulting from an action, it seems more practical than Kantian ethics, which is focused on the Categorical Imperative. For this reason it is a good way for a diverse group of people to come to a collective decision about a controversial topic.

   For example, suppose your state needs to build a new prison because the number of prisoners is growing. Everybody understands the prison must be built somewhere in the state, but nobody wants the prison in their neighborhood. A panel of trusted citizens considers a variety of siting options and, after a series of public hearings to gather evidence, weighs the pluses and minuses of each location. At the end of the process the panel recommends the site with the highest total net good. While some will be unhappy at the prospect of a prison being built near their homes, an open and impartial process can speed their acceptance of the decision.

3. *It is comprehensive.*

   Act utilitarianism allows the moral agent to take into account all the elements of a particular situation. Recall the problem of having to decide what to say about your mother's haircut? Since telling the truth would cause more pain to all parties involved than lying, deciding what the right thing to do would be a "no brainer" using the utilitarian calculus.

2.6.4 The Case against Act Utilitarianism

1. *When performing the utilitarian calculus, it is not clear where to draw the line, yet where we draw the line can change the outcome of our evaluation.*

   In order to perform our calculation of total net happiness produced by an action, we must determine whom to include in our calculation and how far into the future to consider the consequences. In our highway example, we counted the people who lost their homes and the people who would travel the new highway in the next 25 years. The proposed highway may cut neighborhoods in two, making it more difficult for some children to get to school, but we did not factor in consequences for neighbors. The highway may cause people to change their commutes, increasing

traffic congestion in other parts of town, but we did not count those people either. The highway may be in existence more than 25 years, but we didn't look beyond that date. We cannot include all morally relevant beings for all time into the future. We must draw the line somewhere. Deciding where to draw the line can be a difficult problem.

2. *It is not practical to put so much energy into every moral decision.*

   Correctly performing the utilitarian calculus requires a great deal of time and effort. It seems unrealistic that everyone would go to so much trouble every time they were faced with a moral problem.

   A response to this criticism is that act utilitarians are free to come up with moral "rules of thumb." For example, a moral rule of thumb might be "It is wrong to lie." In most situations it will be obvious this is the right thing to do, even without performing the complete utilitarian calculus. However, an act utilitarian always reserves the right to go against the rule of thumb if particular circumstances should warrant it. In these cases, the act utilitarian will perform a detailed analysis of the consequences to determine the best course of action.

3. *Act utilitarianism ignores our innate sense of duty.*

   Utilitarianism seems to be at odds with how ordinary people make moral decisions. People often act out of a sense of duty or obligation, yet the act utilitarian theory gives no weight to these notions. Instead, all that matters are the consequences of the action.

   W. D. Ross gives the following example [15]. Suppose I've made a promise to A. If I keep my word, I will perform an action that produces 1,000 units of good for him. If I break my promise, I will be able to perform an action that produces 1,001 units of good for B. According to act utilitarianism, I ought to break my promise to A and produce 1,001 units of good for B. Yet most people would say the right thing for me to do is keep my word.

   Note that it does no good for an act utilitarian to come back and say that the hard feelings caused by breaking my word to A will have a negative impact on total happiness of $-$N units, because all I have to do is change the scenario so that breaking my promise to A enables me to produce 1,001 $+$ N units of good for B. We've arrived at the same result: breaking my promise results in 1 more unit of good than keeping my word. The real issue is that utilitarianism forces us to reduce all consequences to a positive or negative number. "Doing the right thing" has a value that is difficult to measure.

4. *Act utilitarianism is susceptible to the problem of moral luck.*

   Sometimes actions do not have the intended consequences. Is it right for the moral worth of an action to depend solely on its consequences when these consequences are not fully under the control of the moral agent? This is called the **problem of moral luck.**

   Suppose I hear that one of my aunts is in the hospital, and I send her a bouquet of flowers. After the bouquet is delivered, she suffers a violent allergic reaction

to one of the exotic flowers in the floral arrangement, extending her stay in the hospital. My gift gave my aunt a bad case of hives and a much larger hospital bill. Since my action had far more negative consequences than positive consequences, an act utilitarian would say my action was bad. Yet many people would say I did something good. For this reason, some philosophers prefer a theory in which the moral agent has complete control over the factors determining the moral worth of an action.

Two additional arguments have been raised against utilitarianism in general. We'll save these arguments for the end of the section on rule utilitarianism.

While it is not perfect, act utilitarianism is an objective, rational ethical theory that allows a person to explain why a particular action is right or wrong. It joins Kantianism on our list of workable ethical theories we can use to evaluate moral problems.

2.7 Rule Utilitarianism

2.7.1 Basis of Rule Utilitarianism

The weaknesses of act utilitarianism have led some philosophers to develop another ethical theory based on the Principle of Utility. This theory is called rule utilitarianism. Some philosophers have concluded that John Stuart Mill was actually a rule utilitarian, but others disagree.

Rule utilitarianism is the ethical theory that holds we ought to adopt those moral rules which, if followed by everyone, will lead to the greatest increase in total happiness. Hence a rule utilitarian applies the Principle of Utility to moral rules, while an act utilitarian applies the Principle of Utility to individual moral actions.

Both rule utilitarianism and Kantianism are focused on rules, and the rules these two ethical theories derive may have significant overlap. Both theories hold that rules should be followed without exception. However, the two ethical theories derive moral rules in completely different ways. A rule utilitarian chooses to follow a moral rule because its universal adoption would result in the greatest happiness. A Kantian follows a moral rule because it is in accord with the Categorical Imperative: all human beings are to be treated as ends in themselves, not merely as means to an end. In other words, the rule utilitarian is looking at the consequences of the action, while the Kantian is looking at the will motivating the action.

2.7.2 Evaluating a Scenario Using Rule Utilitarianism

~ Scenario

A worm is a self-contained program that spreads through a computer network by taking advantage of security holes in the computers connected to the network. In August 2003 the Blaster worm infected many computers running the Windows 2000, Windows NT, and Windows XP operating systems. The Blaster worm caused computers it infected to reboot every few minutes.

Soon another worm was exploiting the same security hole in Windows to spread through the Internet. However, the purpose of the new worm, named Nachi, was benevolent. Since Nachi took advantage of the same security hole as Blaster, it could not infect computers that were immune to the Blaster worm. Once Nachi gained access to a computer with the security hole, it located and destroyed copies of the Blaster worm. It also automatically downloaded from Microsoft a patch to the operating system software that would fix the security problem. Finally, it used the computer as a launching pad to seek out other Windows PCs with the security hole.

Was the action of the person who released the Nachi worm morally right or wrong?

Analysis

To analyze this moral problem from a rule utilitarian point of view, we must think of an appropriate moral rule and determine if its universal adoption would increase the happiness of the affected parties. In this case, an appropriate moral rule might be: "If a harmful computer worm is infecting the Internet, and I can write a helpful worm that automatically removes the harmful worm from infected computers and shields them from future attacks, then I should write and release the helpful worm."

