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2 New Media Technology: *Growth and Integration*

Near the end of the 18th century, William Blake (1946: 150) wrote

> To see a World in a Grain of Sand,
> And heaven in a Wild Flower
> Hold Infinity in the palm of your hand
> And Eternity in an hour

Prophet and visionary, Blake was affirming the omnipresence and holiness of life. Yet we are approaching the time when we can achieve these goals through our communication media. Optical fibers of spun glass, made from the silicon in sand, bring worlds of sound and sight into our lives; the same laser beam used in optical fiber transmission, when used in holograms, contains enough information in any part of its message to recreate the entire original three-dimensional image; a single strand of spun glass can contain nearly infinite bandwidth; and an hour's worth of information transmitted by these fibers would take nearly an eternity with most other media.

New ways of encoding, transmitting, distributing, and displaying information appear most overtly in the form of new communication technologies. For example, digital, as compared to analog, encoding dramatically increases the speed, accuracy, and volume of information that can be exchanged. It efficiently integrates voice, data, and video. It facilitates signal processing and coding techniques. It offers greater privacy and security. But more important, humans are beginning to communicate in new ways as well. New media—from videotex to personal computer networks, from communication satellites to fiber optics—are blurring distinctions that seemed so clear and useful a generation ago:

(1) Technician versus artist. Computer graphics is a new art form that challenges technical expertise as well as creative genius.

(2) General versus limited access. The telephone currently provides near-universal access to people in the United States; with regulatory and commercial developments, local telephone usage may in fact become less accessible.

(3) Regulated versus unregulated media. Commercial network television is heavily regulated: yet the new Federal Communications Commission (FCC) policies for direct broadcast satellites are so unrestricted that potential service providers are asking for more guidelines.

(4) Communication versus processing. This is what the divestiture of AT&T was all about; computerization and communication have nearly completely converged, and both AT&T and IBM are in the "information business." These distinctions are useful at the gross level: local distribution and long-haul transmission are officially communications but not processing; value-added carriers provide both; while service bureaus provide processing but not communication. AT&T's Teleterminal does it all.

(5) Time and space. A public speech delivers a common content to a common set of people at a common time at a common location. Network television delivers a generally common content to a generally common mass. Cable television delivers a (debatably) more diverse content to a generally more diverse set of people. Videotex delivers customized content across varying sets of people, at undetermined times to places potentially unreached by politicians or television. (See Williams, Rice, and Dordick [1984,] for further discussion of these factors.)

(6) Active versus passive control. Early computer-assisted instruction was heralded for letting the student take an active role in learning, but the early systems required nearly mindless passivity from its users, compared to the newest video games.

(7) Transmission versus reception. A mediated communication exchange now may involve so many transmission transformations that any given medium can be both a transmitter and receiver, both medium and content. For example, filmed content may be transmitted by satellite, delivered by cable and shown on television.

The last two of these blurred distinctions lead to a concept crucial to the purpose of this book: interactivity. We generally define new media as those communication technologies, typically involving computer capabilities (microprocessor or mainframe), that allow or facilitate interactivity among users or between users and information. Because of developments in technology and applications, even this definition is not without blurred distinctions. Bretz (1971, 1983) distinguishes between "quasi-interaction" and "interaction": Fully interactive media imply that the sender and receiver roles are interchangeable; they imply that there be a response from A to B based on B's response to A's first initiation (though A or B may be nonhuman). So, teletext systems would not be considered interactive. He does not include videogames either, because there is no cognitive message between interactants; but that is a matter of debate. The distinction is helpful, though, in that our definition as yet provides little lower boundary: choosing among three network stations does, after all, provide some interactivity.

However, this distinction is too fine for the purposes of considering the social and organizational uses and consequences of new media. Perhaps the social distinction lies between interactivity that still operates at the "mass" level and interactivity that makes it very difficult to define a particular mass using a specified content of a given medium. Under this refinement, teletext *is* interactive because it would be quite difficult to argue that a given mass was using the same specific information at the same time. The technical distinction of this definition typically requires a two-way link, within the same transmission channel (as, networked microcomputers) or using different paths each way (as, one-way cable content chosen by a one-way telephone link). This distinguishes between telephone and radio, which are otherwise quite similar technically, in that they use similar components and are transmitted over similar media (wires, microwave, satellites); but radio involves only a one-way link.

We also extend the notion of interactivity to include the expansion of the utility and capabilities of media by means of a computer. Joining a computer (whether mainframe, personal, or microprocessor) to a telecommunications medium or transmission system enables interactivity among the system components, as well as human control over the pace, structure, and content of the communication. So, for instance, computer conferencing is not only interactive in the sense that participants may exchange comments with other participants in real or delayed time, but the system as used is a product of interactions with the system designers, programmers, and conference moderators as they create a communication environment.

SOME COMPONENTS OF THE NEW MEDIA

This book is not about technology. There are fine texts on all manner of communications technology. We might suggest Dordick, Bradley, and Nanus (1981), Martin (1978), Meadow and Tedesco (1984), Pool (1983), or Robinson (1978, particularly the chapter by Walter Bear) as readable places to start. However, subsequent chapters will have occasion to mention certain communication technologies or components of new media. This section very briefly describes processing, transmission, and recording media, and then more fully describes videotex as an example of how various media are redesigned and combined to create new media. As an aid to the reader, Figure 2.1 relates the frequency spectrum to frequency allocations of particular transmission systems.

