CHAPTER

1

CONTEMPORARY COMMUNICATION

Contemporary telecommunications facilities augment human capabilities. In doing so, they have affected the scale and rhythm of our lives and become essential to the modern, global economy, on which we all depend.

1.1 EXTENDING PERSONAL CAPABILITIES

As human beings, we use technical means to augment and extend the natural capabilities of speaking, drawing, writing, and counting to provide a rich diversity of ways of communicating. The result is an impressive array of intercommunication and mass communication facilities. In this section, I describe the development, characteristics, and applications of telephone, facsimile, television, and electronic mail. They are the paramount telecommunications capabilities employed among persons.

1.1.1 COMMUNICATION, TELECOMMUNICATION, AND INFORMATION

In all studies, questions arise as to the meaning of words. Let's begin with some basic terms. What is *communication*? How does it differ from *telecommunication*? In addition, how do they differ from *telecommunications*? What is *information*? In this book, they are used to mean:

- **Communication**: the activity associated with distributing or exchanging information. Derived from the Latin *communicare*, meaning to make common, to share, to impart, or to transmit, communication may be
  - *One way* in the sense of an announcement
  - *Two ways*. The exchange may be *interactive* as in a conversation between persons in which information is transmitted one way at a time, or *simultaneous*, as in an exchange of data between machines in two directions at once.
- **Telecommunication**: the action of communicating at a distance. Derived from the Greek *τηλε*, i.e., *tele*, meaning far-off, and *communication*. In the broadest sense, it includes several ways of communicating (e.g., letters, newspapers, telephone, etc.); however, it is customary to associate it only with electronic communication (e.g., by telephone, data communication [including telegraph], radio, and television).

Communication and telecommunication may be between persons, persons and machines, and between machines. Note that both terms imply the act of distributing or exchanging information, but telecommunication also implies that the activity is undertaken between entities separated by a distance.

In a more general sense, the following terms refer to the ways in which telecommunication is achieved:

- **Intercommunication**: telecommunication in which information flows between two sites
  - when computers and data processors are involved, intercommunication takes place on demand, between units that are authorized to communicate
  - when persons are involved, intercommunication takes place by agreement at a mutually convenient time and is controlled by the participants—as their conversation develops, they control the format and content of the exchange.

So as not to interfere with others, in intercommunication each pair of users requires a separate, exclusive connection. This sets a limit to the number of parties that can be served simultaneously by a particular complement of equipment (a facility or network). Consequently, at times of peak use, some of those who wish to communicate may not be able to do so immediately. Intercommunication services can become congested during periods of peak demand so that some potential users are refused service.

- **Mass communication**: telecommunication in which information flows from a single (transmitting) site to a large number of (receiving) sites simultaneously, without response from the receivers

- among persons, mass communication is associated principally with the delivery of entertainment and information services; the originators control the contents of the messages and the times at which transmissions take place
- among computers and data processors, mass communication may be employed to update a database or data-file that is possessed by many secondary stations.

Mass communication services do not suffer capacity limitations in the sense of a limit on the number of sites that can receive a service. However, the number of originators who can operate simultaneously is limited. For instance, in radio broadcasting, only a certain number of frequency assignments are possible. In cable television, the characteristics of the cable used to distribute the signals set a limit to the number of channels that are available.

In contrast to telecommunication, telecommunications is not an activity but the technology that supports the activity.

- **Telecommunications**: the technology of communication at a distance. An *enabling* technology, it makes it possible for information that is created *anywhere* to be used *everywhere* without delay.

Telecommunications may be used as an adjective to describe hardware and services. Two examples of its use are

- **Telecommunications facility**: the combination of equipment, services, and associated support persons (if any) that implements a specific capability for communicating at a distance
- **Telecommunications network**: an array of facilities that provide custom routing and services for a large number of users so that they may distribute or exchange information simultaneously.

Finally, what is meant by information? It depends on the context; thus

- **Information**: that which is distributed or exchanged by communication
  - when associated with computers and data processors, it may be defined as *organized or processed data*—i.e., the output that results from processing data according to a given algorithm. Data, per se, are not information; information is created by organizing them.
  - when associated with persons, it may be defined as the *substance of messages*—i.e., that which is known about, or may be inferred from, particular facts or circumstances
  - when associated with the exchange of symbols, Claude Shannon (a 20th-century American mathematician) defined it in terms of the probability of the symbol (message) being sent.

The first implies a quantitative result—something that has resulted from processing data. The second implies a qualitative result—the intellectual product of communication. The third is the easiest with which to deal—it is the basis for information theory. We return to it later in Section 3.3.4(1).

1.1.2 TELEPHONES

At some time in prehistory, persons began to make specific noises that were commonly understood to represent feelings, things, actions, and, eventually, ideas. When married to 19th- and 20th-century technologies, speaking over great distances became possible.

In 1876, at the Centennial Exhibition in New York City, Alexander Graham Bell demonstrated the transmission of voice signals over a wire. This feat stimulated persons to purchase telephones for use over private circuits and led to the formation of local telephone companies under Bell licenses. Soon, as they competed with telegraph companies to serve public demand, the major thoroughfares were festooned with strands of wire attached to taller and taller poles. In 1900, there were approximately 1.6 million telephones in service in the United States. By 1913, some 20,000 telephone companies provided connections within local communities. Long-distance messages continued to be carried by telegraph. Today, there are more than 500 million telephones worldwide—and the vast majority of telephone subscribers have ready access to one another.

Between the world wars, the development of vacuum tube amplifiers, and other devices, allowed customers to talk to one another over greater and greater distances until transcontinental conversations were possible. In addition, electromechanical switches replaced an increasing number of manual switchboards, making the dial telephone a household commodity. In the late 1940s and early 1950s, reliable long-distance routes that used microwave radio relay equipment were installed across the United States. In 1956, the first voice cable to span the Atlantic Ocean was placed in service. In the 1960s, computer-controlled switches were introduced, and nationwide direct-distance-dialing (DDD) became a reality.

In 1970, *Viewdata*, an information retrieval system with the generic name *wired-Videotex*, was introduced in Great Britain, and a similar system was deployed in France. They used the telephone for access to a database and a television receiver for display of the data retrieved. In addition, in the 1970s, geostationary satellites were deployed, providing continental and intercontinental voice, video, and data links. In 1977, optical fibers were first used for interexchange connections, and toward the end of the decade, all-digital telephone switches were being installed. At the same time, in Europe, cellular radio systems were sanctioned and mobile telephone systems were deployed rapidly throughout the developed and developing countries of the world. In the United States, competitive cellular services were introduced.

In the 1970s, those who would provide alternative intercity transport facilities challenged the telecommunication establishment of the United States for the opportunity to serve the data needs of businesses. In 1984, after several years of protracted hearings before the Federal Communications Commission, and an antitrust suit brought against AT&T by the Department of Justice, some of the monopoly powers of AT&T were abolished. Under the settlement (called MFJ, Modified Final Judgment)

- The Bell System was divided into:
  - seven autonomous holding companies (Regional Bell Operating Companies, RBOCs)
  - a long-distance carrier with manufacturing capabilities (AT&T and Western Electric).
- A competitive long-distance telecommunications industry was established
  - independent carriers (such as MCI and Sprint) were confirmed as providers of long-distance services
  - the creation of new carriers was encouraged.

In the 1980s, the telephone carriers of the world agreed on standards for digital telephone networks (Integrated Services Digital Networks, ISDNs). In the 1990s, many of them have implemented a level of ISDNs and broadband ISDNs. To facilitate the development of multimedia services, a new sort of digital switching system called asynchronous transfer mode (ATM) has been standardized. In the United States, the carriers implemented intelligent networks (INs). Based on signaling system 7 (SS7, an integral part of ISDN), intelligent networks are market-driven vehicles for the speedy provision of whatever communication services users require (such as call forwarding, call waiting, caller ID, etc.).

In the 1990s

- Digital switches and high-speed optical fiber transmission facilities continue to replace existing analog facilities
- Personal (portable) communications systems (PCSs) are being developed to provide universal voice, video, and data (multimedia) services
- Low- and medium-earth orbiting satellite systems are being deployed to facilitate a new level of worldwide communication
- Undersea, optical fiber cable systems have been laid that encircle the earth with wideband channels
- Congress passed the 1996 Telecommunications Act. Under certain conditions, it provides for competition in all phases of telecommunication.

