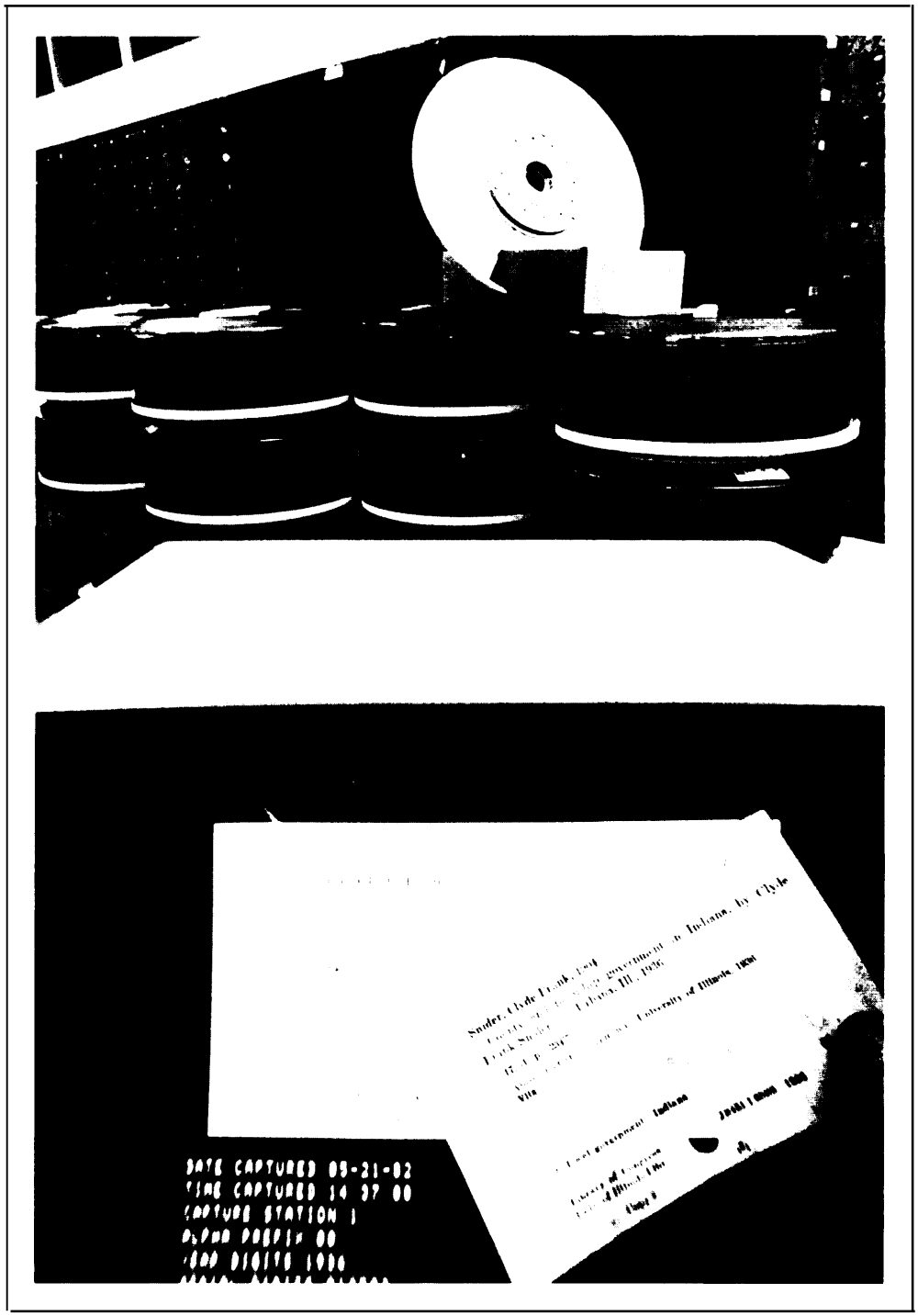
Chapter 2

The United States as an Information Society



To facilitate the storage and accessibility of an increased amount of information, the main card catalog at the Library of Congress is being converted to computer records. Thousands of entries are stored on the correctable magnetic disks. Twenty of these disk packs are entered into one optical disk (seen atop the magnetic packs for permanent record). These optical disks can be randomly accessed and are connected to a printer. They contain an amount of information that was formerly held in 144 card drawers

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The United States as an Information Society

All societies depend to some extent on information—to conduct trade, to govern their society, and to transmit culture and social mores. Because of this, past inventions such as writing, arithmetic, and the printing press have stimulated profound changes. Similarly, development of new information technologies will also deeply effect present-day society. Many of these effects will be in the realm of education.