A Crucial Part Of New Media—The Microprocessor[1]

Some observers claim that the transistor represents the most important single invention of this century. Its discovery occurred in 1947 at Bell Telephone Laboratories in New Jersey. The transistor is so important because it makes possible the miniaturization of electronic equipment such as the computer. Until the transistor, the heart of electronics was the vacuum tube, which had the undesirable characteristics of producing heat, burning out, and taking up quite a bit of space. With transistors replacing vacuum tubes, electronic devices became much smaller and cheaper. Thus the invention of the transistor set off a revolution in miniaturization.

One of the three coinventors of the transistor was Dr. William Shockley. In 1955 he left Bell Labs and moved back to his hometown of Palo Alto, California, to launch Shockley Semiconductor Laboratory. Shockley was very effective in attracting talented young scientists, but they were not happy working under his supervision. In 1957 eight of these brilliant young men left to form Fairchild Semiconductor. Their entrepreneurial fever was copied by other electrical engineers in what soon came to be known as Silicon Valley. Fairchild was the ancestral firm from which about 80 other semiconductor companies have spun off. All but three of the large U.S. semiconductor firms are located in Silicon Valley (a 10-by-30-mile area between Palo Alto and San Jose, California), laying the foundation for the computer firms that were to spring up a few years later. Today there are about 3100 electronics manufacturing firms in Silicon Valley, with about half having fewer than 10 employees. In contrast, 54 firms have 1000 employees or more (Rogers and Larsen, 1984). The dominant themes of Silicon Valley culture are entrepreneurship, high technology, competition in technological innovation, and free market forces (rather than public policies) as a basis for important decisions.

A *microprocessor* is a semiconductor chip (or a set of two or more chips) that contains the logic circuitry or "brains" of the computer. A microprocessor (together with memory chips) forms the essential part of a computer. The microprocessor was invented by Dr. Ted Hoff at Intel

FIGURE 2.1 Frequency, Bandwidth and Categories of Transmission Media

TRANSMISSION MEDIA		APPLICATION	FREQUENCY	WAVE LENGTH	DESIGNATION
Optical Fibers	Laser Beams	Experimental	10^{15} Hz 10^{14} Hz	10-6m	Ultraviolet Visible Infared
Waveguide	Microwave Radio	Experimental Navigation Satellite/Satellite Microwave Relay Earth/Satellite Radar	100 GHz 10 GHz 1 GHz	1 cm 10 cm	Millimeter Waves Super High Frequency (SHF) Ultra High Frequency (UHF)
Coaxial Cable	Shortwave Radio	UHF TV Mobile Aeronautical VHF TV & FM Mobile Radio Business Amateur Radio International Citizen's Band	100 MHz 10 MHz	1 m 10 m 100 m	Very High Frequency (VHF) High Frequency (HF)
Wire Pairs	Longwave Radio	AM Broadcasting Aeronautical Submarine Cable Navigation Transoceanic Radio	1 MHz 100 kHz	1 km 10 km	Medium High Frequency (MF) Low Frequency (LF)
		Telephone Telegraph	10 kHz 1 kHz	100 km	Very Low Frequency (VLF) Audio

Corporation in Santa Clara, California, in 1971, thus opening the way for the continued miniaturization of computers. Hoff's invention was a key event setting off the Information Revolution; it made possible the microcomputer. The first "real" personal computer was devised in late 1974, and combined the Intel 8080A microprocessor, Altair hardware, and Bill Gates's (founder of Microsoft) Basic software. Two thousand kits were shipped in 1975. The second breakthrough came that fall when M05 Technology demonstrated the 6502 microprocessor for $25.00 ($154 less than the 8080 or Motorola's 68000). This made it easier for hobbyists to design their own kits.

The microprocessor amounted to putting computing functions on a tiny semiconductor chip. In the past decade or so, the most widely sold microprocessor (the Intel 8080) has decreased in cost from $360 in 1974 to $2.50 (if purchased in bulk today), and has been used as a component in over 100,000 new products. Such low-priced computing power has facilitated the development of new media in general, and has led to possibilities for increased decentralization and democratization with new media. Such tendencies are, of course, greatly debated. See Danzinger, Dutton, Kling, and Kraemer (1982), Slack and Fejes, (1984), Schiller (1982), and Wicklein (1981) for a skepticism based upon past patterns of multinational and governmental control of information and technologies.

Microcomputers are smaller than either mainframe computers or minicomputers, usually costing from $50 to $10,000. A microcomputer (also called a "personal computer" or a "home computer") sits easily on a desk top, and some are smaller than a briefcase. A typical microcomputer system comprises (a) input devices (such as a keypad, joysticks or keyboard); (b) magnetic storage devices (cassette tape recorder, disk drives for "floppy" diskettes, or large-storage "hard" disks); (c) the central processing unit consisting of the microprocessor, working memory, and connections for the various components; (d) output devices (a TV set or a monitor or a hard-copy printer); and (e) communication to the outside world (modems to connect to telephone lines). Perhaps the most crucial component is the software—disk operating system software for running the central processing unit, and task software for word processing, file management, calculations, custom programming, and the like. Future developments will include light pens, "mouse" or "cat" cursors (such as Apple's Macintosh, Tymshare's Augment, and Xerox's 860 office systems now offer), graphics tablets, voice recognition, and voice synthesis.

