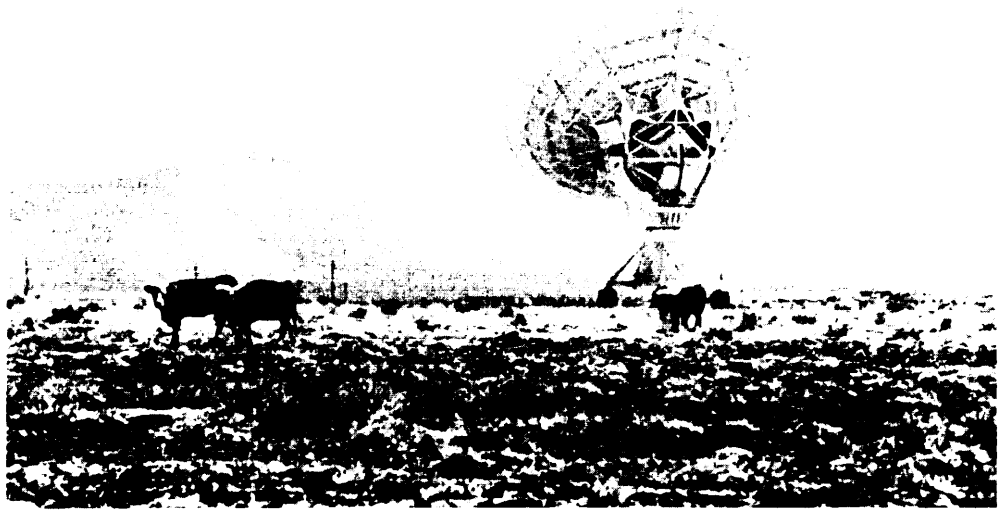
Chapter 4

Trends in Information Technology



Satellite communications systems depend on dish antennas to forge the necessary radio links between Earth and space

Chapter 4

Trends in Information Technology

Electronics technology in general has evolved rapidly over the last few decades, but the changes now taking place in communications, computers, and video technology are, perhaps, the most profound.

Findings

- The next decade will see a wide assortment of new information technology products and services offered to the consumer. Many existing products and services, such as the telephone or television set, will be altered and enhanced by incorporating microelectronics technology.
- These new products and services are being provided by a rapidly growing business sector called the information industry. This sector is composed of both new firms experienced in technology, and some traditional publishing and entertainment companies that are adapting to technological advances.
- While it is not possible to predict with certainty which of these products will succeed in the marketplace, it is clear that a wealth of new technology will be available to the home, school, and business. Many of these products and services will, at least initially, be directed to upper-income consumers.
- Educational users are not likely to stimulate the development of technology specifically oriented to their needs. Rather, they will use products and services designed to serve other consumer markets such as business and entertainment.
- New firms in the information industry may play key roles as new providers of educational hardware and curricula. Curricula may also be provided by a few traditional textbook publishers that are moving into new information technology markets.
- Automated work stations, such as word processors, are beginning to incorporate training and job assistance software.

Communications

Several new types of communication technologies are being developed and installed. They will offer the following improved capabilities:

- The *cost* of communications, particularly high-speed, long-distance data transmission, will continue to drop.
- Users will have a *variety* of communication services available to serve different needs.
- Communications networks will be *easier* to use, so that users can build distributed networks of interlinked computers and terminals.
- Much larger *volumes* of data can be carried over the lines.
- An international *data communications network* is evolving that will allow the establishment of high-speed communication links between virtually any two points on the globe.

Specific communications technologies contributing to this picture are two-way cable, satellite communication, digital telephone networks, new local loop distribution technologies, and new broadcast technologies, such as the direct broadcast satellite and the low-power broadcast.

Cable

Cable television transmits the signal to a television receiver directly through a wire rather than through air waves. Its principal advantages are better reception, the ability to direct specific signals to specific receivers, and the availability of more channels for use.

Originally viewed simply as an antenna shared by a community, usually in an area with reception problems or with limited local service, some cable systems have been in place for over 30 years, and their growth has been slow. Cable now, however, seems to have passed a critical threshold and is growing rapidly. This growth is spurred by the availability of a number of new services and, in the view of some, by the deregulation of the cable industry. The number of past and projected installations of cable in homes and the number of local community franchises for new cable networks to serve them are shown in table 8.

The principal technological differences between older and new cable systems are the *numbers of channels* and *two way access.* Older cable installations provide only **a small** number of channels into the home, in some cases, less than 12. Some modem systems now being installed provide over 100 channels. It has been estimated that by 1990 over 50 percent of the homes served by cable will have access to more than 30 channels.[1] This additional channel capacity is important for educational purposes, since it implies the potential availability of a wider variety of programing aimed at narrower audiences (called narrowcasting). The content of television programing no longer must be determined by a limited number of channels serving a mass market.

Two-way access means that in addition to receiving programing from the cable center—the "head-end"--the user has a communication channel back to the center. In current systems such as the Qube system in Columbus, Ohio, the viewer has a hand-held keyboard through which he can make responses to program inquiries. Some two-way systems allow the connection of security devices such as fire or burglar alarms and meters that can be read remotely for utility billing.