1.1.3 Facsimile Machines

Long before men and women could write, they created colorful shapes on two-dimensional surfaces to tell stories of everyday life. Married to 20th-century technologies, drawing has given rise to combinations of physical media, bearers, and transducers that transport images.

In the 1860s, telephotograph machines scanned relief photographs line by line to create an electrical signal that is proportional to the picture features. At the receiving station, a V-shaped cutting stylus produced lines of variable widths to create a facsimile of the source picture. Improved through the years, today's facsimile machines produce high-quality images of printed pages, as well as pictures. Digital versions transmit mixed text and graphical information with a resolution of several hundred dots per inch in 10 seconds per page, or less.

1.1.4 Television

Based on experiments conducted in the late 1920s and in the 1930s, black-and-white television was introduced to the public in the late 1930s. It brought visual messages to the home, capturing the attention of every member of the household with the sights of far-off events and with entertainment designed to attract audiences for messages from those paying for the service. In the 1960s, this window was filled with living color, and in the 1970s it was extended in real-time across the oceans, and around the world, by satellites. In addition, in the 1970s, data were added to the television signal to provide an electronic magazine. With the generic name of *broadcast-Videotex*, the service is generally known today as *Teletext*.

Techniques for recording and reproducing television signals became available in the 1970s. Quickly, wideband tape recorders permeated the television industry. With perseverance, they were developed into affordable consumer units that are used to provide alternative programming at the convenience of the viewer. Through the use of videocassette recorders (VCRs), television programs are recorded on videotapes for replaying at a later time, and movies that have been converted to videotape are played instead of current programming. In addition, digital videodiscs (DVDs) are available. They reproduce video sequences stored on metal or plastic disks.

Television is broadcast at frequencies that require the transmitter to have a clear line of sight to the receiver. For this reason, television transmitting antennas are placed on the top of very tall towers, or on very high buildings. However, if the receiving antenna's view of the transmitter's antenna is obstructed by hills, or by steel-frame buildings, the signal will be attenuated and may be lowered below the level required for satisfactory signal reception. In the late 1940s, to overcome this limitation, residents of a hilly section of Pennsylvania constructed an antenna on the top of a hill from which the transmitter's antenna was visible. They dis-

tributed the received signal to their homes by coaxial cable. In this manner, cable television (CATV) was born.

Throughout the 1950s, CATV was regarded as a technique for making network signals available to rural communities. However, in the late 1960s, 1970s, and 1980s, CATV was expanded to carry many more signals, including some produced specifically for cable systems, and was introduced into suburban and urban areas. Today, a majority of the U.S. population has access to cable service; modern single cable systems deliver over 50 channels to the subscriber, and two cable systems deliver over 100 channels. A few installations include a return channel so that customers can respond to the head-end (interactive CATV). Competing with cable, in the mid-1990s, geostationary satellites began to broadcast several hundred digitally encoded channels to micro dishes (approximately 18 inches in diameter) mounted on the subscriber's premises.

The broadcast of high-definition, digital television services began in 1998, and the FCC has directed that this format replace existing low-definition analog services some time in the early 21st century. Terrestrial broadcasters have been allocated additional spectrum space that they may fill with digital signals similar to those employed by satellite service providers. Encouraged by the 1996 Telecommunications Act, cable companies are beginning to provide telephone and high-speed data services to residential subscribers.

In the late-1960s, on a trial basis, some Bell System companies offered videotelephone service in selected locations. Providing a black-and-white, limited resolution, television picture, and telephone-quality voice, the service required special transmission and switching facilities. For many reasons, including lack of public interest, service was withdrawn.

At about the same time, geostationary satellite systems created an interest in videoconferencing. Usually limited to two studios, the service provided participants in separated locations with a standard color television picture of the parties at the remote end. In the early 1970s, several companies with nationwide facilities built private satellite-based teleconferencing systems for internal use. Toward the end of the 1970s, networks of public studios were created so that persons without access to a private studio could still participate in videoconferences. The service met with limited success.

In 1991, AT&T introduced a new version of videotelephone service. Using a telephone that incorporates a small screen on which still color pictures of the remote party are displayed, the service requires a single telephone channel. To give a semblance of motion, the individual frames are replaced every few seconds by a more recent one.

In the 1990s, the availability of powerful digital signal processors and the development and standardization of video coding and compression techniques have led to satisfactory (quasi-full motion) videoconferencing over digital telephone channels. Employing portable equipment, the service can be accessed in the office or at home. In addition, videoconferencing (of limited quality) is now possible over Internet.

1.1.5 Electronic Mail

Most letters are private communications between individuals. On a personal level, they provide status reports between relatives and friends, informing, counseling and seeking help. In business, letters carry information that makes it possible for organizational entities to operate in the larger world of the corporation. Other letters involve exchanges between citizens and government; still others contain commercial messages; and some letters are written for publication.

In the last half of the 20th century, electronic technologies have made it possible to prepare and transport letters using electrical means. Delivered to an electronic mailbox, messages are called up on a video screen at the request of the receiver. Electronic mail is a principal use of Internet and is used in just about every enterprise.

REVIEW QUESTIONS FOR SECTION 1.1

1 Differentiate among communication, telecommunication, and telecommunications.
2 Give three definitions of information.
3 Distinguish between intercommunication and mass communication; discuss the limitations on their capacity.
4 Give a brief history of the telephone and telephone network.
5 What was the effect of the Modified Final Judgement (1984)?
6 List the technological developments of the 1990s.
7 What is the impact of the 1996 Telecommunications Act?
8 What was the origin of the facsimile machine?
9 Describe the origin of television.
10 Describe the origin of cable television. How does its original purpose differ from present applications?
11 Distinguish between videotelephone and videoconferencing.
12 For what purposes is electronic mail used?

1.2 DATA COMMUNICATIONS

Despite the efforts of mathematicians to make numbers continuous, counting is essentially a digital function. Married to 20th-century technologies, it has given rise to the computer and data processor together with a myriad of specialized ter-

minals, and has created a new class of communication capabilities that facilitates sharing data amongst machines.

1.2.1 Telegraphy

In the early years of the 19th century, Oersted, Henry, Gauss, and Weber, among others, developed the sciences of electricity and magnetism. One of the first applications of their work was the electric telegraph. In 1843, Samuel Morse and Alfred Vail reduced it to practice. By interrupting the electric current flowing in a wire strung between the cities, Morse demonstrated that a message could be sent from Washington, DC., to Baltimore, MD. Running their copper wires beside railroad tracks, telegraphers began exchanging messages over ever-increasing distances on the first real-time communication system. With the formation of the Associated Wire Service in 1846, and Western Union in 1856, even towns of modest size were able to receive news of important events shortly after they occurred. As a result, the Civil War was reported in timely detail in dispatches telegraphed to local newspapers.

The international promise of telegraphy was recognized in 1865. At the first International Telegraph Convention, the International Telegraphic Union (ITU) was formed. Its charter included the recommendation of operating procedures and standards so as to promote worldwide communication. In 1866, the completion of a transatlantic cable gave same-day access to the major cities of Europe. In 1886, Hertz discovered radio waves; in 1894, Marconi demonstrated the wireless telegraph; in 1898, ship-to-shore telegraphy was established; and in 1901, transatlantic wireless telegraphy came into being.

1.2.2 Development of Data Communication

Adopted by the railroads in the mid-19th century, telegraphs provided coded communication between control points (railroad stations) that was used for dispatching trains and supervising freight. Before long, the messages spread out to other enterprises, and centralized, quasi-real-time management of a distributed organization through sharing data became a reality. As the number of messages increased, the telegrapher's key, sounder, and message pad were replaced by a combination typewriter and printer. It prepared a paper tape image of the message to be sent and printed the messages received on a similar strip of paper.

In the 1950s, as electronic computers emerged from universities and research laboratories, updated versions of these machines, known as teletypewriters, were used to communicate with them. By the 1960s, an increasing number of commercial tasks produced a need to connect remote data terminals to central processors, and these processors needed to exchange information among themselves.