Leading manufacturers of microcomputers in the United States are Apple, Tandy/Radio Shack (TRS), IBM, and Commodore. The once clearcut distinction between microcomputers and minicomputers is becoming less important as microcomputers gain more computing capacity. Archetypical of the microcomputer industry is Apple, founded by Steve Jobs and Steve Wozniak—two college dropouts—in 1976, to manufacture microcomputers; today Apple and IBM have a dominant market share (20%-25% each) followed by Tandy/Radio Shack, Timex, and Commodore in the low-cost bracket; producers of larger PCs are being threatened by IBM. See Blundell (1982), Byte (1983), Electronic Business (1982),

Home Video and Cable Yearbook (1982), and Libs (1982) for market share and units shipped for each major vendor. Today there are an estimated 167 firms producing microcomputers in the United States. Before 1975 there were none. During 1982, from 621,000 to 2.8 million microcomputers were sold in the United States for $4.9 to $6.1 billion (depending upon the source and definition). From 7 to 10 million personal computers are expected to be shipped in 1990 (Blundell, 1982; Byte, 1983). About 5%-8% of United States households today have a microcomputer, and an estimated 20% of companies (Time, 1983a).

Currently, based upon a January 1983 Gallup poll[2] the uses mentioned by most PC owners are videogames (51%), business/office homework (46%), children's learning (46%), adults' learning (42%), checkbook budget balancing (37%), home business work (27%), and word processing (18%). Consumer Reports (1983) summarizes how over 2800 of their readers use a PC: games (69%), learning about computers (63%), learning to program (61%), word processing (59%), home accounting (45%), and so on. The primary uses stated in a Yankelovich survey[3] were business (33%), games (25%), learning about computers (15%-20%), and household record-keeping (10%-15%).

Personal computer users are better educated, younger, more affluent, predominantly male, and racially white according to several research organizations specializing in defining the market. Users watch less television, listen to average amounts of radio, and read more magazines than the norms. Primary consumers of PCs are innovators, self-achievers, inner-directeds, and forerunners in the population. That is, they are psychographically predisposed toward adopting new products and services before the rest of the consumer universe (such as cable and pay TV). Two-thirds live in metropolitan areas of 250,000 or more persons. Three-quarters live in central city and urban areas. They are more likely to have had some college or graduated. They are heads of households (with 3-5 persons) and/or are professional/technical workers or lower-middle managers to directors. Their salaries range from $20,000 on up to $90,000, and they are aggressive and goal-oriented (IDC, 1983; Naisbitt, 1980; Simmons Market Research Bureau, 1983; SRI, 1982; Yankelovich, Skelly and White, 1979).

Transmission Channels

This section briefly describes some common means for transmitting communication content.

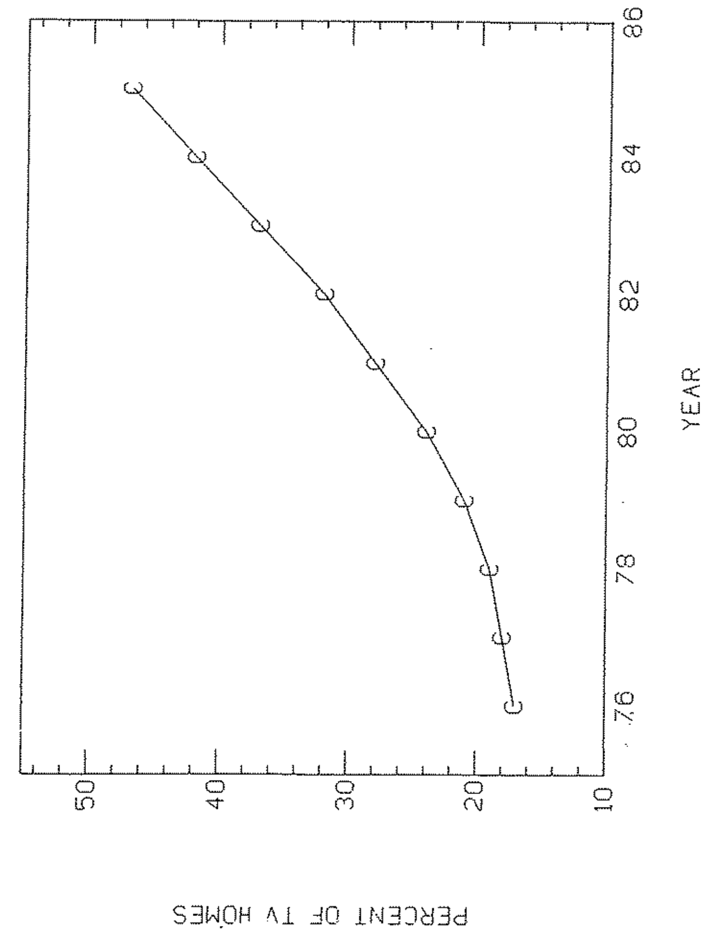
Twisted pair. Local exchange telephone lines consist of a pair of twisted copper wires. These are quite versatile, but a major problem until recently is what is known as the skin effect: At higher frequency transmission, electrons tend to gather on the surface of the wire. Due to system congestion, the skin effect and other problems, high speed data or wideband video just cannot be pushed through twisted pair; even at low speeds the error rate of telephone line transmission is too high for satisfactory computer communication, which is not nearly as redundant (and thus tolerant) as human voice communication. New transmission techniques and termination equipment are making phone lines capable of handling increasingly greater analog and even digital transmission.

In fact, the public switched telecommunications network as we now know it is being dramatically changed due to its conversion to digital transmission. Already value-added services like packet-switched networks (such as Telenet) use high-speed long-haul telephone lines (not twisted copper, but a combination of microwave, satellite, and cable) to connect computers with computers and people with computers. Other processing/computers with computers and people with computers. Other processing/transmission services are described by Dorros (1982). They include automatic call billing, whereby a caller can enter a personal identification number to which the call will be billed; localized answering of 800-number requests, by means of a data base of zip codes and phone numbers that will reroute 800 requests to the most appropriate location or service representative; and a personal locator number, whereby you would inform a local service where you will be, again by means of a dialed identification number, and all calls would be routed to that number.

