The Videophone:

New Life for an Old Idea?

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EXECUTIVE SUMMARY

Since the unveiling of the AT&T Picturephone in 1964, telephones that combine audio and visual capabilities have failed to achieve widespread popularity. Despite this unsuccessful history, several companies plan to introduce video telephones, or videophones, over the next few months. These instruments simultaneously transmit moving color pictures and sound over standard telephone lines.

There are two types of videophones: videophone handsets and videophone attachments for personal computers. Representative models are priced near $1,500. Some videophones can be used on standard analog phone lines, while others require digital phone lines. Videophone picture quality varies, but it is considerably lower than that of broadcast television.

Although many issues will affect the success of videophones, picture quality and price may be most critical. The current generation of videophones may not be acceptable to a society that enjoys high-quality videocassette recorders and big screen TVs. Changes in the telecommunications infrastructure are required to achieve major improvements in picture quality. The high price of videophones may also limit their popularity.

If videophones become widespread, the most likely impacts will be increased business efficiency, decreased energy consumption for travel, and increased opportunities for the hearing impaired.

Most policy options for government and the telecommunications industry involve complementary technologies. The government and the telecommunications industry may choose to invest in digital or fiber-optic telecommunications infrastructures. Sexually-explicit pay-per-call services and entertainment services that compete with television may prompt government regulation.

Chapter 1
INTRODUCTION

Western civilization has long relied on technology to enhance human survival (Porter et al. 1980, 2). It has helped human beings increase production, accelerate learning, facilitate communication, and change both the quality and quantity of leisure time. "Technology and applied science constitute a dominant and crucial force in causing change in modern Western society" (Allen et al. 1957, ix). An awareness of this has led to the study of technology's impact on the economy, the environment, political forces, institutional structures, legislation, and society itself.

Telecommunications technology has had a major effect on the world, allowing people to communicate over great distances nearly instantaneously. This has reduced the importance of proximity between friends, families, and business associates.

Until recently, only the telephone has been able to provide quick audio communication services to the general public. Facsimile (fax) machines have made it possible to transmit still images easily over phone lines. Over the next few months, several companies plan to introduce video telephones, or videophones. These instruments transmit moving color pictures and sound simultaneously over standard telephone lines.

PURPOSE

The purpose of this assessment is to present a balanced and objective analysis of the issues, impacts, and policy options related to the videophone.

SCOPE

Ideally, a technology assessment should consider all relevant cultures and social spheres influenced by the technology under study. However, limited resources and imperfect information rarely allow this degree of comprehensiveness. This section bounds the technological, geographical, and social scope of this study.

Technological Scope

This study focuses only on videophones which link one user to another via standard telephone lines. Video conferencing, which connects multiple users, is thus excluded from the scope of this assessment. Video transmission over dedicated private lines is also excluded. The two types of videophones which will be discussed in this technology assessment are videophone handsets and videophone enhancements for personal computers.

Manufactured by over 25 companies worldwide, these two types of videophones function similarly and raise essentially the same issues, forecasts, impacts, and policy options. Unless stated otherwise, the word "videophone" in this assessment refers to both of these systems.

American Telephone and Telegraph Company's (AT&T) Videophone 2500 and Compression Lab, Inc.'s (CLI) Cameo Personal Video System, Model 2001, are described at length in this assessment because they are representative of the current state of videophone technology.

Geographic Scope

The scope of this assessment is limited to the impact of videophones within the United States. Although the videophone models examined in this assessment are produced by American manufacturers, they are representative of videophones manufactured around the world.

Time Frame

This assessment will consider issues, impacts, and policy options within a 10 year time frame--from 1992 to 2002.

Scope of Audience

This assessment is intended to be informative to lawmakers, videophone manufacturers, and other members of the telecommunications industry.

METHODOLOGY

Several strategies outlined in Porter et al. (1980) were used to identify and analyze impacts and issues related to the videophone. These include the following: brainstorming, surveys,

literature searches, scenarios, checklists, relevance trees, historical analogies, and genius forecasts.

To help forecast the technological future of the videophone, expert opinions were solicited through questionnaires mailed electronically to computer and telecommunications experts. A public survey was conducted to gage consumer reaction towards the videophone.

Chapter 2
TECHNOLOGY DESCRIPTION

This chapter describes a videophone handset, a Macintosh-based videophone codec board, video compression and formats, and physical media for phone transmissions. The chapter focuses primarily on the AT&T VideoPhone 2500 and the CLI Cameo Personal Video System, Model 2001. These products were selected as typical examples of a videophone handset and a videophone coder/decoder (codec) board, respectively. The VideoPhone 2500 is the first in a series of video products and services that AT&T intends to introduce over the next several months (PR Newswire 1992). Cameo is the first item in CLI's desktop-video product line to be released (CLI 1992).