What would be the benefits if everyone followed the proposed moral rule? Many people do not keep their computers up to date with the latest patches to the operating system. They would benefit from a worm that automatically removed their network vulnerabilities.

What harm would be caused by the universal adoption of the rule? If everyone followed this rule, the appearance of every new harmful worm would be followed by the release of many other worms designed to eradicate the harmful worm. Worms make networks less usable by creating a lot of extra network traffic. For example, the Nachi worm disabled networks of Diebold ATM machines at two financial institutions [16]. The universal adoption of the moral rule would reduce the usefulness of the Internet while the various worms were circulating.

Another negative consequence would be potential harm done to computers by the supposedly helpful worms. Even worms designed to be benevolent may contain bugs. If many people are releasing worms, there is a good chance some of the worms may accidentally harm data or programs on the computers they infect.

A third harmful consequence would be the extra work placed on system administrators. When system administrators detect a new worm, it is not immediately obvious whether the worm is harmful or beneficial. Hence the prudent response of system administrators is to combat every new worm that attacks their computers. If the proposed moral rule is adopted, more worms will

be released, forcing system administrators to spend more of their time fighting worms [17].

In conclusion, the harms caused by the universal adoption of this moral rule appear to outweigh the benefits. Therefore, the action of the person who released the Nachi worm is morally wrong. ≈

2.7.3 The Case for Rule Utilitarianism

1. *Performing the utilitarian calculus is simpler.*

   When calculating the expected total happiness resulting from an action, act utilitarians struggle with determining whom to include in the calculation and how far into the future to look. It's easier for a rule utilitarian to think in general terms about the long-term consequences on society of the universal adoption of a particular moral rule.

2. *Not every moral decision requires performing the utilitarian calculus.*

   A person that relies on rules of behavior does not have to spend a lot of time and effort analyzing every particular moral action in order to determine if it is right or wrong.

3. *Exceptional situations do not overthrow moral rules.*

   Remember the problem of choosing between keeping a promise to A and producing 1,000 units of good for A, or breaking the promise to A and producing 1,001 units of good for B? A rule utilitarian would not be trapped on the horns of this dilemma. A rule utilitarian would reason that the long-term consequences of everyone keeping their promises produce more good than giving everyone the liberty to break their promises. Hence in this situation a rule utilitarian would conclude the right thing to do is keep the promise to A.

4. *Rule utilitarianism solves the problem of moral luck.*

   Since it is interested in the typical result of an action, the occasional atypical result does not affect the goodness of an action. A rule utilitarian would conclude that sending flowers to people in the hospital is a good action.

5. *It appeals to a wide cross section of society.*

   Bernard Gert points out that utilitarianism is "paradoxically, the kind of moral theory usually held by people who claim that they have no moral theory. Their view is often expressed in phrases like the following: 'It is all right to do anything as long as no one gets hurt,' 'It is the actual consequences that count, not some silly rules,' or 'What is important is that things turn out for the best, not how one goes about making that happen.' On the moral system, it is not the consequences of the particular violation that are decisive in determining its justifiability, but rather the consequences of such a violation being publicly allowed" [18]. In other words, an action is justifiable if allowing that action would, as a rule, bring about greater net happiness than forbidding that action.

2.7.4 The Case against Utilitarianism in General

As we have just seen, rule utilitarianism seems to solve several problems associated with act utilitarianism. However, two criticisms have been leveled at utilitarian theories in general. These problems are shared by both act utilitarianism and rule utilitarianism.

1. *Utilitarianism forces us to use a single scale or measure to evaluate completely different kinds of consequences.*

   In order to perform the utilitarian calculus, all consequences must be put into the same units. Otherwise, we cannot add them up. For example, if we are going to determine the total amount of happiness resulting from the construction of a new highway, many of the costs and benefits (such as construction costs and the gas expenses of car drivers) are easily expressed in dollars. Other costs and benefits are intangible, but we must express them in terms of dollars in order to find the total amount of happiness created or destroyed as a result of the project. Suppose a sociologist informs the state that if it condemns 150 homes, it is likely to cause 15 divorces among the families being displaced. How do we assign a dollar value to that unhappy consequence? In certain circumstances utilitarians must quantify the value of a human life. How can the value of a human life be reduced to an amount of money?

2. *Utilitarianism ignores the problem of an unjust distribution of good consequences.*

   The second, and far more significant, criticism of utilitarianism is that the utilitarian calculus is solely interested in the total amount of happiness produced. Suppose one course of action results in every member of a society receiving 100 units of good, while another course of action results in half the members of society receiving 201 units of good each, with the other half receiving nothing. According to the calculus of utility, the second course of action is superior because the total amount of good is higher. That doesn't seem right to many people.

   A possible response to this criticism is that our goal should be to promote the greatest good of the greatest number. In fact, that is how utilitarianism is often described. A person subscribing to this philosophy might say that we ought to use two principles to guide our conduct: (1) we should act so that the greatest amount of good is produced, and (2) we should distribute the good as widely as possible. The first of these principles is the Principle of Utility, but the second is a principle of justice. In other words, "act so as to promote the greatest good of the greatest number" is not pure utilitarianism. The proposed philosophy is not internally consistent, because there are times when the two principles will conflict. In order to be useful, the theory also needs a procedure to resolve conflicts between the two principles. We'll talk more about the principle of justice in the next section.

The criticisms leveled at utilitarianism point out circumstances in which it seems to produce the "wrong" answer to a moral problem. However, rule utilitarianism treats all persons as equals and provides its adherents with the ability to give the reasons why a particular action is right or wrong. Hence we consider it a third workable theory for evaluating moral problems, joining Kantianism and act utilitarianism.

2.8 Social Contract Theory

In the spring of 2003 a coalition of military forces led by the United States invaded Iraq and removed the government of Saddam Hussein. When the police disappeared, thousands of Baghdad residents looted government ministries [19]. Sidewalk arms merchants did a thriving business selling AK-47 assault rifles to homeowners needing protection against thieves. Are Iraqis much different from residents of other countries, or should we view the events in Baghdad as the typical response of people to a lack of governmental authority and control?

2.8.1 The Social Contract

Philosopher Thomas Hobbes (1603–1679) lived during the English civil war and saw firsthand the terrible consequences of social anarchy. In his book *Leviathan* he argues that without rules and a means of enforcing them, people would not bother to create anything of value, because nobody could be sure of keeping what they created. Instead, people would be consumed with taking what they needed and defending themselves against the attacks of others. They would live in "continuall feare, and danger of violent death," and the life of man would be "solitary, poore, nasty, brutish, and short" [20].