The development of a vigorous, general-purpose computing community produced demands for communication between remote machines. Ignored by the telephone companies, users began experimenting with various techniques. Led by the Advanced Research Projects Agency (ARPA) of the Department of Defense, government researchers pioneered packet-switched networks and procedures for a national network that could survive a nuclear attack. Led by IBM, industrial and commercial users adopted networks and procedures based on Systems Network Architecture (SNA) that provided a tightly managed network with minimum, predictable delays. Encouraged by the success of these activities, Specialized Common Carriers challenged the Bell System for the right to carry data signals over private facilities between major cities. At about the same time, the modern data terminal, with video display and keyboard, was introduced. Today, data terminals allow persons to communicate with each other, and with machines, and the digital coding they employ (data communication) permits the exchange of information between machines.

In the last half of the 20th century, the development and deployment of information technology created a demand for the exchange of data among data centers, and other facilities, that has revolutionized the business communication environment. A rapidly expanding number of jobs require communication to support the use of data terminals that are connected to host computers, database servers, and other equipment.

1.2.3 Internet, Intranets, and Extranets

Perhaps the most important development of the last part of the 20th century has been the establishment and growth of Internet. Founded on the pioneering work of ARPA, Internet uses packet-switching technology to interconnect personal computers, hosts, and servers in a global data network that facilitates the retrieval of information from anywhere and its use everywhere. At first restricted to government projects, the use of the facility has been expanded to provide ready access to commercial and residential users.

Internet has become a vehicle for disseminating information on every conceivable topic. Quick to grasp an opportunity to improve their internal dissemination and use of company information, firms have adapted Internet for their own communications. By establishing secure subnetworks called *intranets*, they have created an island of company information that can be accessed by authorized employees, no matter what sort of platforms they are using—and where they are located. Furthermore, by establishing secure links outside the firm, platform-independent information sharing can be extended to suppliers, vendors, and customers. Called *extranets*, these arrangements can help manage shared projects, encourage collaboration, and improve performance (as described in Section 1.2.4).

1.2.4 Areas of Application

In a 1988 study by the Office of Technology Assessment (OTA) of the United States Congress,[1] technologies for collecting, storing, manipulating, and communicating information are identified as having the potential to revolutionize the economy of the United States. Two areas of application singled out in the report are

- **Productivity**: they can increase the productivity of operations where real changes may never have been considered seriously
- **Economic networks**: they can link production systems together in ways that improve the performance of entire economic networks.

One (productivity) is concerned with improving the internal efficiency of economic units; the other (economic networks) is concerned with improving the ways in which economic units cooperate to produce finished goods. What the authors of the OTA study had in mind is that the information technologies have a decisive role to play in stimulating and maintaining a strong, expanding national economy in the information age of the 21st century. Telecommunications (for collecting and communicating information), databases (for storing information), and data processors and information systems (for manipulating information) will have a significant impact on the future success of business enterprises. As individual entities, and in combination with one another, they can contribute to increased margins and improved performance.

(1) Telecommunications and Automation

Modern business enterprises employ computers and computer-controlled machinery to sustain their competitive edge. They use them to control operations, increase productivity, incorporate custom features in their products, maintain quality standards, and provide accurate, timely responses to the demands of their markets. To continue to reduce the cost of units of output, and to improve the efficiency of operations, they must constantly increase the level of automation. What is more, as technical changes and competitive offerings diminish the overall life cycle of each product, there is a need to reduce development, engineering, procurement, and deployment times.

To promote timely decisions that have a high likelihood of being correct, a growing amount of data must be collected from many locations and processed into information that is distributed in a timely fashion. Achieving this performance depends on speedy collection and distribution facilities, information sys-

[1] U.S. Congress, Office of Technology Assessment, *Technology and the American Economic Transition: Choices for the Future*, OTA-TET-283, U.S. Government Printing Office, May 1988.

tems that organize the data in useful ways, and the free flow of comments and instructions among employees, suppliers, and customers. By providing voice, data, and video services over networks of increasing sophistication, telecommunication facilities contribute to the successful attainment of these goals and to the cost-effective operation of today's enterprises.

(2) Information Systems

An information system is a software entity that organizes data to produce information for the benefit of an enterprise. More specifically, information systems process data to create useful information for control and operating purposes. The types of systems needed to support each product or service depend on the positions they occupy in their respective life cycles. Thus, for a new product or service, information systems can identify markets and develop positioning strategies; for a mature product or service, information systems are used to improve manufacturing efficiency and match customer requirements with optional capabilities. Information systems can be classified as follows:

- **Evaluative**: one that provides information with which to plan future activities
- **Informative**: one that provides information with which to control present activities
- **Supportive**: one that provides (historical) information with which to operate the enterprise.

(3) Telecommunications and Information Systems

What sets one enterprise apart from another is its use of the combination of telecommunication facilities and information systems. Some of the applications that are improving the way in which enterprises conduct their business include the following:

- **Manufacturers** link together the computer-based tools they use to design, engineer, and manufacture products to create computer-integrated manufacturing (CIM). CIM is essential for organizations that must match the quality and turnaround time of global competitors. To make the producing process as efficient as it can be, these capabilities must be shared with their suppliers, distributors, and customers.
- **Financial institutions** broker global financial markets, serve multinational businesses, buy and sell currencies around the world, and sell financial services based on proprietary information packages. These activities are pursued over real-time networks that integrate many islands of information and expertise. To retain the attention of a dynamic, global customer base, it is necessary to cover the world with instant information, acceptances, and analysis.
- **Passenger airlines** depend on filling seats; their strategy is threefold:

  - provide attractive fares and attractive schedules, and get them to travel agents ahead of competing airlines
  - provide travel agents with special terminals linked to the airline's database so that the agents can sell and confirm tickets on the airline
  - build customer loyalties through frequent flier, senior citizen, and other programs that are based on records stored in reservation systems.
- **Property** and **casualty insurance companies** link agents with proprietary programs and databases so that they can quote the best available terms to clients—immediately. Independent agents have the same access through special terminals. In this environment, underwriters must provide additional services to agents if they expect to retain their customers.

While the success of these applications is due in large measure to the information systems that they employ, the results would be diminished or negated without the immediacy of which telecommunication facilities are capable. Furthermore, the benefits they provide produce only temporary market leadership. To remain the leader, a stream of new services must be added to offset aggressive attempts by followers to regain market share. The right kind of telecommunications facilities can facilitate these actions.

1.2.5 Linking Production Systems Together

In the information age of the 21st century, the speed with which companies can do the following depends on the speed with which computer-based, telecommunications-assisted capabilities are adopted

- Serve large numbers of highly specialized markets by connecting together complex networks of producers around the nation or around the world to forge tighter (less costly and more timely) links between retail, wholesale, transportation, and manufacturing operations
- Concentrate production in areas (domestic or overseas) where labor skills, wages, business conditions, or living conditions are judged to be favorable—including the opportunity to move production activities (both goods and services) to any place in the world
- Control the activities of far-flung units of the enterprise to make the whole efficient and competitive
- Reduce travel among company locations for routine matters.