[1]LINK, New *Electronic Media Program.*

Table 8.—The Growth of Cable Television in the United States

	1955	1960	1965	1970	1975	1980	1985
Operating systems	400	640	1,352	2,490	3,506	4,225	6,000
Total subscription households	150,000	650,000	1,275,000	4,500,000	9,800,000	16,000,000	33,000,000

SOURCE: LINK

Satellite Communication

In slightly over a decade, communication satellites have become a major component of the national and international communication network. The past and projected growth of communication satellite usage for **a variety** of services is shown in table 9. These projections of growth depend on assumptions about what new services may be developed and about how much satellite capacity may be available.

Table 9.—Projected Demand for Satellite Communications in Number of Transponders

	1985	1990	1995
Data	124	74	117
Voice	288	660	1,008
Video-conferencing	20	100	200
Video-television	100	200	225
Total	432	1,034	1,550

NOTE: Projections vary greatly.

SOURCE: U.S. Satellite Systems Inc., *Filing Before FCC, Nov.* 23, 1981.

Availability is affected by technical, economic, and regulatory factors that are independent of the existence of a potential market.

Different studies have resulted in strikingly different estimates of communication satellite usage. The numbers shown in table 9 are estimates based on these studies and are thus useful only to indicate trends.

The growth of communication satellites is closely connected with that of cable systems. Satellites stimulated the development of new types of television networks formed specifically to serve cable subscribers with specialized programing in such areas as news, sports, religion, minority interests, movies, and fine arts. This programing is distributed over a combination of satellite and land communication lines to the cable center, where it is then redistributed to the subscribers' homes.

Digital Telephone Network

The basic technology of the telephone network and its use is changing. The principal shift is from an analog-based system to a *digital-based* one. In analog transmission, the human voice (or any sound pattern) is transformed into electrical wave form, similar to the way music is stored on a record as a series of wavy lines. Digital transmission, on the other hand, encodes the information as a series of discrete pulses. In a manner similar to that of Morse code, different sequences of pulses represent different numbers. The sound wave is encoded as a series of numbers and then converted into sequences of electrical pulses on the line.

The shift to digital transmission will profoundly affect both the potential uses of the network for data transmission and the types of sophisticated communication services that can be provided. Digital technology allows the transmission lines to carry more information at higher rates. Moreover, transmission is more accurate. Distortion of analog signals does not usually affect normal voice conversation; however, computer data transmission is far more demanding. Digital coding allows for error correction.

The digital communications network combined with the presence of computers, both within the network and at the terminal ends, will provide a basis for a wide array of new communication services that unite the communication of information with the ability to store and process it. Most electronics technology on which the telephone network is becoming dependent is digital. Central office switching is computer-based, as are most new PBX (Private Branch Exchange) systems on the market. A new generation of telephones based on digital microcomputer electronics is also appearing.

A service already being offered is "packet-switched" data transmission, which is designed specifically to carry data between a computer and either another computer or a computer terminal. In this type of system, digital information is packaged in small pieces called packets. A packet contains information about the source and destination of the data and the relationship of that piece to the whole message. The packets are transmitted separately through the network, sometimes taking different paths, depending on which paths are free at the moment.

The telephone network was originally designed for human conversation, not for computer data transmission. That the requirements of these two types of communication are significantly different is shown in table 10. Packet switching systems incorporate computers into the network in such a way as to make it far more efficient for data transmission. It is cheaper, faster, more accurate, and eliminates some incompatibilities between the various types of equipment on the network.

Table 10.-Chief Characteristics of Voice v. Data Communication

	Voice	Data
Transmission speed	Low	Very high
Characteristics of message	Infrequent bursts of data	Nearly constant use of line
Length of time connected to network	Minutes	Hours
Sensitivity to distortion	Very low	Very high

SOURCE: Off Ice of Technology Assessment.

Packet systems, because they lease telephone lines from AT&T and produce a different type of service for their own customers, are called "value-added carriers." They are under Federal Communication Commission (FCC) regulation. Other future services that link computers and communication lines will not be so clearly classifiable as common carriers, since computers within the network and at its nodes will provide services that look like data processing and storage. For this reason, they may not be regulated.

It has not been completely decided–either by the courts, by the regulators, or by the marketplace-which of these advanced services the telephone companies will be allowed to provide in competition with other companies in the information business, and what the rules of competition will be. The implications of the recent reorganization of AT&T, agreed on between AT&T and the U.S. Department of Justice, are still not clear, although the telecommunications and information services marketplace will be affected. Congress may wish to legislate in certain areas of telecommunications policy that it still feels to be unresolved.

Digital data communication services have been particularly important to higher education, which has been experimenting with their use to form nationwide computer networks. For example, the *Edunet* system facilitates the exchange of educational computer programs and the sharing of unused computer resources among institutions. Under sponsorship of the National Science Foundation, university computer science departments are forming a network of their departmental education and research computer systems to allow scientists all over the country to share programs, resources, and ideas and even to work on joint research projects.