To avoid this miserable condition, which Hobbes calls the *state of nature*, rational people understand that cooperation is essential. However, cooperation is possible only when people mutually agree to follow certain guidelines. Hence moral rules are "simply the rules that are necessary if we are to gain the benefits of social living" [5]. Hobbes argues that everybody living in a civilized society has implicitly agreed to two things: (1) the establishment of such a set of moral rules to govern relations among citizens, and (2) a government capable of enforcing these rules. He calls this arrangement the **social contract.**

The Franco-Swiss philosopher Jean-Jacques Rousseau (1712–1778) continued the evolution of social contract theory. In his book *The Social Contract* he writes, "Since no man has any natural authority over his fellows, and since force alone bestows no right, all legitimate authority among men must be based on covenants" [21]. Rousseau states that the critical problem facing society is finding a form of association that guarantees everybody their safety and property, yet enables each person to remain free. The answer, according to Rousseau, is for everybody to give themselves and their rights to the whole community. The community will determine the rules for its members, and each of its members will be obliged to obey the rules. What prevents the community from enacting bad rules is that no one is above the rules. Since everyone is in the same situation, no one will want to put unfair burdens on others.

While everyone might agree to this in theory, it's easy for a single person to rationalize selfish behavior. How do we prevent individuals from shirking their duties to the group? Suppose Bill owes the government $10,000 in taxes, but he discovers a way to cheat on his taxes so that he only has to pay $8,000. Bill thinks to himself, "The government gets billions of dollars a year in taxes. So to the government another $2,000 is just a drop in the bucket. But to me, $2,000 is a lot of money." What restrains Bill from

acting selfishly is the knowledge that if he is caught, he will be punished. In order for the social contract to function, society must provide not only a system of laws, but a system of enforcing the laws as well.

According to Rousseau, living in a civil society gives a person's actions a moral quality they would not have if that person lived in a state of nature. "It is only then, when the voice of duty has taken the place of physical impulse, and right that of desire, that man, who has hitherto thought only of himself, finds himself compelled to act on other principles, and to consult his reason rather than study his inclinations" [21].

James Rachels summarizes these ideas in an elegant definition of social contract theory:

Social Contract Theory

"Morality consists in the set of rules, governing how people are to treat one another, that rational people will agree to accept, for their mutual benefit, on the condition that others follow those rules as well" [5].

Both social contract theory and Kantianism are based on the idea that there are universal moral rules that can be derived through a rational process. However, there is a subtle, but important difference in how we decide what makes a moral rule ethical. Kantianism has the notion that it is right for me to act according to a moral rule if the rule can be universalized. Social contract theory holds that it is right for me to act according to a moral rule if rational people would collectively accept it as binding because of its benefits to the community.

Hobbes, Locke, and many other philosophers of the seventeenth and eighteenth centuries held that all morally significant beings have certain rights, such as the right to life, liberty, and property. Some modern philosophers would add other rights to this list, such as the right to privacy.

There is a close correspondence between rights and duties. If you have the right to life, then others have the duty or obligation not to kill you. If you have a right to free health care when you are ill, then others have the duty to make sure you receive it. Rights can be classified according to the duties they put on others. A **negative right** is a right that another can guarantee by leaving you alone to exercise your right. For example, the right of free expression is a negative right. In order for you to have that right, all others have to do is not interfere with you when you express yourself. A **positive right** is a right that obligates others to do something on your behalf. The right to a free education is a positive right. In order for you to have that right, the rest of society must allocate resources so that you may attend school.

Another way to view rights is to consider whether they are absolute or limited. An **absolute right** is a right that is guaranteed without exception. Negative rights are usually considered absolute rights. For example, there is no situation in which it would be reasonable for another person to interfere with your right to life. A **limited right** is

a right that may be restricted based on the circumstances. Typically, positive rights are considered to be limited rights. For example, American states guarantee their citizens the right to an education. However, because states do not have unlimited budgets, they typically provide a free education for everyone up through the 12th grade but require people to pay for at least some of the costs of their higher education.

Proponents of social contract theory evaluate moral problems from the point of view of moral rights. Kant argued that rights follow from duties. Hence Kantians evaluate moral problems from duties or obligations.

2.8.2 Rawls's Theory of Justice

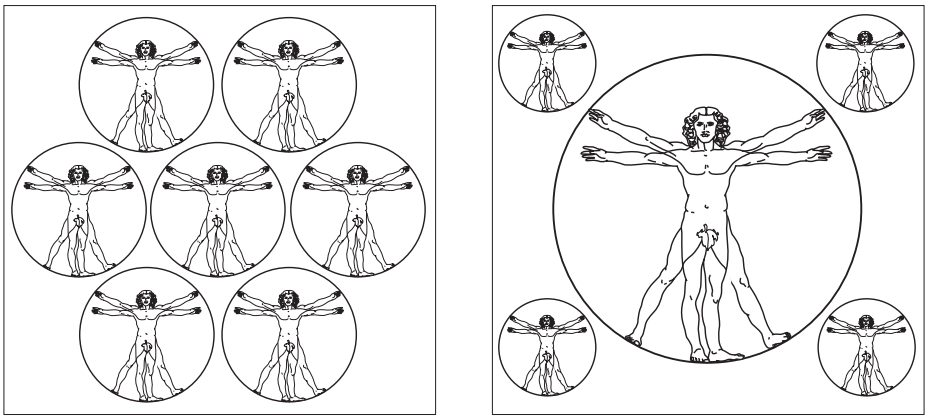
One of the criticisms of utilitarianism is that the utilitarian calculus is solely interested in the total amount of happiness produced. From a purely utilitarian standpoint, an unequal distribution of a certain amount of utility is better than an equal distribution of a lesser amount of utility.

Social contract theory recognizes the harm that a concentration of wealth and power can cause. According to Rousseau, "the social state is advantageous to men only when all possess something and none has too much" [21]. John Rawls (1921–2002), who did much to revive interest in social contract theory in the twentieth century, proposed two principles of justice that extend the definition of the social contract to include a principle dealing with unequal distributions of wealth and power.

John Rawls's Principles of Justice

1. Each person may claim a "fully adequate" number of basic rights and liberties, such as freedom of thought and speech, freedom of association, the right to be safe from harm, and the right to own property, so long as these claims are consistent with everyone else having a claim to the same rights and liberties.
2. Any social and economic inequalities must satisfy two conditions: first, they are associated with positions in society that everyone has a fair and equal opportunity to assume; and second, they are "to be to the greatest benefit of the least-advantaged members of society (the **difference principle**)" [22].

Rawls's first principle of justice, illustrated in Figure 2.7, is quite close to our original definition of social contract theory, except that it is stated from the point of view of rights and liberties rather than moral rules. The second principle of justice, however, focuses on the question of social and economic inequalities. It is hard to imagine a society in which every person has equal standing. For example, it is unrealistic to expect every person to be involved in every civic decision. Instead, we elect representatives who vote in our place and officials who act on our behalf. Likewise, it is hard to imagine everybody in a society having equal wealth. If we allow people to hold private property, we should



Just Unjust

FIGURE 2.7 Rawls's first principle of justice states that each person may have a "fully adequate" number of rights and liberties as long as they are consistent with everyone else having the same rights and liberties.

expect that some people will acquire more than others. According to Rawls, social and economic inequalities are acceptable if they meet two conditions.

First, every person in the society should have an equal chance to assume a position of higher social or economic standing. That means that two people born with equal intelligence, equal talents, and equal motivation to use them wisely should have the same probability of reaching an advantaged position, regardless of the social or economic class to which they were born. For example, the fact that someone's last name is Bush or Kennedy should not give that person a greater probability of being elected President of the United States than any other American born with equal intelligence, talent, and determination.