HARDWARE

AT&T VideoPhone 2500

The AT&T VideoPhone 2500 is an analog videophone handset that looks like a traditional telephone with a fold-up 3.3-inch (diagonal) color liquid crystal display (LCD) video screen (see Figure 1, page 6). AT&T claims the product will be available to consumers in May 1992 for a retail price of $1,499. Above the screen is a 1/3-inch fixed-focus electronic camera lens that has a focal range of 1 to 9 feet. The screen and lens can be tilted and swiveled. The VideoPhone 2500 plugs into standard electrical outlets and modular telephone jacks and can be used on standard touch tone or pulse-dial analog phone lines. It can achieve a maximum transmission speed of 10 frames per second and a resolution of 112 X 128 pixels. However, resolution becomes less sharp as transmission speed increases (AT&T 1992; PR Newswire 1992). According to John Slevin (1992), AT&T's VideoPhone marketing director, transmission speed drops to two frames per second when resolution is at its best. Broadcast television transmission speed is approximately 30 frames per second.

The VideoPhone 2500 has a variety of videophone and standard telephone features. Screen messages and prompts remind callers when to press appropriate buttons. Light-emitting diodes (LEDs) on each side of the screen indicate when callers have moved out of the camera's range. In addition, the VideoPhone 2500 has several controls including "focus" (to adjust screen resolution versus speed of motion), screen brightness, and volume. It also has a

Figure 1. AT&T VideoPhone 2500

manual lens shutter, memory features, and speakerphone capabilities (AT&T 1992; PR Newswire 1992).

The VideoPhone 2500 operates in four modes: normal telephone mode for ordinary calls, self-view mode so that callers can check their own images, one-way video mode so that callers can see without being seen, and two-way video mode so callers can see each other (AT&T 1992; PR Newswire 1992).

The VideoPhone 2500 operates at 19.2 kilobits per second (kb/s) over standard analog phone lines using a codec developed for AT&T by CLI. According to Ken Goodgold (1992), area manager at Southwestern Bell's Advanced Technology Laboratory, a digital version of the VideoPhone is expected to be available for $1,800 later this year.

Although AT&T says that the VideoPhone 2500 will be available in May 1992, only six demonstration models were available in April; this may indicate production problems (Goodgold 1992). At the end of April, Slevin (1992) claimed the product would still be available by the end of May. However, he said it might be some time before the company fills orders that were already placed.

Cameo Personal Video System, Model 2001

In January 1992, CLI announced the introduction of its Cameo Personal Video System, Model 2001, a Macintosh-based videophone. It uses standard Basic Rate Interface (BRI) integrated-services digital network (ISDN) telephone lines to transmit 15 color frames per second. Scheduled to be available in the second quarter of 1992, Cameo is list priced at $1,595; the camera module can be purchased for an additional $500 (CLI 1992).

The Cameo System includes a video processor module that plugs into the serial port of a personal computer, a fixed-focus camera module with a focal range of 2 to 7 feet, basic telephone software, and cables. In addition, the following equipment is required: a Macintosh IIci, IIfx, or Quadra running System 7 with QuickTime; an ISDN NB card; a digitizing video card; access to ISDN lines; and a standard telephone. Not including the Macintosh and the cost of the ISDN lines, these extras cost about $2,200. The video processor module sits next to the Macintosh, while the camera module is usually placed on top of the Macintosh screen (see Figure 2, page 8). Users can also use an ordinary video camera in place of the camera module (CLI 1992).

The Cameo System creates a 128 X 112-pixel video window on the user's Macintosh screen. The user can control window size (6-, 3-, or 1 1/2-inch diagonal), tint, and brightness. In addition, the user can keep other applications active while using Cameo and can transmit data from these active applications to the receiving party. Furthermore, the Cameo System has a variety of other features including auto speed dialing, hold and mute functions, and automatic redial (CLI 1992).

VIDEO COMPRESSION AND FORMATS

Video compression techniques are necessary to send video images across a limited-bandwidth medium, such as a telephone line, at high speeds. A conventional copper telephone line can carry no more than 56 kb/s, while an ISDN line can carry 144 kb/s. However, 10 Megabits per second (Mb/s) is necessary for broadcast television-quality video, and 100 Mb/s is required for high-definition television (HDTV). Unless copper telephone lines are replaced with fiber-optic telephone cables, which can carry 100-200 Mb/s (Jurgen 1992, 28; Ang 1991, 16), the speed and quality of moving video images will be limited by the

Figure 2. Cameo Personal Video System, Model 2001

best available compression techniques.