Findings[1]

- The United States has become an information society, dependent on the creation, use, and communication of information for its economic and social well-being.
- Computer, data communication, and video technologies have become a large and essential element of U.S. society, central to the handling of information by individuals and organizations.
- In the past, information technology inventions such as the telephone have fundamentally altered social institutions and individual behavior; thus, it is reasonable to expect that current and future innovative developments will have corresponding effects, particularly on activities such as education that depend on information.
- Trends in the use of information technology are creating new demands on education in terms of who is to be educated, when education occurs, what is to be taught, how it is to be taught, and what it is to cost.

In a complex, highly technological society, demands grow for quick access to and use of large amounts of information in order to control economic, social, and political processes. It has been suggested that the creation, use, and communication of information are essential components of the infrastructure of a "postindustrial society" such as that of the United States.[2] As a consequence, many societal functions are completely dependent on information technology. For example:

- Airlines use computer networks to control passenger reservations, schedule equipment usage and maintenance, and prepare flight plans; and the Federal Government uses a large computer-based system to control the resulting air traffic.[3]
- Banks and other financial institutions rely completely on computers and worldwide communication networks for managing accounts, clearing checks, exchanging funds, and providing a wide variety of new financial services.[4]
- Major Government agencies, such as the Internal Revenue Service and the Social Security Administration, require large, automated information systems to handle the accounts of hundreds of millions of clients.

[1]Much of the information presented in this chapter is based on OTA'S previous study, *Computer-Based National Information Systems: Technology and Public Policy* Issues, OTA-CIT-146 (Washington, D. C.: U.S. Congress, Office of Technology Assessment, September 1981).

[2]D. Bell, *The Coming of Post-Industrial Society (New* York: Basic Books, 1973).

[3]*Airport and Air Traffic Control System,* OTA-STI-175 (Washington, D. C.: U.S. Congress, Office of Technology Assessment, January 1982).

[4]*Selected Electronic Funds Transfer Issues: Privacy, Security, and Equity—Background Paper,* OTA-BP-CIT-12 (Washington, D. C.: U.S. Congress, Office of Technology Assessment, March 1982).

- The operation of national defense depends on complex computer-communication systems, both for day-to-day management of the military establishment and for command and control of modem sophisticated weaponry.
- Multinational corporations depend on international networks of computers for such applications as production control, management, and financial administration.

Since these and other users of information in the United States are relying increasingly on sophisticated computer and communication systems, it is reasonable to anticipate that information technology will have significant effects on the structure and operation of most of our social institutions. Furthermore, institutions and social processes such as education, which are so dependent on the communication and use of information, will be most affected.

The basic goals of education are the communication of knowledge and skills, the transmission of culture, and the instilling of basic literacy. * Since all of these require that education be closely linked to information processes, education will be deeply affected, both in content and form, by the technological revolution.