The second condition, called the difference principle, states that social and economic inequalities must be justified. The only way to justify a social or economic inequality is to show that its overall effect is to provide the most benefit to the least advantaged. The purpose of this principle, illustrated in Figure 2.8, is to help maintain a society composed of free *and equal* citizens. An example of the difference principle in action is a graduated income tax system in which people with higher incomes pay a higher percentage of their income in taxes. An example of a violation of the difference principle would be a military draft system in which poor people had a higher probability of being drafted than wealthy people.

2.8.3 Evaluating a Scenario Using Social Contract Theory

~ SCENARIO

Bill, the owner of a chain of DVD rental stores in a major metropolitan area, uses a computer to keep track of the DVDs rented by each customer. Using this

Figure 2.8 Rawls's difference principle states that social and economic inequalities must be arranged so that they are of the greatest benefit to the least advantaged members of society.

information, he is able to construct profiles of the customers. For example, a customer that rents a large number of Disney titles is likely to have children. Bill sells these profiles to mail order companies. The customers begin receiving many unsolicited mail order catalogs. Some of the customers are happy to receive these catalogs and make use of them to order products. Others are unhappy at the increase in the amount of "junk mail" they are receiving.

Analysis

To analyze this scenario using social contract theory, we think about the rights of the rational agents involved. In this case, the rational agents are Bill, his customers, and the mail order companies. The morality of Bill's actions revolve around the question of whether he violated the privacy rights of his customers. If someone rents a DVD from one of Bill's stores, both the customer and Bill have information about the transaction. Are their rights to this information equal? If both the customer and Bill have equal rights to this information, then you may conclude there is nothing wrong with him selling this information to a mail order company. On the other hand, if customers have the right to expect transactions to be confidential, you may conclude that Bill was wrong to sell this information without gaining the permission of the customer. ~

2.8.4 The Case for Social Contract Theory

1. *It is framed in the language of rights.*

   The cultures of many modern countries, particularly Western-style democracies, promote individualism. For people raised in these cultures, the concept of individual rights is powerful and attractive.

2. *It explains why rational people act out of self-interest in the absence of a common agreement.*

   Suppose we are living in a city experiencing a gasoline shortage. If every car owner uses public transportation two days a week, there will be enough gasoline to go around. I need to decide if I will take the bus two days a week.

   Suppose no other car owners ride the bus two days a week. If I decide to ride the bus, I will have to put up with the inconvenience and the city will still run out of gas. Alternatively, I can do what everybody else is doing and continue driving my car until the gasoline supply is exhausted. Since the city will run out of gas either way, I experience less inconvenience by continuing to drive my car every day.

   On the other hand, suppose all the other car owners decide to ride the bus two days a week. If I decide to ride the bus, I will have plenty of company, which is good, but I will still have to adjust my work schedule to fit the bus schedule, waste time waiting at the bus stop, and so on. Alternatively, I can continue to drive my car. That will be more convenient for me. The amount of gasoline my car consumes is insignificant compared to the needs of the city, and the city will not run out of gasoline. Since the city will not run out of gas either way, I experience less inconvenience by continuing to drive my car every day.

   To summarize, if no one else rides the bus, it's better for me if I drive my car. If everyone else rides the bus, it's better for me if I drive my car. I have used logic to conclude that I should continue to drive my car. *Unfortunately, everyone else in the town logically reaches the same conclusion!* As a result, the city runs out of gasoline.

   The reason we all decided to act selfishly was because we did not have a common agreement. If all of us agreed that everyone should ride the bus two days a week, and those who did not would be punished, then logic would have led people to choose to use public transportation.

   Social contract theory is based on the idea that morality is the result of an implicit agreement among rational beings who understand that there is a tension between self-interest and the common good. The common good is best realized when everyone cooperates. Cooperation occurs when those acting selfishly suffer negative consequences.

3. *It provides a clear ethical analysis of some important moral issues regarding the relationship between people and government.*

   For example, social contract theory provides a logical explanation of why it is morally acceptable to punish someone for a crime. You might ask, "If everyone has a right to liberty, how can we put in prison someone who has committed a crime?" The social contract is based on the notion that everyone benefits when ev-

eryone bears the burden of following certain rules. Knowledge that those who do not follow the rules will be punished restrains individuals from selfishly flouting their obligations. People will have this knowledge only if society punishes those who commit crimes.

Another example is the problem of civil disobedience. While civil disobedience is difficult to justify under Kantianism and utilitarianism, social contract theory provides a straightforward explanation of why civil disobedience can be the morally right decision.

Consider the lunch counter sit-ins of the 1960s. On February 1, 1960, four African-American students from North Carolina A&T walked into the Woolworth's store on South Elm Street in Greensboro, sat down at a whites-only lunch counter, and asked for service. When they were denied service, they refused to leave. Two days later, 85 students participated in the "sit-in" at Woolworth's. All of these students were breaking segregation laws, but according to social contract theory their actions could be considered morally justified. As we have said, the social contract is based on the idea that everyone receives certain benefits in return for bearing certain burdens. The segregation laws were designed to give people of color greater burdens and fewer benefits than white people. Hence they were unjust.

2.8.5 The Case against Social Contract Theory

1. *None of us signed the social contract.*

   The social contract is not a real contract. Since none of us have actually agreed to the obligations of the citizens of our society, why should we be bound to them?

   Defenders of social contract theory point out that the social contract is a theoretical notion that is supposed to explain the rational process through which communities adopt moral guidelines. As John Rawls puts it, social contract agreements are *hypothetical* and *nonhistorical*. They are hypothetical in the sense that they are what reasonable people "could, or would, agree to, not what they have agreed to" [22]. They are nonhistorical because they "do not suppose the agreement has ever, or indeed ever could actually be entered into" [22]. Furthermore, even if it could be entered into, that would make no difference. The reason it would make no difference is because the moral guidelines are supposed to be the result of analysis (facts and values plus logical reasoning), not history. Social contract theory is *not* cultural relativism in disguise.

2. *Some actions can be characterized multiple ways.*

   This is a problem social contract theory shares with Kantianism. Some situations are complicated and can be described in more than one way. Our characterization of a situation can affect the rules or rights we determine to be relevant to our analysis.

3. *Social contract theory does not explain how to solve a moral problem when the analysis reveals conflicting rights.*

   This is another problem social contract theory shares with Kantianism. Consider the knotty moral problem of abortion, in which the mother's right to privacy is

pitted against the fetus's right to life. As long as each of these rights is embraced by one side in the controversy, the issue cannot be resolved. What typically happens in debates is that advocates on one side of the issue "solve" the problem by discounting or denying the right invoked by their adversaries.

4. *Social contract theory may be unjust to those people who are incapable of upholding their side of the contract.*

   Social contract theory provides every person with certain rights in return for that person bearing certain burdens. When a person does not follow the moral rules, he or she is punished. What about human beings who, through no fault of their own, are unable to follow the moral rules?