Coaxial cable places insulated multiple conductors inside each other in one cable; the increased wire surface reduces the skin effect. Use of coax for telephone transmission began in 1936, and is used for long-haul phone (carrying as many as 13,000 simultaneous voice channels) and cable TV (a 450-Mhz(Megahertz) system provides 60 TV channels). Cable delivery of television was originated for areas that could not receive broadcast TV, but of course now has begun to compete with network and local TV by providing tremendous diversity. See Figure 2.2 for the increase since 1976 in basic and pay cable TV; see Chapter 12 for a discussion of media competition. As of July 1983, 35% of U.S. TV households have cable service and 50% are passed by cable services. Currently 6200 cable systems serve 10,500 communities; another 1,500 systems are under construction. There are 65 satellite-delivered cable services (35 nation-wide, 30 regional). Concentration is increasing here as with newspapers: 10 companies or multiple system operators have 50% of all subscribers. The most popular basic service is Spanish International Network, with 3.2 Spanish subscribers alone; the most popular pay service is Home Box Office, with 12 million. However, pay cable demand has dropped off in 1982-1983.

Interactive cable involves either one bidirectional or two coaxial channels, and a microprocessor at the head end (or both ends) to control the flow of information and use the TV as a distribution system. The first two-way cable experiments were in 1971 (see Veith, 1976). They were (a) Rediffusion, Inc.'s pilot system, in which 200 participants were able to view and order a delicatessen's offerings; (b) Sterling Communications' TV polling system, involving 10 terminals in four buildings (they were bought out by Time, which invested in HBO); and (c) Telecable Corp, which provided educational applications with audio and visual communication for some institutional users. Later the National Science Foundation

FIGURE 2.2 Penetration of Basic TV Cable in the United States



SOURCE: Cablevision (1983a).

sponsored two-way cable experiments (see Journal of Communication, 1978).

Optical fibers are finely spun silicon (in some cases, "plastic") threads (from 5 micrometers for "monomode" fibers to 100 micrometers for some "multimode" fibers). Monochromatic light from a laser (or light-emitting diode) is encoded with information and entered into the fiber at a critical angle to ensure total internal reflection, and received at a photoelectric receptor. Advantages of fiber optics include the abundance of cheap silicon, freedom from interference, weather-resistance, small size, massive bandwidth, and transmission security. At the Olympics, fiber optics carried 1342 simultaneous voice channels at 90 Mbps (megabits per second); some pilot cable TV fibers transmit 35-Ghz (gigahertz) TV signals. The transatlantic cable TAT8 will use optical fiber. However, repeaters are necessary (now, only every 26 km), fibers are quite fragile, so splicing techniques are expensive and touchy; and laser performance is not universally acceptable.

Microwave transmission is high-frequency radio transmission, and is used extensively for long-haul telephone transmission. Line-of-sight signals from towers within 30 km are amplified and retransmitted. AT&T has utilized analog microwave data links to provide digital service, called Data Under Voice (DUV). Short, high-traffic routes are fairly inexpensive, although a complete network link is dependent on each tower; additional nodes or routes are quite expensive. A related service is Multipoint Distribution Service (MDS), a microwave common carrier service. Until 1982 each city was assigned one 6 Mhz channel for use in redistribution of video signals. Each MDS tower is limited to 100 watts. Now, the FCC will shortly allocate about 10 channels per city (taking spectrum from Instructional Televison Fixed Service). The first commercial MDS service began in late 1973; future systems will likely be used to deliver commercial movie channels, but could be used for hybrid interactive communications such as delivery of software. There are currently about 750,000 subscribers to MDS services.

Cellular radio. Mobile telephone systems until recently were limited to a very few users who typically experienced busy signals. (See Bowers [1982] for an excellent review of mobile communications.) This was because only a few frequencies were available, they had to be separated by 75 miles before being reused, and they were assigned so they could not be shared.

Cellular radio involves a microwave link to a computer switch in the small geographical area (cell) where the user is currently located, and a retransmission to an unused frequency in the cell. Therefore a large area can provide many users with service because any one set of frequencies is unlikely to interfere with another set in another cell. (Digital packet radio uses bursts of digital pulses on the entire mobile frequency.) The 40 Mhz-bandwidth around the 900-Mhz frequency to be allocated by the FCC translates into about 222 simultaneous channels for each of three cells. As more users subscribe, the cell size can be reduced, freeing up more channels overall. (A controversial aspect of the allocation is that one license per city goes to the local telephone company, and one to a competitive provider who has made the best deal in terms of reducing FCC hearing paperwork.) Eventually this will be accomplished by satellite service, so there will be no connection to local telephone switching or retransmission. Telephone calls using cellular radio will have almost nothing in common with the invention by Bell! AT&T currently has a 2,000-user mobile phone pilot in Chicago. Telocator Network of America estimates there are now 180,000 mobile phone users but will be as many as 3 million by 1990. Arthur D. Little estimates 2.5 million beepers (small mobile phones in the form of pagers) now and 7 million by 1990 (Time, 1983a). The most advanced beepers display written text via LEDs; one model can store 9,100 characters (Dizzard, 1983).