Video compression methods exploit data redundancies, nonlinearities of human vision, and space and time relationships. High video compression rates range between 50:1 and 200:1. At these rates compressed data cannot be reconstructed with 100-percent accuracy. However, even at compression ratios of 100:1, it is possible to produce decompressed data close to the quality of an analog videotape (Ang 1991, 16).

To avoid the development of incompatible systems, three major sets of video compression standards have been proposed: the Joint Photographic Experts Group (JPEG) still-picture compression standards, the Telegraph and Telephone Consultive Committee (CCITT) video teleconferencing standards, and the Moving Picture Experts Group (MPEG) full-motion compression standards. CCITT's Recommendation H.261, also called "px64," deals specifically with videophones. This standard applies to ISDN lines with channel capacity equal to px64 kb/s, where p equals an integer between 1 and 30. The most complex video applications require the highest values of p (Jurgen 1992, 26; Ang 1991, 18).

The CCITT standard is designed to allow codecs from different manufacturers to communicate successfully. The standard is a hybrid coder which combines discrete cosine transform-based coding (DCT) with predictive coding. According to Ang (1992, 17-18), in DCT-based coding time-domain data is converted into frequency-domain data, while in predictive coding "a block in the current frame is predicted from a block in the previous frame using a feedback loop." This inter-frame compression (compression in time) allows the CCITT H.261 standard to achieve a high compression ratio (Ang 1992, 17-18). Inter-frame compression should not be confused with intra-frame compression, which refers to compression in space.

Some videophones are also compatible with the JPEG and MPEG standards (EDGE 1992). JPEG employs intra-frame compression techniques, while MPEG employs both intra- and inter-frame techniques. MPEG, designed for use with digital storage media, is limited to a data rate of 1.5 Mb/s, the maximum data rate of today's digital storage media (Ang 1992, 18).

CCITT has specified Common Intermediate Format (CIF) and Quarter-CIF (QCIF) as video formats for videophones. All codecs following the CCITT standards must use the QCIF format. In addition, they may also use the CIF format. Both CIF and QCIF have maximum picture rates of about 30 frames per second. At that rate CIF requires a bandwidth of 36.45 Mb/s while QCIF requires a bandwidth of 9.115 Mb/s. However, compression techniques can reduce the bandwidth required. Arrays of luminance and chrominance blocks describe the video image in QCIF and CIF formats. CIF uses a 288 x 360 array of luminance blocks and a 144 x 180 array of chrominance blocks, while QCIF uses arrays a quarter of the size of the CIF arrays. When the value of p equals 1 or 2 (as is the case for most currently available ISDN lines), only the QCIF format operated at 10 frames/second or less with a compression ratio of about 50:1 or greater can be used. This is generally unacceptable for videoconferencing, but can be used for videophones. CIF's increased resolution is feasible only when p is greater than 5 (Liou 1991, 60-61).

The Cameo Personal Video System, Model 2001 and the AT&T VideoPhone 2500 support CLI's proprietary DCT-based PV2 algorithm, which uses a video format in between the quality of QCIF and CIF. CLI says customers will be able to add px64 upgrades to the Cameo System soon (CLI 1992).

PHYSICAL MEDIA

Analog Twisted Pair

Most telephone lines are composed of a pair of insulated copper wires, each about 1 millimeter in diameter, twisted together to form a "twisted pair." Twisted pairs are often bundled together to form a cable several centimeters in diameter. Because they are twisted, adjacent pairs do not interfere with each other when bundled. Twisted pairs are cheaper than other transmission media, roughly $1,000 to $1,500 per phone line (Shandle 1991, 29), and can be used for both analog and digital transmission.

Until recently, phone lines were exclusively analog. In analog transmission, the voltage of an electrical signal varies as a function of time, producing a wave of varying frequencies and amplitudes. Analog phone lines have a bandwidth of 56 kb/sec.

Integrated-Services Digital Network (ISDN)

Recently, phone companies have begun converting phone lines from analog to digital. In digital transmission, sounds are converted into strings of 1s and 0s, which are transmitted using electrical pulses. Digital lines have a higher data rate (144 kb/s over copper lines) and a lower error rate than analog lines. In addition, unlike analog lines, they allow voice, data, and video to be transmitted using the same equipment. The ability to integrate these different services gives the digital phone system its name: integrated-services digital network (Tannenbaum 1989, 90-93).

Although narrow band ISDN can be implemented over existing copper phone lines, it is currently 80 to 100 percent more expensive than analog lines due to the cost of the integrated circuit chips needed for digital switching (Kessler 1999, 199). However, the price is dropping. ISDN service is currently being offered on an experimental basis in several U.S. cities, including Manhattan, San Francisco, Atlanta, St. Louis, and Portland (Decina 1990, 116). Until recently, ISDN customers could only communicate locally. ISDN long-distance capabilities are currently being implemented, and ISDN service should become available in most areas in 1993 (Goodgold 1992).