   A response to this objection is that there is a difference between someone who deliberately chooses to break a moral rule and someone who is incapable of understanding a rule. Society must distinguish between these two groups of people. People who deliberately break moral rules should be punished, but people who cannot understand a rule must be cared for.

   However, this response overlooks the fact that distinguishing between these two groups of people can be difficult. For example, how should we treat drug addicts who steal to feed their addiction? Some countries treat them as criminals and put them in a prison. Other countries treat them as mentally ill people and put them in a hospital.

These criticisms demonstrate some of the weaknesses of social contract theory. Nevertheless, social contract theory is logical and analytical. It allows people to explain why a particular action is moral or immoral. According to our criteria, it is a workable ethical theory, joining Kantianism, act utilitarianism, and rule utilitarianism.

2.9 Comparing Workable Ethical Theories

The divine command theory, Kantianism, act utilitarianism, rule utilitarianism, and social contract theory share the viewpoint that moral good and moral precepts are objective. In other words, morality has an existence outside the human mind. For this reason we say these theories are examples of **objectivism.**

What distinguishes Kantianism, utilitarianism, and social contract theory from the divine command theory is the assumption that ethical decision-making is a rational process by which people can discover objective moral principles with the use of logical reasoning based on facts and commonly held values. While each of these four theories has weaknesses, all of them are workable in the sense that they pass this test.

We can make several important distinctions among the four workable theories.

1. *Faced with a moral problem, what is the motivation for taking a particular action?*

   Do we think about rights, responsibilities, and duties, or do we consider the consequences of the action? Kantianism and social contract theory are clearly oriented toward the notion that people should "do the right thing." Kantianism starts more

Theory	*Motivation*	*Criteria*	*Focus*
Kantianism	Dutifulness	Rules	Individual
Act Utilitarianism	Consequence	Actions	Group
Rule Utilitarianism	Consequence/Duty	Rules	Group
Social Contract	Rights	Rules	Individual

Table 2.1 Comparison of four workable ethical theories. All of these theories are based on objectivism and reasoning from facts or commonly held values.

from the viewpoint of duty, while social contract theory begins by considering the rights of the persons involved. Utilitarian theories are oriented toward the consequences of actions, the notion that people should "do good." Note, however, once a complete analysis has been done, rule utilitarians adopt rules that people are obliged to follow without exception. Hence rule utilitarianism ends up with a mixed motivation.

2. *What criteria are used to determine if an action is ethical or unethical?*

   Kantianism, rule utilitarianism, and social contract theory use universal moral rules as their metric. An act utilitarian computes the total change in utility to determine if an action is right or wrong.

3. *Is the focus on the individual or the group?*

   Kantianism and social contract theory focus on the individual decision-maker. In contrast, act and rule utilitarianism must consider all affected parties when evaluating the consequences of an action.

Table 2.1 provides a summary of these differences among Kantianism, act utilitarianism, rule utilitarianism, and social contract theory.

2.10 Morality of Breaking the Law

What is moral and what is legal are not identical. Certain actions may be wrong, even if there are no laws forbidding these actions. Is it possible that an illegal action may be the right action?

Let's analyze this question from the point of view of our four workable ethical theories. To ground our analysis, we will consider a particular illegal action: violating a licensing agreement by copying a CD containing copyrighted music and giving it to a friend.

2.10.1 Social Contract Theory Perspective

Social contract theory is based on the assumption that everyone in society ought to bear certain burdens in order to receive certain benefits. The legal system is instituted to guarantee that people's rights are protected. It guarantees people will not choose their

FIGURE 2.9 According to social contract theory, we have a *prima facie* obligation to obey the law. (Beth Anderson)

selfish interests over the common good. For this reason we have a *prima facie* obligation to obey the law (Figure 2.9). That means, everything else being equal, we should be law-abiding. In return, our own legal rights will be respected. Our obligation to obey the law should only be broken if we are compelled to follow a higher-order obligation.

From the point of view of social contract theory, then, it is wrong to give a friend a copy of a CD containing copyrighted music, because that action violates the legal rights of the person or organization owning the copyright.

2.10.2 Kantian Perspective

According to the Categorical Imperative, we should act only from moral rules that we can at the same time will to be universal moral laws. Suppose I think the current copyright laws are unjust because they unfairly favor the producers of intellectual property rather than the consumers. I could propose the following rule: "I may ignore a law that I believe to be unjust."

What happens when we universalize this rule? If everyone acted according to this rule—ignoring laws they felt to be unjust—then the authority of Congress to legislate laws would be fatally undermined. Yet the goal of Congress is to create laws that ensure we live in a just society. Hence there is a logical contradiction, because I cannot both will

there be justice (by ignoring what I consider to be an unjust law) and will there be no justice (by denying Congress the authority it needs to create a just society).

Another line of Kantian reasoning leads us to the same conclusion. If I copy a CD containing copyrighted material, I am violating the legal rights of the person who owns the copyright. No matter how good my intended use of the CD, I am using the copyright owner if I make a copy without their permission. This violates the second formulation of the Categorical Imperative. Hence it is wrong to copy the CD.

2.10.3 Rule Utilitarian Perspective

What would be the consequences of people ignoring laws they felt to be unjust? A beneficial consequence is the happiness of the people who are doing what they please rather than obeying the law. There are, however, far more harmful consequences. First, the people directly affected by lawless actions will be harmed. Second, people in general would have less respect for the law. Third, assuming increased lawlessness puts an additional burden on the criminal justice system, society as a whole would have to pay for having additional police officers, prosecutors, judges, and prisons. Hence, from a rule utilitarian viewpoint, breaking the law is wrong.

2.10.4 Act Utilitarian Perspective

We will do an act utilitarian analysis to show there can be situations where the benefits of breaking a law are greater than the harms. Suppose I purchase a music CD. I play it, and I think it is great. A friend of mine is in a terrible automobile accident. While he recovers, he will need to stay quiet for a month. I know he has no money to spend on music. In fact, people are doing fundraisers simply to help his family pay the medical bills. I don't have money to contribute to a fundraiser, but I think of another way I could help him out. I give my friend a copy of the CD. He is grateful for having a diversion during his time of bed rest.

What are the consequences of my action? As far as I can tell, there is no lost sale, because even if I had not given my friend a copy of the CD, he would not have bought it. In fact, giving a copy of the CD to my friend may actually increase the sales of the CD if my friend likes it and recommends it to other people who do have money to spend on CDs. I am not likely to be prosecuted for what I did. Therefore, there will be no impact on the legal system. No extra police detectives, prosecutors, or judges will need to be hired as a result of my action. The principal harm I have done is to have violated the legal rights of the owner of the copyright. The benefits are that my friend is thrilled to have something to do during his recovery and I am happy to have been able to do something to help him out during his time of need. Overall, the benefits appear to outweigh the harms.

2.10.5 Conclusion

There is nothing intrinsically immoral about copying a CD. However, our society has chosen to enact laws that grant intellectual property rights to people who do creative work and distribute it on CDs. From the viewpoint of Kantianism, rule utilitarianism,

and social contract theory, breaking the law is wrong unless there is a strong overriding moral obligation. Copying a disc to save a few dollars or help a friend does not fall into that category. Copying a CD containing copyrighted music is immoral *because* it is illegal.