Communication satellites are based upon the fact that an object orbiting at 35,680 km above the earth revolves around it at the same rate the earth rotates; hanging above the equator, it appears stationary over the earth. Thus, only three satellites are needed to cover most of the earth. Communication satellites are microwave relays, receiving and retransmitting frequencies in the C-band (6/4 Ghz), Ku-band (14/12 Ghz) and soon in the Ka-band (30/20 Ghz). (Japan already has a Ka-band satellite for data, facsimile, and video.) The satellite's transponders provide the communication relays; typically there are 24 per satellite, each with a bandwidth of 36 Mhz. For example, one of Westar's transponders provides one color TV channel, 1,200 voice channels, 16 1.544-Mbps channels, 400 64-Kbps (kilobits per second) channels, 600 40-Kbps channels, and some 50-Mbps channels used in the remaining 2 Mhz. At higher satellite frequencies and power, smaller ground antenna satellites can provide thin-route point-to-point networks, multipoint specialized networks (such as business data or teleconferencing), or point-to-multipoint networks (for audio, video, data broadcasts). They provide low-cost, low-error data communications, theoretically distance-insensitive pricing, and great flexibility for adding or changing network configuration. However, transmission security is still a problem, there is a half-second delay from the ground-satellite-ground "hop" that is a difficulty for data transmission, and inexpensive ground antennae require higher-frequency and more powerful satellites. The issue of satellite design, particularly for inexpensive international development purposes, is discussed by Rice and Parker (1979). With powerful-enough satellites combined with innovative transmission techniques, 2-foot receiver-only dishes are now being sold for $2,500 (Parker, 1982, 1983; Markoff, 1983). There are about 55,000 (of all sizes) in use now, up from 25,000 in 1981. These small antennae are already in use by information providers—such as Equatorial's "Spacetext," which will update online personal computer data bases, from satellites in the C-band. Continuing developments to conserve spectrum includes reducing the orbital spacing from 3 degrees to 2, reusing frequencies (polarizing, time division multiple access) and switching between satellites.

The next step, of course, is *direct broadcast satellites* (DBS; see Wigand, 1980, 1982). The FCC has given DBS "regulatory carte blanche," requiring no limits on the number of channels an operator may provide, no programming or access requirements, no ownership restrictions, and allowing either common-carrier or broadcast status. Service has been allocated to 50 Mhz in the 12-Ghz range. DBS services will broadcast commercial video directly to home receivers, as well as provide teletext capability. This will force local TV stations to localize and advertise, will stimulate more program production, extend coverage past cable limits, and will compete with theaters (although it may provide content to theaters). International DBS issues are very controversial (see the Wigand articles), insofar as national sovereignty (cultural and political) as well as economic exploitation and data security are concerned.

A variety of these separate transmission technologies may be combined into a transmission *network*. The motivation for the development of data networks came from an effort in the late 1960s by the Advanced Research Projects Agency (ARPA) to connect computer terminals over long distances, so that research institutions could use other institutions' computers. The first contact civilians had with such a network came in the form of the now-famous ARPANET, which also stimulated much of the early electronic messaging activity (see Rice and Case, 1983).

The ARPANET project director, Larry Roberts, was persuaded in 1972 to join some staff in forming Telenet, which was the first, and is still the most successful, public data network. Acquired by General Telephone (GTE) in 1979, Telenet corners 40% of the network market, serves about 250 cities, and in over 20 provides a 56 Kbps transmission channel by means of "backbone switches," which concentrate the data flow. Tymshare's Tymnet has nearly 40% of the market as well, and serves a similar number of cities with 4.8 or 6.9 Kbps lines. Following in revenue shares are United Telecommunications' Uninet, RCA's Cylix Corporation, Control Data's Cybernet, and Compuserve's Comlink. Several of these are or will soon begin using satellite distribution, to avoid long-distance carrier rates. A recent entry, Satellite Business Systems, is founded on the concept of satellite transmission to rooftop antennas belonging to large corporations with extensive data communication needs. AT&T's Net 1000 offers data storage, remote data processing, and data communications services.

Telecommunications networks represent the convergence and integration of many developments in communication technology. As such, they are the focus of intense engineering, marketing, and competitive efforts. They are also becoming the lightning rod for critical analyses of telecommunications infrastructures. Networks are seen to facilitate better control and coordination by transnational corporations of their activities in less developed countries; thus perpetuating the stratified world system (Mosco, 1982: Chap. 6). To provide their own national networks, or to compete with government-supported transnationals, developing countries have to avoid entering into dependent economic and technological relations. Yet it is very difficult to achieve the necessary technical expertise and financial resources without being drawn into such relations. Further, networks encourage unbalanced flows of information between the developed and developing nations, by storing and processing data outside of the country where they originated or are applied (Schiller, 1982: Chap. 2).

These issues are beyond the scope of this discussion, although alternative perspectives on telecommunications impacts are considered in the next chapter. The social and economic structures generating and maintaining telecommunications networks are appropriate and, some argue, the most fundamental elements of understanding media systems and technologies (Murdock and Golding, 1977).