(1) Manufacturing Chain

Figure 1.1 shows an electronic goods manufacturing chain. Goods are manufactured in a sequence of operations beginning with raw materials and ending

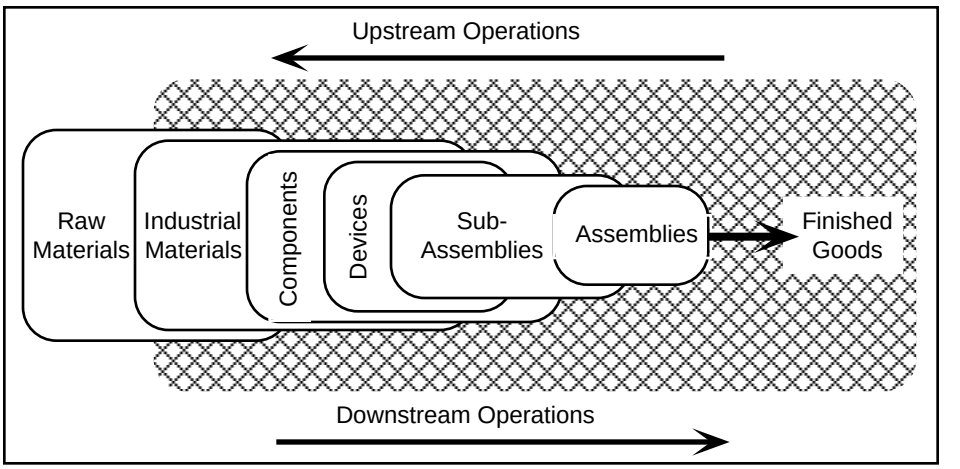

Figure 1.1 Electronic Goods Manufacturing Chain

Goods are manufactured in a sequence of operations beginning with raw materials and ending with the finished article. At each step, the input is transformed into what is needed for the next step.

with finished goods. At each step, the input is transformed into what is needed for the next step. Thus, raw materials are processed into industrial-grade materials. In turn, they are made into components, then devices, subassemblies, and assemblies to produce the final product. Separate companies may perform the steps one at a time, or a single company may perform several steps. At each step, the product may be dispatched to other manufacturing chains. For this reason, the shading denoting finished goods extends back up the chain to industrial materials. To complete the goods in a timely and cost-effective way, information is passed along the chain.

(2) Interenterprise Uses of Telecommunications

Figure 1.2 shows part of a manufacturing chain that produces electronic goods for consumers. Company A, a low-cost producer, links backward to two levels of suppliers to manage inventories and acquire confidence in the suppliers' abilities to deliver their products as required. Company B, an aggressive supplier of subassemblies, links backward to suppliers D, E, and F to assure their ability to support just-in-time manufacturing, and forward to company A to provide information support that will differentiate the product from others. The link from B to A represents a switching cost (to A) that may prevent A from changing suppliers in times of poor performance by B. At the component level, company D links forward to company B for the same reasons. Less aggressive than company B, company C links back only to supplier G to manage inventories.

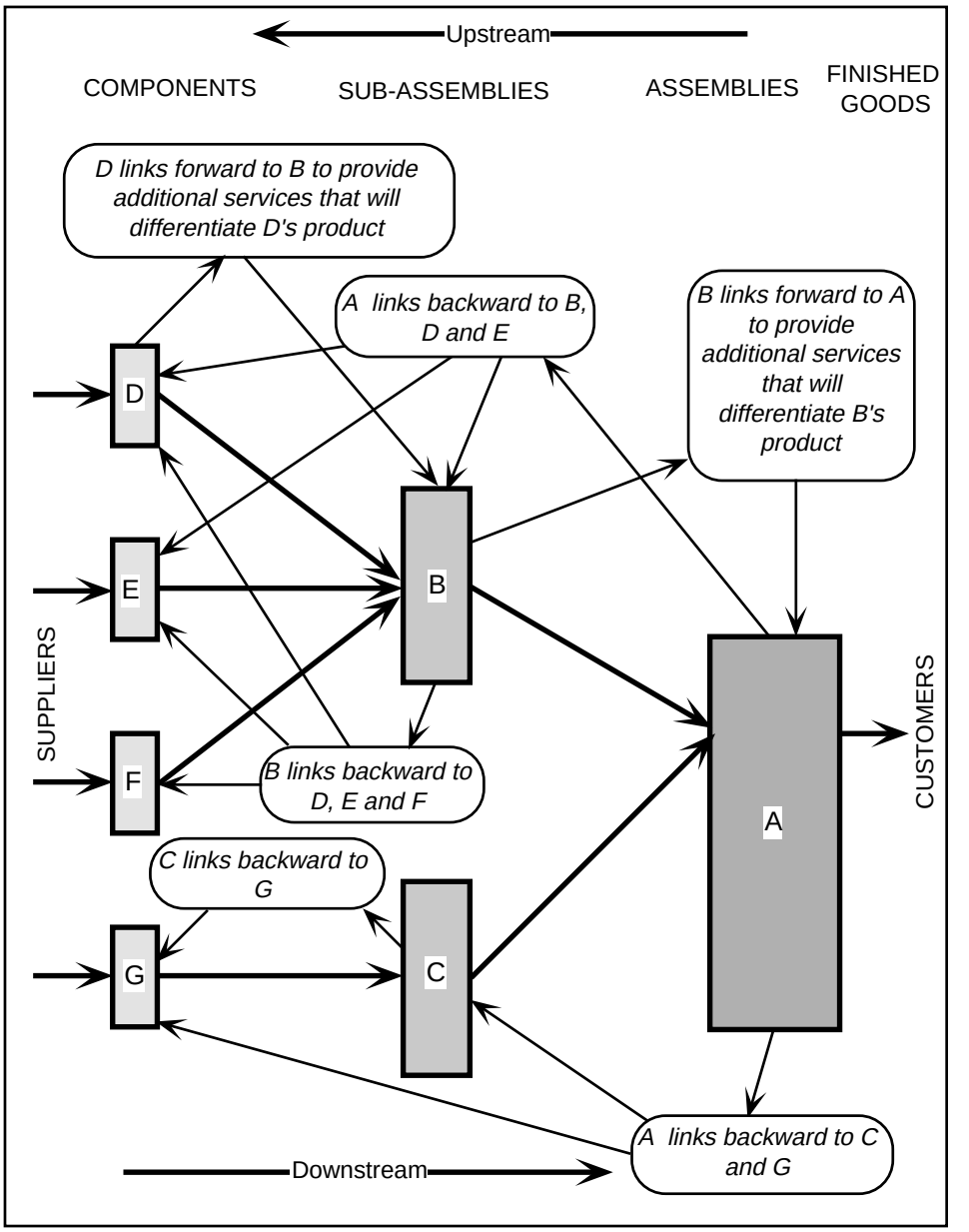

Figure 1.2 Interenterprise Uses of Telecommunication

Company A, a low-cost producer, links backward to suppliers to manage inventories. Company B, an aggressive supplier of subassemblies, links backward to suppliers, and forward to the customer. Company C, less aggressive than company B, links back to a supplier.

(3) Linking to Suppliers

The path to finished goods may lead through several firms that are responsible for a portion of the endeavor. To achieve the timely delivery of high-quality goods, the final downstream firm in the chain depends on the performance and skill of its upstream suppliers; in turn, they depend on their suppliers. To gather information with which to build confidence in their performance and the strengths of their commitments, each firm can extend telecommunications links to information nodes in their suppliers' internal networks—if they agree. The data they provide will permit the customer to evaluate progress on orders and to estimate the probability of on-time deliveries.

Moreover, once the link is established, the customer can send information to the supplier concerning future orders and schedules. Once suppliers and customer gain confidence in each other—and the system—the customer can take advantage of just-in-time operation as a way of reducing the cost of money for goods that might otherwise be held in the customer's inventory. In fact, with several telecommunications-based information systems, inventory costs can be reduced all the way upstream. Using customer-to-supplier linkages between the firms in the chain, the individual supplier to customer segments can operate more efficiently, and the entire chain is likely to achieve a higher percentage of on-time deliveries of higher-quality, less costly finished goods.

(4) Linking to Customers

One of the ways to create links forward is to place a terminal in the customer's office and support uses that the customer considers important. Not all of them need to be related to the supplier's product. For instance, if the product is a common use item, inventory management and automatic reordering might be included. In addition, the system could provide inventory services for related products—including those supplied by competitors—making it more difficult for the competition to persuade the customer to replace the terminal with one it supplies. This action may also encourage the notion that the convenience of automatic reordering could be extended to more products if they came from the same supplier. Fully exploiting the advantage of occupancy means finding creative ways to assist the customer and benefit the supplier.

In Figure 1.2, company B, an aggressive supplier, is attempting to build a relationship with A that will achieve a competitive advantage. Over the link to A, B provides information services. At worst, these services will differentiate B from other suppliers, and at best, they will create a relationship that prevents A from going elsewhere for B's products.

(5) Integrating the Chain

If the final supplier of finished goods is a significant customer of the other firms in the manufacturing process, it can use this fact to put links in place to connect it to the other firms. In this way, it is able to integrate data from the entire manufacturing chain—and communication does not have to be between manu-

facturing entities only. Engineering may collect data and exchange information with other engineering organizations in the chain; marketing may share information with the other marketing organizations, etc. Given cooperation, the more activities that can be coordinated, the greater the levels of efficiency that are likely to be achieved. Such networks will build relationships among suppliers and customers so that the entire manufacturing chain for a particular set of finished goods becomes the single, integrated, economic network referenced in the OTA study.