Local Distribution Networks

A local exchange is that part of the telecommunications network that provides point-to-point service within a given geographical area, ranging from a single office building to an entire metropolitan area. The telephone company has historically been the provider of this service; however, competitors, stimulated by deregulation to make use of new technology, are now developing technologies that promise to change the economics and form of local data transmission.

Thus, for example, some experts predict that as an outgrowth of the potentially large capacity of cable transmission technology, the next stage of cable services will be the provision of full two-way data transmission services within local areas. Some channels of two-way cable service will be withheld from general home use and sold to Government agencies, school systems, and businesses to form their own private cable-based communication networks. Local franchises in a few areas (e.g., the New Orleans, La., agreement with Cox Cable) are already providing for this type of facility.[2]

Other firms are experimenting with packet communication systems that use broadcast media. Networks for interoffice communication are also being developed, principally by firms interested in the office automation

[2] *'Cable TV's Third Wave: Local Broadband Communication Services, NRM,* vol. 2, 6. LINK, New York, 1981.

market which will make it possible for different types of computer equipment located in different parts of a building to communicate with one another, transferring data and processing work as needed. Finally, a new form of broadcast transmission, called cellular radio, will greatly increase the availability and use of mobile telephone communication.

Both regional and office technologies promise a number of benefits to educational users: they will provide a mechanism to distribute programing among schools in a district or within a school; they will facilitate the sharing of expensive resources; and they will allow educational services to be directed outside the school—to homebound students, to students with special needs and interests, and to vocational students at their workplaces.

New Broadcast Technologies

A number of recently developed communication technologies will make new services available for the distribution of programing. While most of the industry is focusing on applications in the entertainment market, these services will also have important potential educational use.

Direct Broadcast Satellite

In a direct broadcast satellite (DBS) system, a satellite transmits a program directly to a receiver in the home or office, bypassing the intermediate step of using cable. Several companies have applied to FCC for permission to offer this service, and, if approved, it would become available toward the end of the 1980's.

The applicants have different views of the forms a DBS service might take, ranging from traditional pay television to new video technologies such as high-resolution television. * One applicant would use it as a more highly developed form of network transmission to cable and other redistributors, rather than to home consumers. It is noteworthy that at least one applicant, COMSAT, has included an educational channel in its proposal. If available, DBS could be a relatively inexpensive means of distributing educational programing, particularly in rural areas where providing adequate education and other social services is still a costly and difficult process.

A number of market, technological, and regulatory issues, some of them international in scope, must be resolved before a DBS system can become operational. Many questions remain about the potential utility and market for such types of services. Will DBS simply compete with current cable offerings, and if so, what are its advantages? Would high-resolution television find a viable market? Are special provisions needed to encourage its use for such public services as education? Finally, many users are competing for the increasingly fewer available frequencies of the electromagnetic spectrum and for orbital "parking places" for satellites.** Would current or potential uses of these resources allocated to DBS be more productive, more economical, or of greater value to society?

Low-Power Broadcast

In 1980 FCC began to consider applications for licenses to establish low-power television stations. Such stations broadcast with restricted power that limits their range to a few miles (10 to 15 miles or even less).

*A television receiver "draws" its picture as a number of dots on the screen. Its resolution, the fineness of detail that can be displayed, is fixed by decades-old transmission standards. The higher resolution displays that occur in computer graphics systems are technically feasible. Because more information must be transmitted to produce more image detail, substantially greater bandwidth is needed for transmission.

**Broadcasting equipment such as satellites transmit their information on an assigned radio frequency. When this frequency is being used for one purpose, no other use of the same frequency can be tolerated in geographical areas where the two signals might interfere with one another.

It is estimated that low-power stations will require a relatively small capital investment to set up, possibly as little as $5,000. Furthermore, since the stations have a restricted range, many more licenses can be granted within any geographical region. FCC's stated purpose for promoting low power is to provide greater diversity of ownership and programing than that traditionally available over the restricted number of broadcast channels currently serving an area. The advantages of low entry cost and license availability may make low-power stations attractive as a medium for distributing educational programing and providing other public services.

Low-power stations can be connected and used to distribute programing from a central source similar to the way that cable operates now. Programing can be distributed by satellite or by less exotic means, such as by mailing video cassettes. A network of inexpensive low-power stations could serve as an economical way to provide television broadcast to regions with low population density. For example, the Alaskan Public Broadcasting Commission has authorized an experimental network of low-power stations to serve the residents of Bethel, Alaska. Similar systems are also being developed in Canada to serve remote northern regions.

Computers

The fundamental technological base for computer hardware has undergone revolutionary changes over the last decade that are expected to continue in the next. In 20 years, computer designers have advanced from using vacuum tubes, through solid-state transistors, to using microelectronic integrated circuits on single silicon chips the size of a dime. Researchers are now developing the ability to print electronic circuits in the sub-micron (less than 1 millionth of an inch) range.

These developments have had an enormous influence on the way computers are used and on who uses them. A mass market for computers and computer software has developed that serves retail consumers. Where computer ownership and operation used to be restricted to large, expert organizations, it now potentially extends to millions of homes, small businesses, and schools. Contributing to this trend is the fact that the cost of computing has dropped steadily and rapidly-to the point that so-called desktop computers can be purchased for no more than a few thousand dollars. These small machines have the capability of computers that two decades ago sold for hundreds of thousands of dollars, and it is anticipated that their price will continue to drop.