A Storage Medium: Videodisc

Videodisc is a medium struggling for consumer acceptance, yet with vast potential for interactive education as well as for straightforward random-access storage. The earliest instructional projects were designed by Negroponte at MIT. These involved a simulated "tour" around Aspen, an interactive instructional program showing how to assemble and repair a bicycle, and an online visual catalogue of the Boston Museum of Fine Arts. Other applications include the entire slide collection of cell cultures for a biomedical specialty. A single optical videodisc can contain up to 54,000 visual frames on each side with a bandwidth of 14.7 Mhz. Sony (1982) considers videodisc part of a continuum of interactive video, from basic videotape recording (VTR), remote controlled VTR, "Responder" VTR, consumer laser videodisc, industrial laser videodisc, microcomputer-driven VTR, and microcomputer-driven videodisc. Each of these systems combines various attributes, such as fast duplication, compatibility with standard VTRs, media wear and recyclability, recording "in the field," system monitoring of user performance, frame-accurate access, flow-charting of the progress through content, branching capabilities, user-control of data encoding, and types of responses accepted. Videodiscs themselves have reached .3% to .7% penetration in the United States (Media Science, 1983; Nielsen, 1982a).

The videodisc process in general involves frequency modulation of a video and audio signal into one signal; the frequency spacing is then converted into spacings between, and lengths of, micropits in the disc. A read device reconverts signals from these pits into the intended image with sound. (The November 1983 issue of the Journal of the American Society for Information Science is devoted almost entirely to articles on videodiscs; also see Heath [1981] for an excellent introduction to videodisc technology and vendors; and Lerner, Metaxas, Scott, Adams, and Judd [1983,] for detailed tables on technical and storage characteristics.)

There are two general categories of videodisc technologies: stylus/capacitance/constant linear velocity and laser/optical/constant angular velocity. Within the two categories are two more distinctions.

Stylus/capacitance systems include *grooved* and *grooveless* systems. Both use a stylus, but the first involves a diamond-tipped stylus that tracks very thin grooves (38 grooves in the same width as a phonograph groove) to pick up electrical information instead of undulations. The grooveless system involves a flat stylus that does not read grooves but micropits, which convey information to an electrode in the sapphire stylus tip.

Laser/optical systems include *transparent* discs and *reflective* discs. The first type uses a flat, very flexible transparent disc through which light passes to project the micropit information into a laser decoder. The second type uses a stiff opaque disc, and light is reflected off the disc to a small mirror, which reflects the light into a laser decoder. Case (1981) compares the videodisc approaches in Table 2.1.

One of the implications of videodiscs is rapid access to massive storage for office information. Toshiba has released a system called DF-2000, which copies documents with a laser, stores them on a disc, and retrieves them in seconds. A videodisc can hold the equivalent of 2500 double-density floppy diskettes, or 2 gigabytes of data. The error rate is still too high at this time and system interfaces are basically still in development. However, an integrated information system using videodiscs, fiber optics, and simulated touch-sensitive TV screens has been installed at Disney's EPCOT Center in Florida (Guterl and Truxal, 1982). The system mixes still frames and motion video, even with real-time video contact with

TABLE 2.1 Videodisc Designs Compared

	TYPE OF SYSTEM			
	Capitance		*Optical*	
Feature	*Groove*	*Grooveless*	*Reflective*	*Transparent*
Lower price:				
player	X	X		
disc				X
Playback (per side)				
60 min	X	X		
30 min			X	X
Still frame	(some)	(some)	X	X
Random access		X	X	X
Programmable		X	X	X
Microprocessor		(optional)	X	X
Slow motion forward/reverse		X	X	X
No disc/stylus wear			X	X
Local production/reproduction				X
Stereo/two-track sound		X	X	X
Software variety	X		X	
Life	shortest	short	long	long
Developer (Example)	RCA	JVC	Philips	Thompson ARDEV

SOURCE: Case (1981).

reservation clerks at restaurants. The rapid growth of videodiscs in education and training is described by Kearsley (1981).

AN EXAMPLE OF MEDIA COMBINED: VIDEOTEX

Tyler's (1979) definition of *videotex* seems the most serviceable: Videotex is a

> system for the widespread dissemination of textual and graphic information by wholly electronic means for display on low-cost terminals (often suitably equipped television receivers) under the selective control of the recipient, using control procedures easily understood by untrained users.

There are two general kinds of videotex: broadcast videotex, often called teletext, and interactive videotex, often called videotext.

In the most common form, teletext consists of one-way transmission over video broadcast frequencies, using several lines of the vertical blanking interval (VBI). The VBI contains video control lines pertaining to the picture, the audio, line synchronization, framing, testing, and technical codes; and are the (typically unseen) lines during which the picture cursor returns from the bottom of the video screen to the upper left. Some of the VBI lines are empty, so information can be encoded in them. Each time the cursor is returned, one or more pages of information are delivered. A set of "pages" or screens constitutes a cycle of information and is broadcast continuously. The more pages in a cycle, the longer it takes to retrieve a given page, because more pages have to pass through the cycle until the desired page is broadcast again. Using two VBIs, a reasonable access time of ten seconds limits the data base to about 100-200 pages. A teletext user can press a button on the teletext keypad that selects certain pages of information; they are "stripped" from the VBI as they pass by in broadcast stream, decoded, stored, and displayed, either replacing the video or overlaying it (as in captioning for the deaf). A TV set must be connected to a keypad and decoder (which includes memory, a display generator, and processing capabilities) and switched to teletext mode, to provide information service. Further teletext distinctions are between *narrowband* (using the VBI or a FM radio station signal) and *broadband* (using a full video channel, cable, or MDS).

Videotext generally involves two-way (interactive) communication by means of a telephone link between a modem, a processor-enhanced TV screen (possibly even a special, expensive terminal) and a local or distant computer data base via some network. Here the user selects specific pages from a large computer data base. Limits on pages are based upon computer response time and available computer ports. Videotext distinctions are between narrowband (telephone links) and broadband (cable, optical fibers); and further, between *intermittent* interactivity (where the information is downloaded and stored in the processor, freeing up the phone line) and *continuous* (involving a connection during the entire session). Some continuous systems are so-called hybrids in which the downlink uses a different medium than the uplink. Further technical considerations relate to how the data and graphics are transmitted and displayed at the terminal. See Tydeman, Lipinski, Adler, Nyhan, and Zwimpfer (1982) for the most comprehensive discussion of technical, policy, and market aspects of videotex.