(6) Electronic Data Interchange

In industries such as transportation, automobiles, groceries, and pharmaceuticals and personal care products, dominant firms have built economic networks of the sort described and have standardized message formats and messaging procedures for themselves and their suppliers. The development of broader, general-purpose standards for electronic data interchange (EDI) is the task of industry associations coordinated by the ANSI Accredited Standards Committee X12. For buyer and seller transactions, this group has adopted a message architecture that accommodates a broad range of practices. It includes a feature set that can be tailored to different industries, and it is becoming the architecture of choice for many applications. EDI is most beneficial for industries with regular, repetitive buying, selling, and distributing functions.

1.2.6 Strategic Uses of Telecommunications

Telecommunications is one of many resources that are employed in running an enterprise. Normally, the level of management review of, and concern for, telecommunications activities will depend on the fraction of the corporation's total budget that is allocated to running expenses and capital acquisitions. When strategic results are expected, members of the top management team must get involved. Certainly, the preemptive strike described in Section 1.2.6(5) could not have happened without this level of support.

(1) Support of Marketing Strategy

Telecommunications networks can be used to pursue different information-driven marketing strategies. For instance, if the firm seeks to

- **Lower product costs** so as to become the low-cost producer (and market leader), the telecommunication network will emphasize linkages backward to suppliers, and suppliers' suppliers, so as to increase the efficiency of the manufacturing chain
- **Enhance product differentiation** to be the preferred source of supply, the telecommunication network will include linkages forward to the customer to provide information services that are not provided by competitors

- **Produce specialty products** that are tailored to particular market segments and to particular customers, the network will emphasize integrated operations so that custom parts and subassemblies can be produced with a minimum of difficulty.

(2) Building Barriers

By investing in electronic networks to link together all of the activities associated with a particular product, its markets, and its supporting materials, producers can manage the integrated community of firms that support them. Given the right tools for analysis and decision making, they can modify production schedules and adjust incoming supplies and outgoing distribution in an optimum manner to respond to changes in the marketplace and fluctuations in the world environment. Under the control of a dominant producer, the combination of a pervasive telecommunications network and powerful information systems tools can bind groups of firms together in a dependent way. If other producers wish to compete, they must establish a similar combination of telecommunications-based information systems capabilities—not an easy task. Thus, in building an integrated network, the producer has thrown up a significant barrier to would-be followers.

(3) Overintegration and Loss of Flexibility

Participation in these sophisticated arrangements entails more than just connecting to the network. Suppliers and distributors must share some of their proprietary information with the producer, and the producer must reveal proprietary plans and strategies. Thus, firms doing business as part of an integrated network become beholden to each other, and, after a period of confidence-building interaction, they become dependent on each other. Continuing success will bind them even more closely together. Eventually, they may lose the flexibility to pursue new implementations of existing products because the community they have created does not have the necessary expertise or incentives to shift from the mode in which they are operating. In this case, they are in danger of losing their dominant position to a less well established network that has greater flexibility to go after new opportunities.

(4) Retaining Customers

When a producer builds a telecommunications-based information system forward to a customer, it can offer information concerning product characteristics and applications that differentiate the supplier from its competitors. Properly thought out, these services can be important to the customer, yet inexpensive for the producer. A case in point is an original equipment manufacturer (OEM) that supplies a computer system for incorporation in a customer's product. On-line programming help, on-line maintenance guides, on-line applications news, and similar information can enhance the OEM's position with the buyer. The strategy can be particularly effective when the goods involved are complex and are likely to go through an applications evolution in their lifetime. With a linkage in place

that is filled with useful information, the buyer is likely to find that switching to another supplier will have a cost—in time, in convenience, or in training. At times of stress in their relationship, the buyer may find the services to be a persuasive reason not to switch to another OEM's products. At times of price competition from other OEMs, the supplier may find the services provide some protection against the buyer substituting another's product.

(5) Preemptive Strikes

The first implementations of some of the examples cited earlier [in Section 1.2.4(3)] have been called preemptive strikes. The term describes the aggressive use of new technologies, or old technologies in new ways, to the advantage of the innovator, such that

- The move surprised the innovator's competitors
- The move was well received by the innovator's customers and attracted customers served by competitors
- The move reshaped the markets to the advantage of the innovator
- Competitors required significant time, and had to make substantial investments, to catch up.

Using the combination of telecommunications facilities and information systems, many companies have succeeded in attaining these ends.

A good example of a pre-emptive strike is the use made by American Airlines of telecommunications-based information systems.[2] In the 1970s, by building and exploiting an electronic reservation and ticketing system known as SABRE, American Airlines created a new playing field on which other airlines were forced to play. Once the computers and communication links were operational, and SABRE was available at the ticketing desks in airports, terminals were moved into travel agents' offices. The terminals created links forward to customers, assisting them and differentiating American from other airlines. At the same time, having terminals in agents' offices allowed American to provide the agents with promotional materials, and, unless the potential traveler had a strong preference for another line, encouraged the agents to *book American*.

In 1981, American announced a frequent flier bonus program. Designed to foster brand loyalty, it was a linkage forward to the ultimate customers—the travelers. Building a record of flights taken by full-fare passengers (typically business travelers) for which tickets were dispensed through SABRE, American awarded points for miles flown, kept track of the total, and converted the points into addi-

[2] For an extensive discussion of preemptive strikes, see Peter G. W. Keen, *Competing in Time, Using Telecommunications for Competitive Advantage*, updated and expanded (New York: Ballinger Publishing Company, 1988) 110–18.

tional tickets at the request of the flier. Its action met with acclaim from travelers and expanded the fraction of all frequent fliers whose carrier of choice was American Airlines.

Caught at a disadvantage, American's competitors were forced to respond on American's terms. Even those airlines with proprietary reservation systems had to spend a great deal of time and money adapting them to capturing information concerning the total distance flown by individual fliers. Because the record has nothing to do with selling a ticket to fill a seat, it posed a sizeable barrier to entry in the new marketplace of electronic ticketing and bonus programs. American continues to exploit the advantages of occupancy given by a terminal in the travel agent's office and the records of frequent fliers stored in SABRE's processors. This combination of telecommunications and information systems capabilities has helped American maintain a leading position in the airline industry.

1.2.7 Increasing the Productivity of Operations

Internally, the ready availability of telecommunications resources has changed the way in which business is conducted. They have altered work requirements so that the skills possessed by persons presently on the job may not be adequate for the future, and they are changing the way in which work is organized. Intra-enterprise use of telecommunications has aided the rise of concepts of automated enterprises, automated offices, and automated factories.

(1) Person-Centered Applications

Two examples of ways in which telecommunications-based systems are used within the enterprise to improve the efficiency of operations are

- **Materials**: a materials specialist who keys in a part number that defines a manufactured subassembly, the quantity required, and the need date, may cause the
  - display of current inventory
  - ordering of critical parts from a supplier
  - issuing of a revised manufacturing schedule for the subassembly to a facility somewhere else.
- **Integrated circuits**: an engineer who inserts a description of the functions to be performed by an integrated circuit may cause the
  - design and simulation of a circuit
  - generation of the layout information for an integrated circuit chip to perform the task
  - development of the software instructions to adapt it to a specific set of operating circumstances

– development of a test suite that ensures the chip and software perform as specified.

Each of these examples reduces labor, speeds up activities, and increases the expectation of customer satisfaction. They substitute information processing, and the linking and transporting abilities of telecommunications facilities, for the labor of several persons. More than likely, the information systems in these examples will reside in different locations, and the tasks cited are enabled by the availability of telecommunications facilities.

(2) Machine-Centered Applications

Not all activities need be in direct response to actions by persons. At certain times, or under certain conditions, they may be initiated between machines operating under the control of programs designed to transfer information and perform specific functions.