In addition, networks of computers now allow the owners of even a small computer to gain access to special resources—hardware, software, or data bases—and enable them to communicate among themselves. Moreover, software, which instructs the computer how to do specific types of work, is becoming available in the commercial market. In the past, computer operators were faced with the problem of developing most software themselves, an expensive task that required computer expertise. Now, there are enough users with similar computer hardware and needs to form an attractive market for software.

Other consumer devices that use microcomputer technology to increase the capabilities of traditional consumer products such as typewriters, automobile carburetors, television sets, or thermostats are also being marketed. In some cases, entirely new products, such as computer video games, are being developed. However, these are not designed to be used as computers.

These general technological trends are resulting in the availability of a number of specific products.

Desktop Computers

Desktop, or personal, computers are small machines that retail for prices ranging from less than a thousand to a few thousand dollars. They are based on microelectronic technology, using inexpensive memory and computer chips commonly available on the market. Most current desktop computers are based on one of two basic chip designs that use an 8-bit word as their fundamental unit of information. * Newer models are appearing, however, that use a more recently developed 16-bit word chip. (Larger word-size generally results in faster computation and more memory directly available to the machine.)

The owner of a desktop computer has a wide variety of attachments available. These "peripherals" allow the computer to perform various tasks—such as printing results, drawing graphs, communicating over the telephone line, storing information (e.g., on magnetic tapes or disks), and even generating musical sounds. While the computer manufacturers themselves offer a selection of peripheral devices, many have been designed and marketed by independent firms. The role played by these small independent firms has undoubtedly stimulated innovation in the small computer field and, by developing new applications, accelerated the growth of the market.

Over the last 5 years, the structure of the market has undergone substantial changes. Desktop computers were originally developed and sold by small entrepreneurial firms such as Apple, one of the most successful to date. However, an unexpectedly broad consumer market rapidly developed, and in response, larger, more consumer-oriented firms entered it. Tandy Corp., for example, entered the desktop computer market with a machine called the TRS 80. While not a computer company, Tandy had a national network of retail outlets—Radio Shack—through which the small computers could be sold to consumers interested in electronics. This company became a major competitor in the market.

Atari, originally a small firm manufacturing video games, but now a subsidiary of Warner Communications Co., followed soon after. Most recently, giant firms such as IBM, Xerox, and Digital Equipment Corp. (DEC) have entered the market. The growth of this market is continuing, albeit at a slower pace, stimulated by use of computers for entertainment and games, education, household management, and hobbies (e.g., computer-generated art or music).

Another market, originally unanticipated, is that of the small business user. It started slowly, principally because professional users were often nonexperts who needed more reliable assistance and better software than the manufacturers were originally willing to provide. However, growth of the business market has been rapid, and most experts expect that it will predominate in this decade.

Finally, many manufacturers see the education market as one with great potential. Apple, Atari, and Tandy have set up nonprofit

Software selection available at a Yonkers, N.Y., store

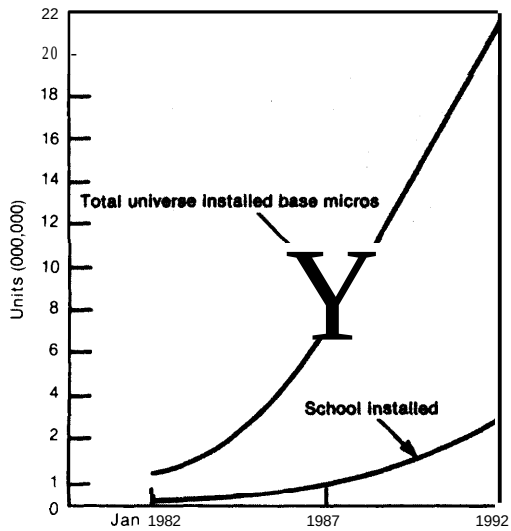
*An 8-bit word is a quantity of information roughly large enough to contain a single alphabetic or numerical character, A 16-bit word can contain twice as much information.

organizations intended to encourage the educational use of computers. (The past and projected growth of the desktop market is summarized in tables 11 and 12, and fig. 2.)

Growing along with the desktop computer industry are the firms that provide the programs for these devices. Nearly all of these companies are new, started by one or a few programmers with a bright idea. Their packaged programs make the computer useful, and therefore attractive, to most customers. Given the current size and expected growth of the personal computer market, a single successful program can make a firm's fortune and establish it in the business. Like the independent peripheral industry, such software companies have been a major force in expanding the use of desktop computers. For example, the availability of VISICALC, a budgeting and planning program offered by Visicorp, has been cited as the principal reason that some businesses bought desktop systems. Similarly, the availability of sophisticated word-processing and accounting packages has opened the business market to small computers.

In some ways the small computer software business resembles that of traditional book publishing. A software company often purchases rights to distribute packages written by independent programmers. The company, which may also assume the costs of testing and documenting the program, handles all the standard publication jobs of production and marketing. Some programmers are beginning to be well known. Their names are attached to the software packages just as those of authors are to books; and, just as with books, customers often show preferences for software written by particular programmers.