There are clear benefits and disadvantages with the teletext and videotext approaches: trade-offs of content limits, access time, interactivity, expense, utilization of networks, and charging mechanisms.

As of March 1983 the FCC has ruled that VBI lines 14-18, 20, and 21 are available for teletext, that individual operators can decide to carry the signals or not, that they are not subject to the fairness doctrine or equal-time rules, and that teletext service providers can decide if they are common or private carriers. Such policy decisions affect the many actors in videotex delivery: the information providers, advertisers, the data-base operators (local and remote), the service center, communication networks, terminal and monitor vendors, billing arrangements, and the users. Tydeman et al. define five kinds of service: information retrieval, transactions (such as home shopping), messaging, computing (including video-games and user storage), and telemonitoring (e.g., home security).

Videotext originated at the British Post Office in the late 1960s, as Sam Fedida figured a way to increase utilization of the phone service. The TV screen was first used only as a display device; Prestel service began in 1970-1971. General U.S. consumer videotext service began in 1979 with THE SOURCE, followed by H&R Block's COMPUSERVE and the Dow Jones News/Retrieval. Other systems—mostly pilots—are shown in Table 2.2.

Videotex is taking all forms and shapes. Cable or satellite can deliver full channels of information and, thus, access to much larger teletext data bases; the channel can be broken into multiple teletext services, or diverse content can be made available at different times of the day or in different proportions (by altering the times it is broadcast within any cycle) or to different subaudiences (as in Reuter's monitor service delivered by satellite and cable). For example, KSL-TV in Salt Lake augments teletext with touchtone teletext; users request additional menus and information pages by phone, which are broadcast once, and that user receives the desired information without delaying others' access time. Videodisc storage is already increasing system capacity and decreasing access time in some videotex projects. Distribution by cellular radio would allow portable terminals. Speech and data can be multiplexed on the telephone network so that videotex use would not obstruct voice use. Video compression would allow delivery of two video channels to be reconstructed in the receiving TV. CBS's REACH service, a joint test with American Bell in Ridgewood, New Jersey, included 100 information sources, a personal electronic clipping service, messaging, a personal calendar with a tickler file, personal files to save pages, financial transaction, and a way to search across all data bases at once. Both the Hi-Ovus interactive community information system in Japan and the Elie/St. Eustache project

TABLE 2.2 List of Videotext Trails and Services

System	Sponsor	Location	Start Date	User[a]	First Status	Number[b]
UK						
Prestel	British Telecom	UK	1978[c]	R	C	25K
Prestel International	British Telecom	Nine countries	1981	B	C	—
France						
Teletel	PTT	Velizy	1981[c]	R	T	10K
Directory	PTT	Ille-et-Vilaine	1981	R	T	250K
Germany						
Bildschirmtext	Deutsche Bundespost	Dusseldorf	1980[c]	R	T	6000
Netherlands						
Viditel	PTT	Netherlands	1980[c]	B	T	6800
Italy						
Videotel	PTT	Rome	1981	—	—	1000
Norway						
Teledata	PTT	—	—	—	—	60
Finland						
Telset	Helsingin Telset Oy	Helsinki	1978	B	C	260
Telset	Teletieto Oy	Finland, six cities	1981	—	T	—
Spain	PTT	—	—	—	—	200
Sweden						
Datavision	Swedish PTT	Stockholm	1979	—	T	100
Switzerland						
Videotex	PTT	Berne	1979	R	T	150

(Continued)

Table 2.2 Continued

System	Sponsor	Location	Start Date	User[a]	First Status	Number[b]
Austria						
Bildschirmtext	PTT	Austria	1981	R	T	300
Denmark						
Teledata	PTT	Denmark	1981	R	T	200
South Africa						
Beltel	PTT	—	1982	—	—	300
Japan						
Hi-Ovis	MITI/VISDA	Higashi Ikoma	1978	R	T	156
CCIS	MPT	Japan	1976	R	C	500
Captain	MPT and Nippon	Tokyo	1979	—	T	2000
Hong Kong						
Viewdata	Tel Co	Hong Kong	1981	R	T	500
Venezuela						
SOI Project	Office of Information & Statistics	Caracas	1980	R	T	30
Brazil						
Videotex	Telsep	Sao Paulo	1982	R	T	—
Venezuela	—	Caracas	1981	—	—	25
Australia	Myer Emporium	—	1982	—	—	12
Canada[d]						
Vista	Bell Canada & Canadian DOC	Toronto & Montreal	1981	R	T	491
Telidon Project	OECA	Ontario	1980	E	T	55
Project Vidon	Alberta Tel Co	Calgary	1980	—	T	150
Grass Roots	Manitoba Tel Co	Manitoba	1981	F	C	700
Mercury	New Brunswick Tel Co	St Johns	1981	R	T	50
Elie	Manitoba Tel Co	Elie	1981	F	T	145
Videotron	Telecable Videotron	Montreal	1981	R	T	250
Ida	Manitoba Tel Co	Winnipeg	1980	R	T	100
CANTEL	Canadian Govt.	National	1981	R	C	100
INET	Transcanada Tel Co	National	1982	B	T	400
Marketfax	Faxtel	National	1982	B	C	30
BC Tel	British Columbia Tel Co	B.C.	1981	B	T	50
—	Alberta Tel Co	Alberta	1981	E	T	30
Pathfinder	Sastzatchewan Tel Co	Sask.	1982	R	T	25+
Teleguide	Infomart	Ontario	1982	R	C	1000
TVOntario	TVOntario, others	Ontario	1979	E	T	—
Vidacom	Communications Dept., Telecable Videotron, others	Montreal	1983	R	T	250
—	Martime Tel Co	New Brunswick	1982	R	T	—
Cabot	Memorial University	New Foundland	1981	R	T	tourists
Novatex	Teleglobe Canada	National	1981	B	T	325
United States						
GTE's 'Infovision'	GTE	US	1982	B	C	—
Green Thumb	USDA	Kentucky	1980	F	T	200
Viewtel/Channel 2000	OCLC	Columbus Ohio	1980	R	T	200
Viewtron	AT&T and Knight-Ridder	Coral Gables	1980	B	T	260
Dow Jones News Retrieval Service	Dow Jones	Princeton	1977	B	C	70K+
The Source	STC/Readers Digest/CDC	US	1979	B	C	75K
CompuServe	CompuServe	US	1979	R	C	100K