From an act utilitarian viewpoint, it is not hard to devise particular instances where making a copy of a copyrighted CD is the right action. Put another way, a blanket prohibition against copying cannot be morally justified from an act utilitarian point of view.

Summary

We live together in communities for our mutual benefit. Every society has guidelines indicating what people are supposed to do in various circumstances. We call these guidelines morality. Ethics, also called moral philosophy, is a rational examination into people's moral beliefs and behaviors. In this chapter we have considered a variety of ethical theories with the purpose of identifying those that will be of most use to us as we consider the effects of information technology on society.

Relativistic theories are based on the idea that people *invent* morality. A relativist claims there are no universal moral principles. Subjective relativism is the theory that morality is an individual creation. Cultural relativism is the idea that each society determines its own morality. If morality is invented, and no set of moral guidelines is any better than another, then there are no objective criteria that can be used to determine if one set of guidelines is better than another. Under these circumstances, the study of ethics is extremely difficult, if not impossible. For this reason we shall not make use of relativistic theories.

In contrast, objectivism is based on the idea that morality has an existence outside the human mind. It is the responsibility of people to *discover* morality. An objectivist claims there are certain universal moral principles that are true for all people, regardless of their historical or cultural situation.

The first objectivist theory we considered was the divine command theory. The divine command theory is based on the idea that God has provided us with moral guidelines designed to promote our well-being. These guidelines are to be followed because they reflect the will of God, not because we understand them. Because this theory does not rationally derive moral guidelines from facts and commonly held values, we reject it as a useful ethical theory.

The second objectivist theory we considered was Kantianism, named after Immanuel Kant. Kantianism is focused on dutifulness. If we are dutiful, we will feel compelled to act in certain ways out of respect for moral rules. A moral rule is appropriate if it is consistent with the Categorical Imperative. Kant provides two formulations of the Categorical Imperative. The first is: "Act only from moral rules that you can at the same time will to be universal laws." The second is: "Act so that you always treat both yourself

and other people as ends in themselves, and never solely as a means to an end." While both Kantianism and the divine command theory hold that actions should be motivated by the desire to obey universal moral rules, Kantianism holds that rational beings can discover these rules without relying upon divine inspiration. Kantianism is considered a non-consequentialist theory because the morality of an action is determined by evaluating the moral rule upon which the will to act is grounded rather than the action's consequences.

Utilitarianism, developed by Jeremy Bentham and John Stuart Mill, is based upon the Principle of Utility, also called the Greatest Happiness Principle. According to this principle, an action is right (or wrong) to the extent that it increases (or decreases) the total happiness of the affected parties. Utilitarianism is called a consequentialist theory, because its focus is on the consequences of an action. Act utilitarianism is the theory that an action is good if its net effect (over all affected beings) is to produce more happiness than unhappiness. An action is bad if its net effect is to produce more unhappiness than happiness. Rule utilitarianism is the ethical theory that holds we ought to adopt those moral rules which, if followed by everyone, will lead to the greatest increase in total happiness. In other words, rule utilitarianism applies the Principle of Utility to moral rules, while act utilitarianism applies the Principle of Utility to individual moral actions. Both of these theories hold that rational beings can perform the analysis needed to determine if a moral action or moral rule is good or evil.

The final ethical theory we considered was social contract theory, identified with Thomas Hobbes, Jean-Jacques Rousseau, and John Rawls. Social contract theory holds that "morality consists in the set of rules, governing how people are to treat one another, that rational people will agree to accept, for their mutual benefit, on the condition that others follow those rules as well" [5]. Rawls proposed two principles of justice that are designed to maintain society over time as an association of free and equal citizens. Like Kantianism and both forms of utilitarianism, social contract theory is based on the premise that there are universal, objective moral rules that can be discovered through rational analysis.

Our survey identified four practical ethical theories: Kantianism, act utilitarianism, rule utilitarianism, and social contract theory. We used these theories to analyze the question, "Is it morally acceptable to break the law?" According to social contract theory, Kantianism, and rule utilitarianism, the answer to this question is "No." It is wrong to break the law unless there is an overriding moral concern. From an act utilitarian perspective, however, it is possible to devise a situation in which the benefits of breaking the law outweigh the harms.

Our discussion of the strengths and weaknesses of Kantianism, act utilitarianism, rule utilitarianism, and social contract theory revealed that none of these theories is perfect. Considering any one of the theories, we will find some moral problems that it is able to solve easily. We will find other moral problems that it is unable to solve. While it is disappointing that no one ethical theory is clearly superior to the others, these four theories together have a lot of power.

FIGURE 2.10 Terry Winograd likens "doing ethics" to being a member of a juggling troupe.

Consider the analogy between ethical theories and tools in a toolbox. A toolbox that contains only a hammer is not very useful, but a well-equipped toolbox enables a handy person to fix a wide range of household problems. In the chapters that follow, we'll use our "toolbox" of Kantianism, act utilitarianism, rule utilitarianism, and social contract theory to propose solutions to many problems arising from the introduction of information technology into society.

Finally, it's important to remember that "doing the right thing" does not refer simply to those situations where we have plenty of time to sit and ponder our choices. Terry Winograd has likened "doing ethics" to being part of a troupe of jugglers (Figure 2.10) [23]. The metaphor conveys the idea that everyday life is filled with situations in which we have to make sound decisions quickly. It also emphasizes our interconnectedness with other people. Jugglers cannot be self-absorbed, thinking only about their own actions. Instead, they must think about how their tosses affect the other members of the troupe and what they are trying to accomplish. The adaptability of jugglers to unexpected situations is a good metaphor for how new information technologies can raise interesting new moral dilemmas.

In the chapters that follow, we'll use Kantianism, act utilitarianism, rule utilitarianism, and social contract theory to propose solutions to many problems arising from the introduction of information technology into society. You'll also have the opportunity to examine a wide variety of additional situations in the exercises ending these chapters. The goal is to help you improve your ability to recognize moral issues in everyday life and make appropriate choices.

Review Questions

1. Define in your own words what "the ethical point of view" means.
2. Define morality and ethics in your own words.
3. What is the difference between morality and ethics?
4. What is the difference between relativism and objectivism?
5. What are the advantages of using an ethical theory in which all humans are treated equally and guidelines are developed through a process of logical reasoning?
6. Two people are debating the morality of a particular action. Person A explains why he believes the action is wrong. Person B disagrees with Person A. Her response to him is, "That's your opinion." Person B has not made a strong ethical argument. Why not?
7. What do we mean when we say an ethical theory is rational?
8. What is the many/any fallacy? Invent your own example of this fallacy.
9. What is the equivalence fallacy? Invent your own example of this fallacy.
10. Come up with your own example of a moral rule that would violate the Categorical Imperative.
11. What is plagiarism? Describe four different ways that a person can commit plagiarism. (See Appendix A.)
12. What is the difference between plagiarism and misuse of sources?
13. What is the difference between a consequentialist theory and a non-consequentialist theory?
14. Give three examples of a situation in which your action would be primarily motivated by a sense of duty or obligation. Give three examples of a situation in which your action would be primarily motivated by its expected consequences.
15. What is the problem of moral luck?
16. Why do businesses and governments often use utilitarian thinking to determine the proper course of action?
17. What is the difference principle?
18. Is social contract theory as first presented a consequentialist theory or a non-consequentialist theory? Is social contract theory as articulated in Rawls's two principles of justice a consequentialist theory or a non-consequentialist theory?
19. Describe similarities and differences between divine command theory and Kantianism.
20. Describe similarities and differences between subjective relativism and act utilitarianism.
21. Describe similarities and differences between Kantianism and rule utilitarianism.
22. Describe similarities and differences between act utilitarianism and rule utilitarianism.
23. Describe similarities and differences between cultural relativism and social contract theory.
24. Describe similarities and differences between Kantianism and social contract theory.