Figure 2.— Installed Base Micros Total Universe and School Installed



SOURCE: LINK

Table 11 .—U.S. Installed Base of Personal Computers by Market Sector[a] (units in thousands)

	1982	1983	1984	1985	1986
Home/hobby	700	1,327	2,357	3,407	4,798
Business/professional . .	1,236	2,345	3,975	6,025	8,428
Total	1,936	3,672	6,332	9,432	13,226

[a]Based on IDC Survey of Desktop Computers.

SOURCE: LINK.

Hand-Held Computers

The hand-held computer is somewhat larger than a normal pocket calculator, contains a microcomputer chip and sufficient memory to allow simple programs to be entered and run, and sells for only a few hundred dollars. It is both much cheaper and considerably more portable than the desktop computer.

Table 12.—Micros in Schools (installed base)

Hardware	Purchased by school district for K-12	School level: Grades K-8	School level: Grades 9-12	School level: College	Total for 1981	Total installed
Totals	10,400	16,800	22,800	30,000	80,000	145,000

SOURCE: LINK.

Its portability, however, is also the source of its limitations: the keyboard is small and difficult to use for entering large amounts of text; the display is limited to a single line of text or numbers; and no convenient, fast, bulk storage such as a floppy disk is attached. These deficiencies may be overcome by designing the hand-held computer to plug into other hardware devices, thus sacrificing its portability.

One promising application of the hand-held computer for educational use will be as an inexpensive terminal. Although containing within itself some computer power, the hand-held computer could also be used in conjunction with a communications network connected to one or more larger computers. In an educational setting, for example, students might use their personal hand-held computer by itself wherever possible. For assignments that require more capacity, the hand-held could be linked over a phone line to a larger system at the school.

Human Interface

Much research and development (R&D) in computer technology is directed at making computers and humans communicate with one another more easily, a process referred to as input/output. The input function has two basic activities: 1) instructing the computer in the task that it is to perform; and 2) reading data or instructions into the computer quickly, accurately, and inexpensively. The output function refers to producing results that are understandable and easily used either by a human or, increasingly, by some other computer or machine.

New languages are being developed to help both experts and nonexperts program computers more efficiently. Many of these languages are tailored to specific applications—such as educational use. For the professional programmer, the goal is to develop languages that allow increased productivity—either faster and more accurate programing, or the creation of more complex programs. For nonexpert users, the goal is to provide a language closely related to their language and problem-solving styles.

Computer experts see a close connection between the language used to program a computer and the mental problem-solving strategy of the person using it. If the logical structure of the programing language is significantly different from the user's mental processes, the language can actually be a barrier to effective computer use. On the other hand, according to this theory, a properly designed programing language can actually guide the user to the solution of a problem. It was this latter observation that led to the creation of a programing language called LOGO, which was designed for educational use. This language teaches children new patterns of thinking about problems, patterns not only more attuned to the use of computers, but also—according to some experts—more powerful for solving very complex problems.

Data have traditionally been typed into the computer, either directly or through punched cards or some other intermediate medium. Technology is now appearing on the market to input directly, either by speaking to the computer or by showing it pictures. Present voice input capabilities are quite limited, however. Only a few hundred words can be recognized, and these only in a few specific voices for which the system must be trained. During this decade, experts expect that significant advances will be made in both vocabulary size and number of speakers that can be recognized. An interesting application of a hand-held computer would be as a personalized voice input device that is tuned to respond only to the owner's voice.

The principal developments in output technology have been in the areas of low-cost printers, graphics, and voice. Printers have

historically been an increasingly expensive technology to add to small computers. Predominantly mechanical, they have not shared in the price reductions experienced by electronic devices. Recently, however, stimulated by the growing small-computer market, a number of firms have developed inexpensive printers that use electronics more extensively. These "dot-matrix" printers, selling for a few hundred dollars, print characters as patterns of small points. Besides cost, other advantages of the dot-matrix printers are that they can produce a wide variety of type fonts without changing the print mechanism and that they can be used to print graphic material.

Lately, the most active computer peripheral market in new product development has been color graphics output. Systems can now display solid shapes, in full color, with shading to reflect light sources and surface textures. While this technology is still very expensive, prices are dropping rapidly, and new and more sophisticated capabilities are coming on the market. Limited, but inexpensive and useful, color graphic capability is already available on most desktop computers. While elaborate, full-scale graphics would be useful for engineering design education and for simulators—say, for flight training-the limited capability available on small systems has not yet been fully exploited for many educational uses.

Voice output technology, while still primitive, is also improving steadily in price and performance, although it is unlikely that accurate reproduction of human speech will be achieved in this decade. Texas Instruments, with its successful "Speak and Spell" line of products, has illustrated how useful even a limited capability can be for educational applications. *

*Speak and Spell is a small hand-held device with a keyboard and display. It speaks a word to the learner, who types in that word on the keyboard. If the word is spelled correctly, the device moves on to the next word. If not, after giving the child another chance, it displays the correct answer.