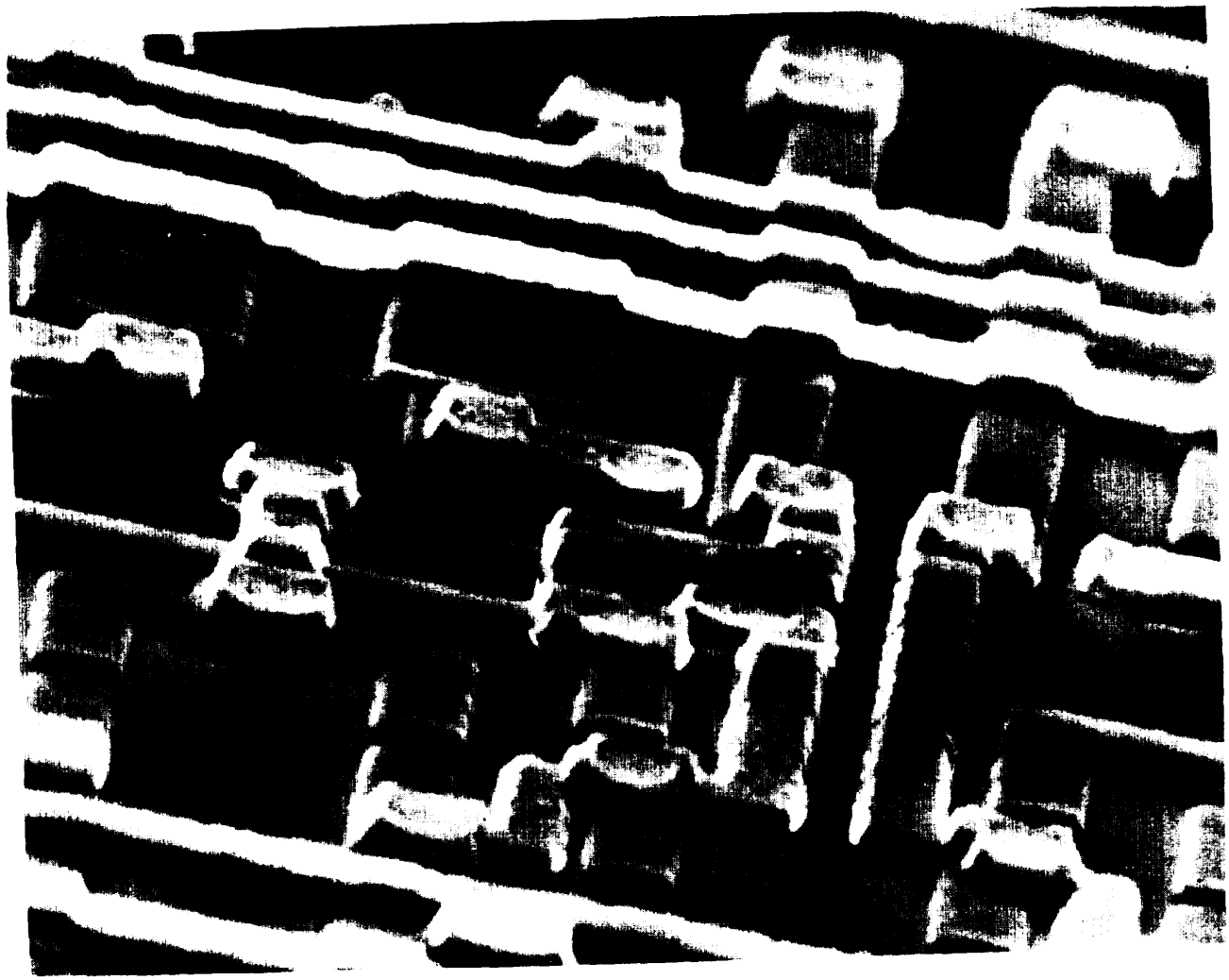
*Definitions of literacy vary among experts. For purposes of this report, a simple definition will be used. Literacy means the ability of an individual to engage in the normal modes of information exchange in a society.

Economic and Societal Impacts of Information Technology

The uses of information and the institutional structures established to collect and communicate it have long historical traditions. For thousands of years, recordkeeping systems have been a basic tool for government, commerce, and finance. They have allowed the formation and management of large organizations. Libraries and museums have existed as archival and reference resources from earliest times–perhaps even earlier than the fourth century B. C., when Alexander the Great built his library. Education also has always served basic societal functions. While the definitions of education and the institutional structures selected to provide it have differed over time and for each particular society, education has always entailed transmitting the values, cultural background, and basic communication techniques (literacy) necessary to function as a member of society.