- **Daily activity consolidation**: during the night, a machine at the headquarters of a supermarket chain will
  - call for information on the day's transactions from machines at branch locations
  - balance the total activity in the company
  - return consolidated records to each branch for use the next day
  - provide a summary of the day's activities to the operating managers when they arrive in the morning.
- **Process control**: periodically, a machine at an operations center that supervises a pipeline will receive status reports from machines at important nodes in the network. Should equipment failure or unusual operating conditions occur, it might transmit instructions to the controllers so as to mitigate the difficulty, or call for human intervention.

These examples reduce the amount of labor involved and increase the expectation of a higher-quality output. They are enabled by the availability of telecommunications facilities.

(3) Scope of Intra-Enterprise Telecommunications

Figure 1.3 depicts a manufacturing enterprise as a value-producing process surrounded by R&D, engineering, and marketing resources. It is coupled to the manufacturing chain by distribution channels and to executive and administrative functions by telecommunications-assisted information systems. The company's telecommunications-based networks collect data from all parts of the enterprise and distribute information to control and action points, as required. The shaded circle that extends over all resources and the distribution channels suggests the pervasive nature of their applications.

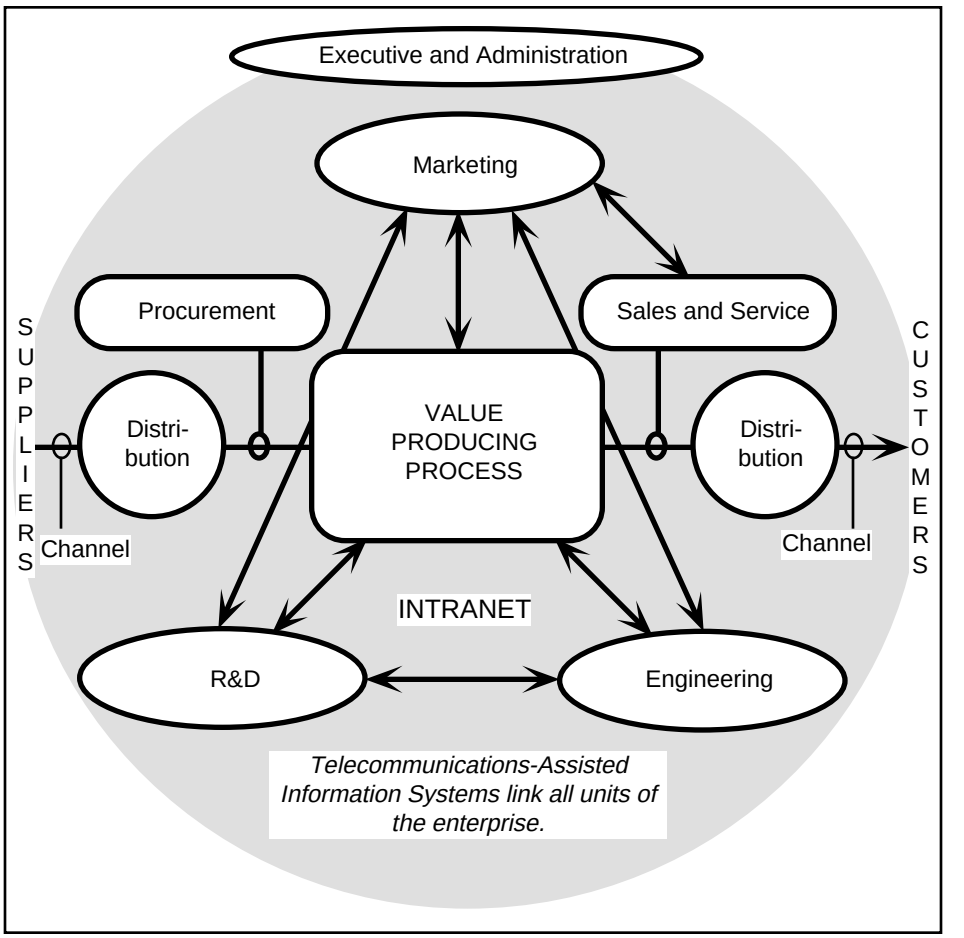

Figure 1.3 Representation of a Manufacturing Enterprise

The value-added process is surrounded by R&D, engineering, marketing, sales, and distribution. It is coupled to customers and suppliers by distribution channels, and to executive and administrative functions by telecommunications-assisted information systems supported by an intranet.

For firms whose operations are located in a limited area, the telecommunications facilities supply a full range of services over short pathways between information nodes. For firms whose operations are distributed across a continent, the telecommunications facilities supply a full range of services over local and long-distance pathways between information nodes. For firms that do not manufacture goods (hardware or software), the diagram can be modified to reflect the generation of value-added services.

1.2.8 AUTOMATED ENTERPRISE

Pervasive use of telecommunications-based systems, and other information technology, creates an environment in which more and more tasks become candidates for automation. As each company using information systems substitutes information technologies for human labor, it creates more information and further opportunities for automation. As each company developing information systems perfects new capabilities, it creates further opportunities for information technologies to substitute for labor. As a consequence, in the modern enterprise, the levels of automation, and dependence on information, increase inexorably. Companies that are caught up in information revolution in this manner make extensive use of telecommunications-based systems; they are called *automated enterprises*. I divide their activities into two categories: automated office and automated factory.

(1) Automated Office

In an automated enterprise, the use of information technologies to improve the effectiveness of persons performing office-based tasks has come to be known as *office automation*, and offices that adopt these services are known as *automated offices*. The specific functions performed in an automated office depend on the work to be done and on the capabilities of the equipment installed. Besides pervasive voice telephone services and desktop computing capabilities, automated offices incorporate telecommunications-based services that

- Achieve desk-to-desk, local, or remote transfers of text, data, and images as easily as voice information is transferred over the telephone
- Provide the ability to reach local or remote databanks, making central storage feasible and ensuring that all available, relevant data can be assembled and reviewed when needed
- Support electronic mail (text, voice, or graphics) and teleconferencing (computer, voice, or video) so that ideas can be exchanged and problems discussed with associates anywhere, thereby providing a higher level of expertise everywhere.

By fostering these activities, telecommunications-based systems merge the individual offices of the geographically distributed corporation into an extended electronic workspace in which to attend to the running of the enterprise.

(2) Automated Factory

A factory can be defined as a set of persons, machines, data processors, and other facilities that work together in a timely and cost-effective manner to produce goods. In an automated enterprise, the use of information technologies to improve the effectiveness of factory processes is known as *factory automation*, and factories that adopt these services are known as *automated factories*. The *goods* they manufacture may be hard goods (i.e., hardware), or soft goods (i.e., software or services).

Under the control of software systems supervised by operators, automated factories that manufacture and distribute hard goods employ computer-integrated manufacturing facilities. They consist of numerically controlled machines, robots, and other tools organized into flexible machining cells that may be served by automated materials handling devices. In addition, supervisory functions such as order entry, inventory control, scheduling, testing, etc., are integrated into the operation of the factory by information systems that collect data, produce information, and feed it to the proper equipment for processing or procurement.

Under the control of software systems supervised by operators, automated factories that manufacture and distribute soft goods employ generic programs, databases, graphical interfaces, expert systems, and other software procedures. They are used to produce information systems or services that meet a customer's requirements.

(3) Knowledge Workers

In many firms, most of the physical labor components of traditional jobs are performed by automated devices—leaving only the intellectual components to be performed by workers. As more of the remaining activities are assumed by information systems, the results are

- Steady increase in the technical skills demanded of a decreasing number of workers
- Decrease in the number of routine tasks performed by all employees
- Rapid decrease in the number of management persons engaged in collecting, analyzing, summarizing, and distributing information.

Overall, the total number of workers per million dollars of revenue is declining, and, for those jobs that remain, higher skills and/or different skills are required. Automated enterprise is creating a group of persons that does not fit the traditional work environment. Known as *knowledge workers*, they perform information-based tasks and communicate knowledge and expertise directly to manufacturing, operations, and other segments of the enterprise. They are the group of talented workers who understand the potential of new telecommunications facilities and information systems, and can apply them to achieve the objectives of the enterprise. Their tools are terminals and their workspaces are combinations of computers, telecommunication networks, and software-directed devices distributed throughout the enterprise.