Storage Technology

Technology for storing data is steadily improving, for both large and small computer systems. The most significant developments for educational use are those storage technologies used by software publishers for the data and programs they sell. The storage medium must be cheap, durable, easily handled, hard to copy (in the view of some firms), and, most important, usable by purchasers on their systems.

Many desktop systems are designed to operate programs stored permanently on silicon chips in a high-speed memory that cannot be changed. This so-called "read-only memory" (ROM), is plugged into a socket on the computer. Its most common form is the game cartridge for the Atari and other electronic game packages.

The other major memory technology for small computers is the floppy disk, which was probably as important to the development of the desktop computer as was the microprocessor, itself. The floppy disk, which comes in 5 ¼- and 8-inch sizes, is most typified in word-processing systems in its 8-inch form. It provides a low-cost, rapid, and reliable storage medium for the small computer. Programs are now commonly distributed on floppy disks. There is currently a debate about whether software firms will favor floppy disks or ROMs as the medium of choice for distributing their products. Disks are cheaper to reproduce, while ROMs are now harder to copy and "pirate."

Now, economical bulk storage systems that use hard disk technology are becoming available for small computers. These systems have many times the capacity of floppy disks and are much faster and more reliable. However, they are also more expensive and do not provide a facility for data backup.

Video Technology

Like the computer and communications industries, the consumer entertainment sector, principally television, is also making technological advances. This decade is likely to see significant developments in several areas of video technology: video cassette recorders, improved quality (high-resolution, flat screen, large screen, high-fidelity sound), filmless cameras, and video disks.

Video Cassette Recorders

Video cassette recorders have already become important consumer goods. Based on consumer surveys, their principal home uses seem divided between viewing movies, particularly those not readily available at local movie houses or on network television, and so-called "time-shifting." Time-shifting means recording a program at the time it is broadcast for later replay. (According to a recent court ruling, such practice may be in violation of the copyright law, although the court also acknowledged the difficulty of its enforcement.)[3]

Video cassette recorders have become an established consumer technology despite their lack of standard recording format and their restricted marketability (to the relatively small upper-income bracket). It has not been difficult to produce and sell tapes in different formats, and time-shifting use does not depend on common standard formats.

Improved Quality

R&D is under way to develop basic new video technologies that promise better performance. Although none of these has yet reached the market place, experts think that at least a limited number will be available in this decade.

The flat and large screen protection systems that are currently available are expensive and awkward to use in small rooms. The goal of researchers is to develop a true flat display screen, since the market for such a technology would be large, not only for entertainment, but also for use in computer systems. Since manufacturers are keeping their progress in this area quiet, it is hard to predict the likelihood of success.

High-resolution television, another area of intensive development, may be closer to technological realization. However, its widespread adoption will be hampered by the need to use different broadcast formats on transmission channels with much higher capacity, as well as by the viewer's need to purchase expensive new receivers. For this reason, CBS is proposing the use of direct broadcast satellites for transmitting high-resolution programing. Cable is another possible transmission medium. Initial users are likely to be institutional users, such as theaters, that can afford to purchase receivers and pay relatively high transmission costs.

Filmless Camera

The Japanese firm, Sony, recently announced the development of a camera that operates electronically. The camera, which combines video and computer technology, "writes" a picture on a very small, reusable floppy disk. The picture is then viewed on a television display. The initial version is expensive, and its performance is limited by the resolution capability of current television displays, which is much lower than that of film. However, the future availability of high-resolution television displays will allow a picture quality as good or better than that of film.

Video Disk

A technology eliciting much interest from the education community is the video disk, a medium that stores television programing on a disk resembling a phonograph record. Educators and information publishers are excited

[3] *Universal City Studios v. Sony Corp.*, *659* F. **2d, 963** (9th Cir., 1981).

about its potential because such disks are durable, and copies are cheap to produce. Each disk has two sound tracks, which may be played singly or together, and individual frames on the disk can be addressed and viewed. Moreover, the storage capacity of a disk is high-56,000 frames on a side. Computer data and programs can also be stored on such a disk.

These characteristics suggest that a video disk coupled with a small computer would be a very flexible and powerful device, allowing on the same disk a combination of moving sequences, still pictures, and text, all under interactive control.

There are a number of competing technologies for recording and reading the information on a disk. However, they can be regarded as two basic types, capacitance and laser. The capacitance system, marketed by RCA, stores the information on a disk in a spiral of tiny grooves, much smaller than, but similar to, those on a phonograph record. The information is read by a needle that physically rides in the groove. RCA has marketed its capacitance system directly to the upper-income home buyer, selling it principally in competition with video cassette records as a medium for viewing movies and other packaged program materials. However, since the system does not offer recording capability, it is not useful for those who want to record from broadcasts or create their own video tapes.

The laser system stores information as transparent or reflective spots on the disk. The reader uses a laser light beam that either passes through or reflects from the disk surface. No physical contact is made with the disk surface, and the reading accuracy is immune to damage to the disk surface. Currently available laser disk systems record on one side. However, at least one firm will soon offer a technology that stores information on both sides and that can read both without having to flip the disk.