Technologies such as writing, mathematics, paper, the printing press, and the camera were developed to improve the handling of information. Over the last 100 years there has been a rush of new information technologies that has included the telegraph and telephone, broadcast communication, photocopiers and facsimile transmission, the computer and its related software-considered, in itself, to be an important technology. These inventions have directly affected the collection and use of information. For example:

- The *speed* with which information can be communicated has been increased. Communications that less than a century ago took days, weeks, and even months, now occur within fractions of seconds.
- The quantity of information that can be collected, stored, manipulated, and transmitted has been increased. Data storage systems can hold trillions of characters of information that are instantly accessible through a computer. (One trillion characters of storage contains information equivalent to over 1 million books.)
- Information can be more widely *distributed* and has become more *accessible.* Data communication systems provide instant access to information and to the technology to analyze and use it.



Scanning electron micrograph of a portion of a programmable logic array with locations for up to *4,000 logic elements.* The array was fabricated with the one-micrometer FET technology. Reducing the minimum device dimensions to one micrometer resulted in an increase in speed Of a factor of 3 or 4, and a reduction in power dissipation by a factor of 10, as compared with previous FET circuits

- The ability to use information to account for past actions and to predict future events has been improved. The invention of writing made possible the keeping of historical records. Computers analyze complex statistical models to support management decisionmaking.

These improvements in the quantitative and qualitative aspects of information handling will profoundly affect individuals and organizations that communicate and use information in some of the following ways:

. The *need for* mass literacy: The availability of printed material to the general public has not only made mass literacy possible; in the long run, it has also made it necessary. It has created a world in which it is necessary to be literate in order to fully participate in economic, political, and social activities. In fact, mass literacy has become a basic necessity for economic growth.' Now, with electronic media, defi-

[illegible] W. Schultz, *Investment in Human Capital* (New [illegible] Free Press, 1971).

nitions of literacy must incorporate the ability to communicate and use information technology.

- *An altered relationship between individuals and organizations:* The challenge of the Reformation to traditional church authority, the demise of the feudal system, the great intellectual spurt of the Renaissance, and the birth during the 18th century of political democracy were all due, in part, to the fact that most individuals in society could obtain access to information and could communicate their ideas. If access to information is further enhanced by new technologies, individuals and groups may seek to increase their participation in governmental and organizational processes. If access, on the other hand, is not enhanced, communications technology might provide a new means by which organizations mold social thought and cultural mores and exert their authority.[6]
- *Altered structures in organizational decisionmaking processes:* Technological changes can affect the nature of decisions, the way they are made, and who in an organization makes them. New patterns of decisionmaking can, in turn, affect relationships between organizations and between organizations and their clients and employees.[7]
- *Trends toward centralization or decentralization:* Overall, the trend in communications during this century has been toward centralization. For example, more and more large cities are now served by single newspapers, and a few large networks dominate the distribution of broadcast television programs. However, access to low-cost computers and data communications capabilities can potentially provide organizations and individuals with the ability to tailor applications to their own needs and goals.

Thus, the recent provision via cable television of several new networks to serve the interests of more specialized audiences and the appearance of small specialized newspapers serving individual neighborhoods may be harbingers of greater diversity in services and decentralization of control.

- *Changes in the political process:* Instant domestic and worldwide communications change political behavior and serve to shape public opinion in new ways and in new time frames. Computers allow large-scale and rapid polling of public attitudes and, through sophisticated mailing systems, the formation and coordination of geographically distributed special interest groups. Because they allow for instant public reaction to political decisions, some experts anticipate that new information technologies may bring about a return to a form of political participation that, although involving much larger numbers of people, is reminiscent of the "town meeting.
- *Effects on culture:* Although the new information technologies will undoubtedly affect culture, it is unclear exactly what their effect will be. More people have access to creative products than ever before. And yet the media have, as their critics have pointed out, often served the lowest common denominator of taste. It is also unclear whether information technology will serve to increase uniformity or to promote the diversity of the culture and values of society.
- *Intellectual effects:* The technology that society uses to codify and transmit ideas may affect how people conceptualize and try to solve problems. Some experts have suggested that information technology may break a limiting mental mold forced by writing upon Western thought, and that it may provide new ways to deal with the very complex and difficult problems facing society.[8]

[6] A. Moshowitz, *The Conquest of Will: Information Processing in Human Affairs* (Reading, Mass.: Addison Wesley, 1976).
[7] H. Lucas, *Why Information Systems Fail (New* York: Colombia Press, 1975).
[8] S. Papert. *Windstorms (New* York: Basic Books. 1980).