(4) Changing Organizational Structure

The classical, hierarchical management structure is of little value when the enterprise is dependent on knowledge workers and automation. Knowledge is power, and, in many situations, the understanding of how to manipulate it

makes the knowledge worker indispensable. In contrast, the manager who does not have this understanding is powerless—and expendable. The traditional hierarchical structure in which level is sacrosanct is giving way to loose-knit, ad hoc groups of specialists who form teams (task forces) to suit the requirements of the moment. They bypass regular management channels as they solve problems and perform other tasks. The result is a reduction in the number of manager levels and the elimination of many jobs that existed solely to summarize and interpret information and pass on directives. **Figure 1.4** conceptualizes these changes:

- **Contemporary firm**: in diagram A, a traditional organization is shown as a pyramid with layers occupied by officers, managers, and workers. Information flows upward through several layers to get to the chief executive, and instructions flow down to workers who produce the company's products. An important characteristic of this organization is that the person in charge (manager) is the person in control of an operation (group of workers). The corporation is under overall pressure from global competitors to increase productivity, product quality, and reliability. In addition, the corporation is under internal pressures from automation to reduce the number of middle managers, to reduce the number of low-skilled workers, and to increase the skill levels of the workers who remain.
- **Downsizing corporation**: in diagram B, the corporation is responding to these pressures. There are fewer managers and fewer workers. The organization requires higher levels of skills in all persons to exploit higher levels of automation.
- **Automated enterprise**: in diagram C, the corporation has reached the level of automation that makes it as an automated enterprise. There are still fewer persons involved, and at all levels there are knowledge workers who have risen to the challenge of applying new automation techniques for the good of the enterprise. Reporting to managers, they are in control of operations and are likely to be found in one, or more, of the task forces that guide the enterprise. The corporation's competitive edge will depend on the quality of its knowledge workers and on the teamwork displayed by managers and workers. This includes the understanding that the person in charge (manager) is no longer the person in control (knowledge worker) of an operation (group of workers).

Part businessperson, part computer scientist, and part engineer, *knowledge workers* need an up-to-date understanding of the spectrum of telecommunications. With it, they can implement electronic highways that allow information to be created *anywhere*, and used *everywhere*, without delay. It is for these persons that this book has been written.

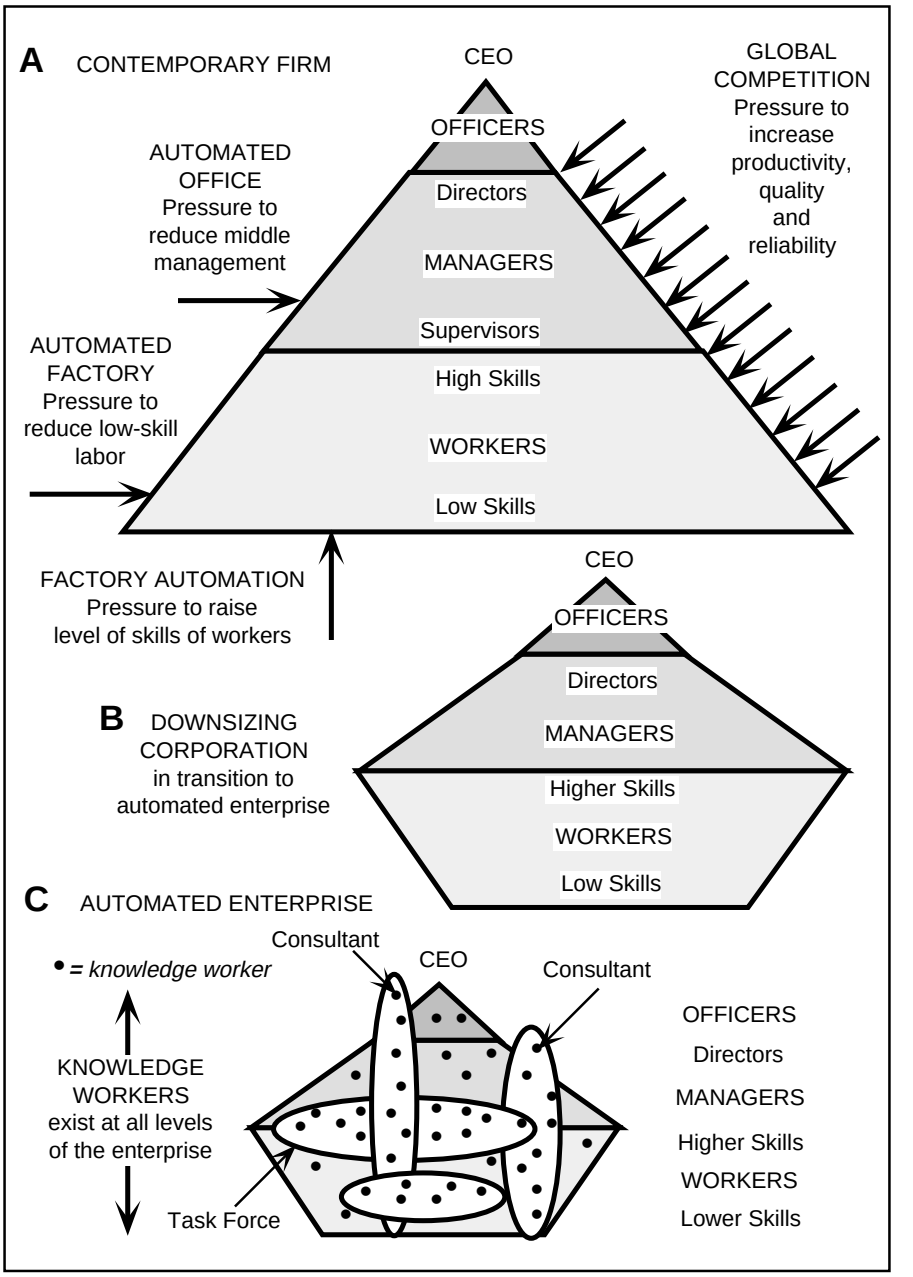

Figure 1.4 Conversion of a Contemporary Firm to an Automated Enterprise

Squeezed by global competition, contemporary firms increase automation, eliminate human tasks whose main purpose is to process data, upgrade workers' skills, create knowledge workers, and adopt a new management style.

REVIEW QUESTIONS FOR SECTION 1.2

1 Describe the origin of telegraphy. What did it contribute to the Civil War in the United States?

2 Describe the development of data communications.

3 What benefits will the adoption of computer-based, telecommunications-assisted capabilities bring to the information world of the 21st century?

4 What is Internet? What are intranets and extranets?

5 What two specific benefits does OTA expect technologies for collecting, storing, manipulating, and communicating information to bring to the economy of the United States?

6 In modern business, how do communication facilities promote timely decisions that have a high likelihood of being correct?

7 Define an information system. How are they classified?

8 Give examples of the use of telecommunications facilities and information systems to improve the way in which enterprises conduct their business.

9 For what productive purposes does an aggressive assembly operation communicate with suppliers and customers?

10 For what purpose have standards for Electronic Data Interchange been developed?

11 Explain how communications can support different marketing strategies.

12 Explain how, by building telecommunications-based information systems capability, a producer can place a significant barrier in the way of would-be followers.

13 What are the dangers in building too extensive telecommunications-based information systems capability?

14 How can a producer use telecommunications-based information systems to retain customers?

15 What is a preemptive strike?

16 Give two examples of the way in which telecommunications-based systems are used within an enterprise to improve the efficiency of operations.

17 What is meant by an automated enterprise?

18 What is meant by an automated office?

19 What is meant by an automated factory?

20 Who are knowledge workers?

21 Explain Figure 1.4.

1.3 TELECOMMUNICATIONS STANDARDS

Today, standards are a hotbed of activity as organizations challenge one another to design and build tomorrow's networks.

- **Standards**: documented agreements containing precise criteria to be used as rules, guidelines, or definitions of characteristics. Their consistent application ensures that materials, products, processes, and services are fit for their purposes.