The principal benefits of the laser system are its ability to lock onto a single addressed frame and to move at random, under computer control, through the information stored on the disk, as well as the durability of the disk itself. Its chief drawback to date is cost.

The principal market for laser video disk systems has been industrial and military users. Experts differ on whether this technology will become common in the home and school. For this to happen, the cost of a computer-controlled video disk reader must drop substantially from its current price, which runs well over $1,000.

Information Services

The new information technology described in this chapter will form the basis for a wide variety of information products and services for the home, office, school, and other locations. The most significant ones will incorporate the integration of several technologies.

The three areas of information technology–computers, communications, and video-have grown up separately, connected only by their joint dependency on microelectronics. Now, it is becoming increasingly difficult to tell them apart. * This technological merger is taking place in two ways:

- The technologies are becoming integrated into each other. The digital telephone network uses computer technology; distrib-

*This overlap creates regulatory problems, since the communications industry is regulated and the computer industry is not. The FCC recently concluded an inquiry, "Computer II, " motivated by this growing overlap, which was intended to better distinguish computer services from communications (5-FCCINQ).

uted computer systems use telecommunication services; video disks are controlled by microcomputers.
- New types of information services that make use of all three technologies are being planned and offered. For example, Pergamon Press offers a patent search system that integrates a personal computer, a video disk, and a remote data base accessed by telephone to allow attorneys to search U.S. patents.

Several sectors of the industry are also beginning to overlap:

- High technology-communications and computers.
- Traditional print publishers—newspapers, magazine, and book publishers.
- The entertainment media-film, television, and radio.
- Other information-dependent firms–banks and credit card companies.

To some extent, mergers of previously independent business sectors reflect normal business growth through diversification, but the firms also see their various business activities as becoming more closely related. Thus, diversification within the information industry has become a way for companies to protect themselves against technological obsolescence. The industry overlap is motivated by two trends:

- Computer and communication technology is becoming central to the provision of many traditional information services. For example, some providers of two-way cable services plan to offer an electronic newspaper. Furthermore, traditional publishing is becoming increasingly dependent on the use of electronic systems.
- Unique new services are appearing that can be interpreted as a blend of more traditional businesses. For example, AT&T has been considering offering an in-home information service that, while resembling an electronic version of the yellow pages, competes in the eyes of some newspaper publishers with classified advertising.

While some of these new information services are described below, the list is not complete. It is possible to predict with some certainty what technological capabilities will exist over the next decade or two. It is not possible, however, to predict how entrepreneurs will use those capabilities to bring innovative services to the marketplace. The new information technology base that is being developed and installed offers a rich opportunity for such invention.

Videotex and Teletext

Some European nations, along with Japan and Canada, have been developing a technology that uses the existing television broadcast medium to bring an information service into homes and offices.

A picture on a television screen is composed of several thousand lines. During the transmission of the television signal that-paints the picture line-by-line on the receiver screen, there are a number of times when no useful information is being transmitted. These so-called “blanking intervals” are needed to allow the receiver and transmitter electronics to catch up and get ready to display the next line. While some of these intervals are used to synchronize and control the picture display, many of them are unused. Information can be transmitted in these intervals. A properly modified television receiver can pick out the information and, on command from the viewer, display it on the screen, either alone or on top of the existing picture.

In a teletext system, several hundred or even thousands of pages of information are continually being transmitted. (It may take several seconds to transmit the entire volume of data.) The user selects a page for viewing; the television set then waits for that page to come along in the information stream, picks it out, stores it, and displays it on the screen.

Videotex is a more sophisticated version of this service. It requires two-way communication between the viewer and the transmitter.

The viewer requests a specific item from the central system; that page of information is then transmitted on the television signal to the viewer's screen.

The term videotex is sometimes used more broadly to include all on-line service designed to display information on demand. Such systems may use cable, telephone lines, or new packet broadcast technology to distribute their products. The advantage of videotex is that a larger data base can be made available to the user, since the entire data base does not need to be transmitted continually. It also allows for interaction between the user and the central data base. One could, for example, examine a catalog of merchandise or an airline schedule and then complete the transaction by buying a product or making a reservation. Because it allows individualized interaction with a data base, the videotex system may offer valuable opportunities for educating and training.

Broadcasters and information publishers in the United States have been experimenting in a small way with various forms of videotex and teletext services, in most cases using technology developed in Europe and Canada. A recent proposed rulemaking by FCC opens the way for their widespread introduction. The principal problems in the commercial development of this type of service will be identifying information markets, assembling an adequate and marketable data base, and pricing recorders for home television sets at a level where they can be purchased for use in the average household.

Information Networks

Closely related to videotex are various services that have developed to provide owners of desktop computers and terminals with access to computer and data services over communication networks. This business is expected to grow rapidly over the next decade. Some experts project over $6 billion in annual billings by 1985.

Providers of these services distinguish their markets by the nature of the services offered and by the types of clients they serve. General *services* offer access to a wide variety of data for a broad customer market. *Specialized services* provide narrow, but usually deeper and more sophisticated, information services to customers with special needs. Some firms serve home, professional, and small business users, while others serve large industrial clients.