Extrapolating the general historical impacts that information technology has had in the past suggests that modern technological trends may have a number of effects on education:

- The nature of *Literacy* for society is changing, as it did when the printing press was invented. While the goal of mass literacy, defined as skill in reading and writing, has been met–at least in the developed world —new goals as to who should be literate and what skills literacy should include may now appear:
  1. *Who should be literate:* Universal literacy—defined as skill in reading and writing for *all* people—will have to become a societal goal. The growing complexity of society, coupled with the automation of unskilled jobs, will make it increasingly difficult for semiliterate individuals to lead useful and productive lives. International economic competition and a predicted tighter labor market in the next few decades will place a greater premium on skilled, productive labor. Illiteracy is costly to society not only because it is expensive to support the unemployable but also because society must forego the social and economic contributions that the illiterate, had they been educated, might otherwise have made.
  2. *What skills literacy includes:* The term *literacy* may come to include *media literacy*—the ability not only to receive critically information presented via radio, television, and film, but also to communicate using these media. While programing in these forms has previously been done by large organizations of experts, developments such as the video cassette, the video disk, and the public access cable will place a greater premium on the ability of individuals to use these technologies in their work, at home, for their social organizations, and for political participation. Media literacy will include *computer literacy* —the ability of individuals to use an information system to help them at home and at work. While individuals will not need to be experts in computer science, they will need to know how to use computer programs and information banks and how to evaluate critically the results they get.
- The rate at which new information is generated is accelerating. The dominant emphasis will be on lifelong learning, retraining, and updating knowledge, rather than on schooling that is terminated at an early age on completion of a standard curriculum.[9] Educational curricula will increasingly focus on learning *how to learn* rather than on learning facts.
- The organizational structure and behavior of educational institutions will change. Schools, particularly public schools, are often large bureaucracies specifically designed to collect and transfer information in an organized fashion. Some experts have questioned whether they can ever adapt organizationally to a new technological environment and to new social needs. They foresee as possible *either the* emergence of completely new types of educational institutions based on information technology, or the radical transformation of existing schools.[10]

[9] Stanley M. Grabowski, *Preparing Educators of Adults (San* Francisco: Jossey-Bass, 1981); Charles A. Wedemeyer, *Learning at the Back Door* (Madison, Wis.: University of Wisconsin Press, 1981).

[10] M. Frobe, et al., *Telecommunications and Higher Education,* Occasional Paper #3 (Pittsburgh, Pa.: Institute for Higher Education of Pittsburgh, 1981).

Changing Economic Base of the Nation

The U.S. economy has undergone fundamental changes during this century. A hundred years ago, the economy was principally agrarian. Then, for several decades, manufacturing dominated. Now, the service sector predominates, measured both in terms of its contribu-

tion to the gross national product and in terms of the size of its labor force. (See table 1.) The service sector, as usually defined by economists, includes economic activity that does not result in a tangible, storable output or necessitate a large base of capital equipment. Given this latter categorization, transportation and communications are usually classified as industries rather than services. Education is classified as a service.

Productivity growth in the service sector compared with that in other sectors has been particularly low. This relative lag in productivity is more significant as the size and importance of the sector grows. Some experts suggest that because of the use of economies of scale, new management techniques, and information technology, the service industry is on the brink of a major improvement in productivity." They argue that, to the extent that services are more resistant to such improvements than are other sectors of the economy, their costs will become too high. Thus, those areas of the economy, such as manufacturing, that show growth in productivity will also show wage increases reflecting, to some extent, that growth. If similar wage increases take place in a sector that has not experienced a corresponding improvement in productivity, the real labor costs will grow relative to those in other sectors.

This analysis suggests that if education does not improve its productivity at a rate consistent with the overall improvement of the economy, it will face even more severe financial problems than plague it now. In fact, if other portions of the service sector are about to undergo significant increases in productivity, as some observers expect, the pressures on education to improve its productivity may be intensified.

The appearance and growth of what some economists refer to as the *information sector* has paralleled the growth of the service sector. This portion of the economy, comprised of both service and traditional industries, includes those enterprises that make the machines that handle information, run the communications networks, and use technology to provide information products and services.