1.3.1 WHY STANDARDS ARE VITAL TO THE INTRODUCTION OF NEW CAPABILITIES

Since telecommunications deregulation in 1984, and since the Telecommunications Act of 1996, competition among telecommunication providers in the United States has increased the sophistication of available facilities and produced a frenzy of activities in standards-making bodies. Mindful of the experience of product developers in other fields—that standardization is a prerequisite for low-cost implementation and market development—service providers, manufacturers, and users are working together. In bodies sponsored by national, regional, and international standards organizations, they are promulgating architectural and physical standards for the anticipated telecommunications requirements of the global information age. With them, manufacturers can produce the necessary equipment and users can pursue applications that build demand for the services they provide. An important consequence of the globalization of telecommunications is the emergence of consensus standards that combine North American and European practices.

1.3.2 PRINCIPAL INTERNATIONAL STANDARDS ORGANIZATIONS

From the middle of the 19th century, the standardization of operating procedures and equipment performance to promote international (global) telecommunication has been the concern of national governments.

(1) Global Standards Organizations

At the global level, standards are developed and maintained by three organizations

- **International Standards Organization** (ISO): a worldwide federation of national standards bodies. ISO is concerned with the development of standards and related activities for the purpose of facilitating the international exchange

of goods and services, and developing cooperation in the spheres of intellectual, scientific, technological, and economic activity (http://www.iso.ch).

- **International Electrotechnical Commission** (IEC): concerned with promoting safety, compatibility, interchangeability, and acceptability of international electrical standards. IEC is the international standards and conformity assessment body for all fields of electrotechnology (http://www.iec.ch). In 1987, by merging their information technology committees, ISO and IEC formed a single body to pursue the development of standards that support the needs of the information industry.
  - *ISO/IEC Joint Technical Committee 1* (JTC1). Responsible for consensus standards in the area of information processing systems.
- **International Telecommunication Union** (ITU): concerned with the creation of standards that facilitate international telecommunication. Founded in 1865 as the International Telegraph Union, since 1947, ITU has been a *specialized* agency of the United Nations (http://www.itu.ch). Its objectives include
  - maintaining and extending international cooperation for the improvement and rational use of telecommunications
  - promoting development of technical facilities and their operation in order to improve the efficiency of telecommunication services and make them available to the public
  - harmonizing the actions of nations in pursuit of these goals.

Often, ITU's objectives are stated as—to *regulate* radio communications, *standardize* international telecommunications, and *develop* global networks.

In 1993, ITU was reorganized into three sectors that reflect these functions.

- **Radiocommunications Sector** (ITU-R): concerned with radio issues and the allocation of the electromagnetic spectrum. Work is accomplished through world and regional conferences and study groups, and the Radio Regulations Board promulgates regulations.
- **Telecommunications Standardization Sector** (ITU-T): develops and adopts *ITU-T Recommendations* designed to facilitate global telecommunication. Work is accomplished through world conferences and study groups.
- **Telecommunications Development Sector** (ITU-D): responsible for promoting the development of technical facilities and services likely to improve the operation of public networks. Work is accomplished through world and regional conferences and study groups.

Each sector is headed by a director who is supported by a staff bureau and an advisory board.

(2) Regional Standards Organizations

While following the lead role of ITU in global standardization, in various regions of the world, telecommunications organizations have banded together to form groups to develop regional standards when no international standards exist. In this way, they influence international standards so that they take account of regional requirements. Among such organizations are

- **European Telecommunications Standards Institute** (ETSI): created by the Committee for Harmonization of the European Conference for Post and Telecommunication (CEPT), and originally intended to serve the needs of the 12 states of the European Community (EC), ETSI now counts Eastern and Central European countries in its membership (http://www.etsi.fr). Its objective is to produce the technical standards that are necessary to achieve a large, unified European telecommunications market.
- **Telecommunication Technology Committee** (TTC): established in 1985 to develop and disseminate Japanese domestic standards for deregulated technical items and protocols, TTC is composed of representatives of Japanese carriers, equipment manufacturers, and users (http://www.ttc.or.jp).
- **Committee T1–Telecommunications** (ANSI-T1): established in the United States in 1984, Committee T1 is sponsored by the Alliance for Telecommunications Industry Solutions (ATIS).[3] Accredited by ANSI and approved by the FCC, it is designated an appropriate forum to address telecommunications networks standards issues (http://www.t1.org). Pledged to work toward consistent, worldwide telecommunications standards, but principally concerned with matters pertaining to the operation of domestic public networks, Committee T1 develops consensus standards and technical positions related to interfaces for United States and associated North American telecommunications networks.

1.3.3 U.S. Standards Organizations

In the United States, the American National Standards Institute (ANSI) is the administrator and coordinator of the United States private sector voluntary standardization system.

[3] ATIS is sponsored by over 100 telecommunications companies to promote the development of national and international standards and operating guidelines.

(1) American National Standards Institute

Founded in 1918 by five engineering societies and three government agencies, ANSI does not develop standards itself but facilitates their development by establishing consensus among qualified groups of interested parties (http://www.ansi.org). ANSI is the sole U.S. representative to ISO and IEC. It performs its work through Accredited Standards Committees, such as the following:

- **X 3—Information Technology**: develops voluntary standards in the areas of information storage, processing, transfer, display, retrieval, and management
- **X 12—Electronic Data Interchange**: develops voluntary standards for interindustry applications
- **Committee T1—Telecommunications**: see Section 1.3.2(2).

(2) Other U.S. Standards Organizations

- **Electronic Industries Association** (EIA): a nonprofit organization that represents the interests of manufacturers and focuses on electronics, national defense, telecommunications, education and entertainment, and technical developments (http://www.eia.org). EIA provides a public forum for the discussion of national laws and policies.
- **Institute of Electrical and Electronic Engineers** (IEEE): a professional society, IEEE develops technical performance standards (http://www.ieee.org). The Institute pioneered in developing standards for local-area networks. The IEEE 802 committee of the IEEE Technical Activities Board includes the following subcommittees:
  - 802.1 High Level Interface
  - 802.2 Logical Link Control
  - 802.3 CSMA/CD Networks (Ethernet)
  - 802.4 Token Bus Networks
  - 802.5 Token Ring Networks
  - 802.6 Metropolitan Area Networks–Distributed Queue Dual Bus
  - 802.7 Broadband Technical Advisory Group
  - 802.8 Fiber Optic Technical Advisory Group
  - 802.9 Integrated Data and Voice Networks
  - 802.10 Network Security
  - 802.11 Wireless Networks
  - 802.12 Demand Priority Networks
  - 802.14 Residential Networks.

The results of the work of many of these groups are included in later chapters of this book.

- **National Institute for Standards and Technology** (NIST): an agency of the U.S. Department of Commerce (formerly the National Bureau of Standards) charged with providing an orderly basis for the conduct of business by maintaining measurement standards (http://www.nist.gov). NIST coordinates voluntary product standards and develops computer software and data communication standards for the federal government [Federal Information Processing Standards (FIPS)].

(3) Industry Forums

Producing and/or using organizations join in industry forums to promote the harmonization of specific technologies or the application or development of products. Often, their work is an important precursor for national, regional, or international standards. Some forums of interest to us are

- **ATM Forum**: an international nonprofit organization of producers and users committed to promoting the application of Asynchronous Transfer Mode technology through the development of interoperability specifications (http://www.atmforum.com)
- **Frame Relay Forum**: an association of producers and users committed to promoting the application of Frame Relay in accordance with national and international standards (http://www.frforum.com)
- **ADSL Forum**: an association of competing companies committed to the promotion of applications of Asymmetric Digital Subscriber Lines (http://www.adsl.com)
- **Telecommunications Information Networking Architecture Consortium** (TINA–C): an association of over 40 of the world's leading network operators, telecommunications equipment manufacturers, and computer manufacturers. They are committed to the definition, validation, and implementation of a *common* and *open* software architecture for the provision of telecommunication and information services (http://www.tinac.com).

REVIEW QUESTIONS FOR SECTION 1.3

1 Define standards.
2 Explain why standards are vital to the introduction of new capabilities.
3 Identify the principal global standards organizations.
4 Describe the three sectors of ITU.
5 Identify the principal regional standards organizations.

6 Describe the role of Committee T1–Telecommunications.
7 Identify the principal standards organizations in the United States.
8 Identify the other principal standards-creating bodies in the United States.
9 What is an industry forum?