25. Evaluate the four scenarios presented in Section 2.1 from a Kantian perspective.

26. Evaluate the four scenarios presented in Section 2.1 from an act utilitarian perspective.

27. Evaluate the four scenarios presented in Section 2.1 from a rule utilitarian perspective.

28. Evaluate the four scenarios presented in Section 2.1 from the perspective of social contract theory.

29. A college student attached a webcam to his laptop computer and left the computer running in his dormitory room in order to broadcast video images of his roommate and his roommate's girlfriend engaged in sexual intercourse. They were unaware of his actions. The student's Web site accumulated thousands of hits for the two weeks it was up. Copies of some images were posted on at least one other Web site [24]. Using each of the four workable ethical theories presented in this chapter, evaluate the actions of the college student.

Discussion Questions

30. If everyone agreed to take the ethical point of view by respecting others and their core values, would there be any need for a rigorous study of ethics?

31. If you had to choose only one of the ethical theories presented in this chapter and use it for all of your personal ethical decision-making, which theory would you choose? Why? How would you respond to the arguments raised against the theory you have chosen?

32. Most ethical theories agree on a large number of moral guidelines. For example, it is nearly universally held that it is wrong to steal. What difference, then, does it make whether someone subscribes to the divine command theory, Kantianism, utilitarianism, or one of the other ethical theories? (Hint: Think about which theories are more persuasive when they lead to different conclusions about the right thing to do.)

33. Suppose a spaceship lands in your neighborhood. Friendly aliens emerge and invite humans to enter the galactic community. You learn that this race of aliens has colonized virtually the entire galaxy; Earth is one of the few inhabitable planets to host a different intelligent species. The aliens seem to be remarkably open-minded. They ask you to outline the ethical theory that should guide the interactions between our two species. Which ethical theory would you describe? Why?

34. According to the Golden Rule, you should do unto others as you would want them to do unto you. Is the Categorical Imperative simply the Golden Rule in disguise?

35. Are there any ethical theories described in this chapter that would allow someone to use the argument "Everybody is doing it" to show that an activity is not wrong?

36. How well does Moor's theory of "just consequentialism" (described in the interview at the end of this chapter) solve the problems associated with Kantianism and rule utilitarianism?

37. What are some examples of contemporary information technology issues for which our society's moral guidelines seem to be nonexistent or unclear? (Hint: Think about issues that are generating a lot of media coverage or lawsuits.)

38. People give a variety of reasons for copying a music CD from a friend instead of buying it [25]. Refute each of the reasons given below using one of the viable theories described in this chapter. (You don't have to use the same theory each time.)

a. I don't have enough money to buy it.
b. The retail price is too high. The company is gouging customers.
c. Since I wouldn't have bought it anyway, the company didn't lose a sale.
d. I'm giving my friend the opportunity to do a good deed.
e. Everyone else is doing it. Why should I be the only person to buy it when everyone else is getting it for free?
f. This is a drop in the bucket compared to Chinese pirates who sell billions of dollars worth of copied music.
g. This is insignificant compared to the billions of dollars worth of music being exchanged over the Internet.

39. Suppose a society holds that it is wrong for one individual to eavesdrop on the telephone conversations of another citizen. Should that society also prohibit the government from listening in on its citizens' telephone conversations?

40. Should moral guidelines for individuals apply to nation-states as well? Are the interactions of nation-states analogous to the interactions of individuals? Should there be a different kind of morality to guide the actions of nation-states, or are the actions of nation-states with each other outside the moral realm?

41. Are the citizens of a representative democracy morally responsible for the actions of their government?

In–Class Exercises

42. Students in a history class are asked to take a quiz posted on the course Web site. The instructor has explained the following rules to the students: First, they are supposed to do their own work. Second, they are free to consult their lecture notes and the textbook while taking the quiz. Third, in order to get credit for the quiz, they must correctly answer at least 80 percent of the questions. If they do not get a score of 80 percent, they may retake the quiz as many times as they wish.

Mary and John are both taking the quiz. They are sitting next to each other in the computer room. John asks Mary for help in answering one of the questions. He says, "What's the difference if you tell me the answer, I look it up in the book, or I find out from the computer that my answer is wrong and retake the quiz? In any case, I'll end up getting credit for the right answer." Mary tells John the correct answer to the question.

Discuss the morality of Mary's decision.

43. In Plato's dialogue *The Republic*, Glaucon argues that people do not voluntarily do what is right [26]. According to Glaucon, anyone who has the means to do something unjust and get away with it will do so. Glaucon illustrates his point by telling the story of Gyges.

Gyges, a shepherd, discovers a magic ring. He accidentally discovers that wearing this ring renders him invisible. He uses the power of the ring to seduce the queen, kill the king, and take over the kingdom.

Glaucon believes that whenever people have the opportunity to act unjustly without any fear of getting caught or anyone thinking the worse of them, they do so. If they do not act to their own advantage when given the opportunity, others will think they are fools. Do you agree with Glaucon?

44. Is the right to life a negative right or a positive right? In other words, when we say someone has the right to life, are we simply saying we have an obligation not to harm that person, or are we saying we have an obligation to provide that person what he or she needs in order to live, such as food and shelter?

45. Which of the following rights should be considered legitimate positive rights by our society?

a. The right to a K–12 education
b. The right to a higher education
c. The right to housing
d. The right to health care
e. The right of a Presidential candidate to receive time on television

Further Reading

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AN INTERVIEW WITH

James Moor

James Moor is a professor of philosophy at Dartmouth College. He is currently President of the International Society for Ethics and Information Technology, as well as Editor–in–Chief of the philosophical journal *Minds and Machines.*

Professor Moor has written extensively on computer ethics, the philosophy of artificial intelligence, the philosophy of mind, the philosophy of science, and logic. His publications include "Why we Need Better Ethics for Emerging Technologies," *Ethics and Information Technology,* Vol. 7, No. 3 (2005) pp. 111–119. He and Terrell Bynum co–edited *The Digital Phoenix: How Computers Are Changing Philosophy* (Oxford: Basil Blackwell Publishers, 1998 and revised edition 2000) and *Cyberphilosophy: The Intersection of Computing and Philosophy* (Oxford: Basic Blackwell Publishers, 2002).