(Continued)

Table 2.2 Continued

System	Sponsor	Location	Start Date	User[a]	First Status	Number[b]
Express Information	Un.Am.Bank/Compuserve Radio Shack	Knoxville	1980	R	T	400
AT&T EIS	AT&T	Albany	1979	R	T	75
Instant Update	Profarmer	US	1981	F	C	—
Cox Cable/Indax	Cox Cable/KPBS	San Diego	1981	R	T	300
Dow Jones Cable	Dow Jones/Sammons	Park Cities, TX	1980	R	T	35
Project Pronto	Chemical Bank	New York	1981	R	T	200
Qube	Warner-Amex	Columbus	1981	R	T	100
Times Mirror Gateway	Times Mirror	Los Angeles	1982	R	T	350
ContelVision	Continental Tel Co	Atlanta, Manassas	1982	R	T	100
PLATO	CDC	US	1961 PLATO IV:1974	E,B	C	1000's
Reach	CBS/AT&T Info. Sys.	Ridgewood, NJ	1982	R	T	200
CompUStar	Comp-U-Card	—	—	R	C	—
Firsthand	J.C. Penney	Minneapolis	1982	F	T	188
Bison	A. H. Belo	Dallas	1981	R	C	80
Knowledge Index	Dialog	Palo Alto, CA	—	B	C	19K
Newsnet (Newsletters)	—	—	1982	B	C	1000
AgVision	Elanco	Indianapolis	1981	F	C	850
Keyfax	Nat'l Teletext Machine	—	—	R	C	350
Electronic News	Harris	Kansas	—	R	C	58
A-T Videotext	Tiffin Advertiser Tribune	Tiffin, Ohio	—	R	C	30
Agristar	Des Moines Register/ Agridata Resources	Des Moines	New	F	C	—
—	Agribusiness	Bakersfield,CA	1982	F	C	500
Learn Alaska Network	University of Alaska	Alaska	1982	E	T	20
Homebase	Citibank	New York	—	R	T	100
Viewcom Electronic Editions	Cowles	Spokane	—	R	T	140
Louisville Courier Journal		Louisville	—	R	T	45
Game Line	Control Video Corp	Vienna, VA	New	R	C	—
Shuttle	Microperipheral	Regional: Seattle 1st	New	R	C	—

SOURCES: Arlen (1983) Butler Cox and Partners, (1980), Canadian Ministry of Supply and Services (1983), Rice and Paisley, (1982), Tydeman et al. (1982), trade literature.

NOTE: Most of these trials have ended or have developed into commercial services. For example, the Cox Indax trial is the first phase of developing commercial services for the 200,000 on the cable system. Most services use specific videotex technology such as Prestel, Telidon, or Antiope, though some (and soon more) offer services via home computers. Most financial transaction services are not included; neither are closed user group/private systems (such as England's SONY which offers 5,000 pages and plans to connect its 4,000 dealers; there are more than 200 private systems each in England and the rest of Europe (CSP International, 1982).

a. Many services actually treat multiple groups, such as residential use of banking transactions, or general/public use. General and public uses are included under residential. B=Business; E=Educational; F=Farming; R=Residential.
b. Number of terminals, trial participants, or subscribers.
c. Experiments were begun in mid-1970s.
d. For an overview of the more than 30 Telidon trials and services, see Feeley (1983).

in Canada use optical fibers—in the former case, to facilitate TV retransmission, TV studio broadcasting, video request services, still pictures, and videotex services; in the latter case, to transmit digital telephone, cable TV, FM radio, and Grassroots (agricultural) videotex simultaneously. It's clear that videotex is a wide-ranging "medium" that is medium-independent!

SUMMARY

The point here is that we must understand technological developments and implications of regulatory policies concerning specific technologies; but it is most important to understand what kinds of communication functions they provide. In the videotex example, nearly any portion of the system may be facilitated by a wide range of media technologies. In one sense this means we have more to learn about the technological aspects of various media; in another it means that the uses and impacts of the medium are the enduring research issues. The next chapter couches both new media and their research issues in the context of traditional and developing communication theories.

NOTES

1. Parts of this section were written by Everett Rogers, and appeared first in earlier versions of Chapter 4.
2. This survey is reported in the *San Francisco Chronicle* (1983).
3. This survey is also reported in the *San Francisco Chronicle* (1983).