There are no clear dividing lines between these markets. In general, however, the large-scale specialized data bases tend to be expensive, and using them requires a great deal of computer processing, at either the provider's or customer's end of the telephone line. Systems oriented to individual customers tend to be less costly and less specialized.

For example, using ordinary telephone lines, owners of small computer systems can connect with on-line services such as The Source and CompuServe. Companies like these offer a wide variety of information to subscribers. Although originally oriented to the needs of the home consumer, these firms are beginning to expand their network offerings to the business market. Their services now include direct access to United Press International and Associated Press news wires, stock exchange transactions, weather information, transportation schedules, restaurant and film reviews, sports scores, and even computer programs that can be directly loaded into the home or office system from the company's network.

A number of newspapers are conducting experiments to provide electronic newspapers. Customers paying a special access charge will be able to get news summaries and special features such as horoscopes and weather. Two-way services such as bill paying and teleshopping will also be offered to network subscribers. Customers can view lists of products and prices and put an order into the system. After the product is delivered, the customer will be billed via credit card. Some banks are experimenting with in-home banking services.

In addition to communication with the central network data bases, customers can exchange messages with one another through the system, allowing a simple form of "elec-

tronic mail."* The network services also use this two-way communication to provide elaborate games that can be played by several customers simultaneously.

While The Source and similar firms sell access to a wide variety of services, other companies offer more specialized products. Dow Jones, for example, sells access to its stock exchange data base. A customer with an Apple or other small computer and a communications interface buys a special program for the computer from Dow Jones and subscribes to the data base. Using the home computer, recent transactions can be monitored and historical trends analyzed.

Some firms offer large sophisticated data bases designed primarily to serve institutional customers with special information needs. Examples are:

- Bibliographic and reference data bases for research, are offered by DIALOG Information Services, Inc. (a subsidiary of Lockheed) and the National Technical Information Service (NTIS) of the U.S. Government; also the New York Times Information Service, which offers indexed abstracts and full text retrieval of news articles appearing in a number of magazines and newspapers.
- Medical information are provided by the Medline service of the National Library of Medicine; also, Harper and Row's HARFAX service publishes an on-line pharmaceutical data base.
- Legal information, such as the Legis data bank of citations and the Pergamon online collection of patent information.
- Econometric information such as offered by Data Resources, Inc.
- Natural resources data such as the petroleum reserves estimates developed by the Department of Energy and offered by the I. P. Sharp Co.

*For example, Congressman James Coyne uses The Source as a way to stay in electronic communication with his constituents.

Electronic Conferencing

With electronic conferencing, a meeting is conducted in which geographically dispersed participants talk with one another over telecommunication lines. There are three categories of electronic conferencing, depending on the technology used:

- *Audio conferencing,* which uses the telephone: individuals at different locations are linked together by a conference call wherein both a loudspeaker and a microphone system are used at each location.
- *Video conferencing,* which supplements the voice connection with television images of the participants or of display charts, tables, or other graphics under discussion.
- *Computer conferencing,* which transmits messages through a central computer that stores them and forwards them on request to another participant. In a computer conference, the participants do not need to be connected at the same time. In addition, since each message in the dialog is stored as computer data, it can be indexed to topic, date, sender, and so on. This facility allows a complete running, indexed transcript to be available to the conferees at all times.

All of these conferencing modes offer an alternative to traveling for meetings, thus saving energy and time. Additionally, because computer conferencing offers time-independence, it is even attractive for use within a single office for meetings between busy executives.

Extensive research has been done on the use and effectiveness of different types of teleconferencing systems.[4] Each has its own advan-

[4]J. V. Johansen and K. Spengler, *Electronic Meetings* (Reading, Mass.: Addison Wesley, 1979).

tages, disadvantages, and costs. Video conferencing, for example, will be more expensive than computer or audio conferencing; however, computer conferencing offers time-independence.

Experimental computer conferencing systerns have been operated for some time by Turoff at the New Jersey Institute of Technology (the EIS system) and by the Institute for the Future (the PLANET system). Commercial systems are now appearing on the market. Infomedia, a small California-based firm, is marketing its NOTEPAD conferencing system to large industrial and government clients.

Advanced Business Services

AT&T is planning to offer an advanced data communications service known as ACS (Advanced Computer Service). This service, principally designed to serve major corporate users, will integrate high-speed data communications for computer applications with such uses as teleconferencing (video and audio) and facsimile transmission. Satellite Business Systems is planning to offer a similar service, and other firms may also enter the market soon.

One principal advantage of these new computer-based communication systems is that they will allow the integration of communication services economically over a single high-capacity channel. Incorporation of computers within the network will provide the customer with more flexibility, since the network can handle incompatibilities between different types of computers and terminals and can also manage the flow of work among several interconnected computers. The network can even offer a customer data storage and retrieval, as well as computer-processing services.

Data networking has been of interest to higher education for several years. Post-secondary education institutions may find fewer technological barriers and lower data communications costs if they link their computers and use teleconferencing for teaching and management. Industrial firms that install ACS-type services almost certainly will use them to provide education and training for their employees.