In 2003 Dr. Moor received the Making a Difference Award from the Association for Computing Machinery's Special Interest Group on Computers and Society. He holds a Ph.D. from Indiana University.

What stimulated your interest in studying the philosophy of technology?

My interest developed initially through a fascination with computing. The philosophy of computing is a combination of logic, epistemology, metaphysics, and value theory—the complete philosophical package wrapped up in a very practical and influential technological form. Who wouldn't be interested in that? Many standard philosophical issues are brought to life in a computer setting. Consider a simple example: In the *Republic* Plato tells a story about the Ring of Gyges, in which a shepherd finds a ring that, when he wears it and turns it, makes him invisible. Being a clever but rather unethical shepherd, he uses the power of the ring to take over the kingdom, including killing the king and marrying the queen. Through this story Plato raises a deep and important philosophical question: Why be just if one can get away with being unjust? Today the Internet offers each of us our own ring of Gyges. Agents on the Internet can be largely invisible. The question for us, echoing Plato, is why be just while using the Internet if one can get away with being unjust?

What distinguishes ethical problems in computing from ethical problems in other fields?

Some have argued that the ethical problems in the field are unique. This is difficult to show, because the problems involving computing usually connect with our ordinary ethical problems in some way. Nevertheless, what makes the field of computer ethics special and important, though probably not unique, is the technology itself–the computer. Computers are logically malleable machines in that they can be shaped to do any task that one can design, train, or evolve them to do. Computers are universal tools, and this explains why they are so commonplace and culturally transforming. Because they are used in so many ways, new situations continually arise for which we do not have clear policies to guide actions. The use of computing creates policy vacuums. For instance, when wireless technology first appeared, there were questions about whether one should be allowed to access someone else's wireless system, e.g., when driving down the street. Should such access be considered trespassing? Ethical rights and duties of novel situations are not always clear. Because computers are universal tools and can be applied in so many diverse ways, they tend to create many more policy vacuums than

other technologies. This is one respect in which the ethical problems in computing are different from other fields at least in degree if not in kind. This makes computer ethics an extraordinarily important discipline for all of us.

How has information technology affected the field of ethics in the past two decades?

Twenty years ago I had to search newspapers and magazines to find stories on computer/information ethics. Such stories were uncommon. Now many such stories appear daily. They are so common that the fact that computing is involved is unremarkable. Stories about body parts being sold on eBay or identity theft over the Internet or spam legislation all presuppose computing, but computing has so permeated our culture that it is not something uncommon, but something almost everybody uses. In a sense, much of ethics has become computer ethics!

Why do you believe it is helpful to view computer ethics issues in terms of policies?

When we act ethically, we are acting such that anyone in a similar situation would be allowed to do the same kind of action. I am not allowed to have my own set of ethical policies that allow me to do things that others in a relevantly similar situation cannot do. Ethical policies are public policies. An act utilitarian, by contrast, would consider each situation individually. On this view, cheating would not only be justified but required if the individual doing the cheating benefited and others were not harmed because they did not know about it. This seems to me to be a paradigm of unethical behavior, and hence I advocate a public policy approach. If cheating is allowed for some, then everyone should be allowed to cheat in similar situations.

Rather than using "policies" I could use "rules." But ethical rules are sometimes regarded as binding without exceptions. A system of exceptionless rules will never work as an ethical theory, for rules can conflict and sometimes exceptions must be made because of extraordinary consequences. One might be justified in lying to save a life, for example. I prefer using the word "policy" because I want to suggest modification may be necessary in cases of conflict or in extraordinary circumstance. Notice that the policies involving exceptions must themselves be treated as public policy. If it is justifiable for someone to lie to save a life, it will be justified for others to lie to save a life in similar circumstances.

Please explain the process of resolving an ethical issue using your theory of "just consequentialism."

The view is somewhat like rule utiliatrianism and somewhat like Kantian ethics, but differs crucially from both of them. Rule utilitarians wish to maximize the good, but typically without concern for justice. Just consequentialism does not require maximization of the good, which is in general unknowable, and does not sanction unjust policies simply because they have good consequences. Kant's theory requires us to act only on those maxims that we can will to be a universal law. But Kant's theory does not allow for exceptions. Kant thought one ought never lie. Moreover, the typical Kantian test question of what would happen if everyone did a certain kind of action is not the right question, for this test rules out far too much, e.g., becoming a computer programmer (what if everyone were to become a computer programmer?). For just consequentialism, the test question is what would happen if everyone were *allowed* to do a certain kind of action. We need to consider both the consequences and the justice of our public policies.

In ethics we are concerned about rights and duties, and consequences of actions. Just consequentialism is a mixed system in that it is part deontological and part consequential. Rights and duties can be challenged if they are unfair or cause significant harm, but usually are properly taken as normative

guides. One's rights as a citizen and one's duties as a parent are examples. In evaluating consequences we need to consider values that all people share, because we want to develop a policy that we can impartially publicly advocate. Everyone in similar circumstances should be allowed to follow it. At least some of these universal values to be considered will be happiness, life, ability, security, knowledge, freedom, opportunity, and resources. Notice that these are core goods that any sane human wants regardless of which society the human is in.

In the ethical decision process, step one is to consider a set of policies for acting in the kind of situation under consideration. Step two is to consider the relevant duties, rights, and consequences involved with each policy. Step three is to decide whether the policy can be impartially advocated as a public policy, i.e., anyone should be allowed to act in a similar way in similar circumstances. Many policies may be readily acceptable. Many may be easily rejected. And some may be in dispute, as people may weigh the relevant values differently or disagree about the factual outcomes.

In general, rights and duties will carry prima facie weight in ethical decision making, and in general cannot be overridden lightly. But if the consequences of following certain rights and duties are bad enough, then overriding them may be acceptable as long as this kind of exception can be an acceptable public policy. In controversial cases there will be rational disagreements. Just consequentialism does not require complete agreement on every issue. Note that we have disagreements in ordinary non-ethical decision making as well. But just consequentialism does guide us in determining where and why the disagreements occur so that further discussion and resolution may be possible.

You have also studied the field of artificial intelligence from a philosophical point of view. Do you believe it is possible to create a truly intelligent machine capable of ethical decision making? If so, how far are we from making such a machine a reality?

Nobody has shown that it is impossible, but I think we are very far away from such a possibility. The problem may have less to do with ethics than with epistemology. Computers (expert systems) sometimes possess considerable knowledge about special topics, but they lack common-sense knowledge. Without even the ability to understand simple things that any normal child can grasp, computers will not be able to make considered ethical decisions in any robust sense.

Can an inanimate object have intrinsic moral worth, or is the value of an object strictly determined by its utility to one or more humans?

I take values or moral worth to be a judgment based on standards. The standards that count for us are human. We judge other objects using our standards. This may go beyond utility, however, as we might judge a non-useful object to be aesthetically pleasing. Our human standards might be challenged sometime in the future if robots developed consciousness or if we become cyborgs with a different set of standards. Stay tuned.