An overall analysis of the input/output structure of this sector, which was made for 1966,[12] determined that the information sector accounted at that time for over 60 percent of the economy. This study defined the information sector very broadly and analyzed it at the national level. It has not been repeated for subsequent years. Analytical efforts have, instead, been directed at refining the analysis and at looking at smaller segments of the economy.

Nevertheless, the original calculations are still useful in illustrating the importance of information and information technology in the U.S. economy. They also document the growth in the number of U.S. jobs requiring the handling of information and information machinery. Because information workers are generally assumed to require literacy skills more than workers in other types of jobs, these trends suggest that the country is experiencing a rise in the level of literacy needed to find and hold jobs.[13] The definition of functional literacy may need to be altered to include the ability to use computer-based knowledge.[14]

[11] T. Stanbock, *Understanding the Service Economy* (Baltimore: Johns Hopkins University Press, 1979).

Table 1 .—Percentage Share of the U.S. Economy by Sector

	1948	1961	1976
Employment			
Agriculture.	10.8	6.9	4.2
Industry	43.2	38.6	35.1
Service	46.0	54.5	60.7
GNP			
Agriculture.	9.84	4.2	3.1
Industry	46.8	45.0	41.2
Service	43.9	50.8	55.7

SOURCE: T. Stan bock, *Understanding the Service Economy* (Baltimore: Johns Hopkins University Press, 1979); V. Fuchs, Service *Industries and Economic Growth,* NBER working paper 211, Stanford,

[12] M. Porat, *The Information Economy,* Ph. D. **Dissertation** (Stanford Calif.: Stanford University, 1976).

[13] E. Ginzberg and G. J. Vojta, "The Service Sector of the U.S. Economy," vol. **244/3**, March 1981, pp. **48-55.**

[14] R. J. Seidel, R. E. Anderson, and B. Hunter (eds.), *Computer Literacy (New* York: Academic Press, 1982).

Another economic trend is the growing information marketplace. The publishing industry has existed since the invention of the printing press as a relatively small sector of the economy. Now, stimulated by social pressures and new technological possibilities, it is growing into a large and important sector of the U.S. economy. [15] (Some illustrative growth figures for sectors of the information industry are shown in table 2.)

There are several indicators of this trend. First, even in the current economy, the information industry is growing at a rate of over 20 percent per year. The computer-based data retrieval market alone is projected to grow from $1 billion in 1980 to over $6 billion in 1985. Second, very large international corporations such as Westinghouse are buying into the information business, and large traditional publishing houses such as McGraw-Hill are acquiring high-technology operations in anticipation of their competing in a very different type of information marketplace in the next decade.

The plan announced by AT&T for entry into the information business is viewed with concern not only by potential equipment manufacturers and providers of communication lines, but also by newspapers and other traditional information publishers who see AT&T's new activities as creating potential competition for their businesses. Others see the potential for new information services made available by a restructured, competitive communication industry.

Another indicator of the increased importance of information in the economy is the changed nature of international economic competition. The attention of policymakers concerned with U.S. industrial strength is now focused on competition in innovation. Competitive strength is seen as dependent on the development of new technology, of new products and services based on that technology, and of new manufacturing techniques to make those products.

Table 2.—Some Representative Growth Figures for the Information Industry

Mainframe computers	1965	1975	1985
Number installed	23,200	62,800	77,600
Value in billions of dollars	$7.65	$33.6	$89.1

Desktop computers	1975	1980	1985
Number installed	4,000	326,000	10,579,000
Value in billions of dollars	$0.05	$2,4	$36.7

Newspapers	$17.79
Magazines	3.43
On-line data bases	1.0
Time sharing	2.455
Broadcasting/cable/special communications	28.5
Computer software	5.5
Total	$58.675

NOTE: Figures have been compiled from best available information Estimated probable error runs – 15% to + 5%

SOURCE LINK

[15] H. S. Dordick, et al., *The Emerging Network Marketplace* (Los Angeles: Center for Futures Research, Graduate School of Business Administration, University of Southern California, December 1978).