ISDN BRI subscribers get three digital phone lines: two 64-kb/s lines and one 16-kb/s line (Kessler 1990, 33). The cost to subscribe to ISDN BRI is currently about 210 percent of the cost of three analog phone lines (Goodgold 1992). Videophones such as the Cameo System use one of the 64-kb/s lines for audio and one for video.

Fiber Optics

Large increases in bandwidth can be achieved by replacing twisted pairs with fiber-optic cables. Composed of a thin glass or fused silica fiber, fiber optics transmit pulses of light. Multimode fibers can transmit this signals for many kilometers with almost no signal loss due to a principle of refraction that causes the light rays to be bent at the fiber/air boundary. The more expensive single mode fibers are only one wavelength of light in diameter; therefore, the fiber acts as a waveguide, causing the light to travel in a straight line. Single mode fibers can run for much longer distances than multimode fibers. Currently, fiber-optic

cables can transmit 1,000 Mb/s for 1 km (Tannenbaum 1989). Fiber-optic phone lines can be installed for about the same price as twisted pairs (Shandle 1992, 29; Decina 1992, 42).

Chapter 3
SOCIETAL DESCRIPTION

One cornerstone of a technology assessment is the identification and projection of the relationships between the technology and societal institutions, values, and trends. The following description of the present state of society is intended to lay a foundation for these projections.

DEMOGRAPHIC DESCRIPTION

During the 1980s average household size declined modestly, while the divorce rate increased by 40 percent (U.S. Bureau of the Census 1991, 49). Migration from the dying inner cities of the "rust belt" of the Northeast brought rapid growth to the "sunbelt" cities of the South and Southwest. For example, the population of Florida and Texas increased by over 15 percent during the past decade (U.S. Bureau of the Census 1991, 21).

The U.S. Bureau of the Census (1991, 16) predicts that the 45- to-54-year-old age group will increase by almost 50 percent by the year 2000 and that there will be fewer young adults in the 28- to 44-year-old age group.

SOCIAL DESCRIPTION

Values

The 1980s has been stereotyped as the "me generation." Individuals pursued self-satisfaction and accumulated material things, especially gadgetry. Revenues of the Sharper Image gadgetry stores, for example, rose from $14 million in 1981 to $130 million in 1986 (Anon. 1986).

Social values, though, are beginning to change. People are becoming more interested in the quality of their lives. Concern about the environment is growing, especially with regard to issues such as stratospheric ozone depletion, global warming, and recycling. Industry is beginning to realize that environmental-problem solving must become an integral part of doing business. This concern is also being extended to community, social, and political problems.

Sexual Behavior

Over the past few decades, society has become more open about sex. The media has heightened society's awareness of Acquired Immune Deficiency Syndrome (AIDS), teenage sexuality, abortion, and homosexuality. Talk show hosts and sex therapists, such as Dr. Ruth Westheimer, have made sex a more acceptable topic of conversation. Pay-per-call (1-900) phone numbers offering romantic or sexually-explicit conversation have proliferated.

ECONOMIC DESCRIPTION

The United States entered a new era in economics in the early 1980s with the introduction of Reaganomics. Incentives for business investment, tax shelters, and easy-to-obtain loans proliferated. Consequently, leveraged buyouts (LBOs) and conglomerations of corporations became common. Gross Domestic Product (GDP) growth declined as investment capital became tied up in LBOs. The present recession is characterized by high unemployment and low interest rates.

Today's markets are more competitive due to the official unification of European markets into the European Economic Community (EEC) in 1992. Competition from Asian and European markets have hurt the U.S. manufacturing sector. The savings and loan crisis and an astronomical federal deficit, both legacies of Reaganomics, promise to be heavy tax burdens for years to come.

LEGAL DESCRIPTION

The American legal system is inherently reactive rather than anticipatory. Laws are passed by legislative bodies in response to constituent pressures. The interpretation of laws evolve within the judicial system through the challenge of legal precedent. Actions by regulatory panels, such as the Federal Communications Commission (FCC), are authorized by Congress and can be challenged in court.

In recent years, federal courts have moved to the political right as liberal judges and justices have retired and been replaced by conservative appointees. The "trickle-down" effect of this movement, though, has been slow to materialize in state and lower federal courts.

INSTITUTIONAL DESCRIPTION

Family

Divorce and single-parent families have become commonplace (U.S. Bureau of the Census 1991, 49). Children often do not live with both natural parents. Family members live farther apart, and visits are mostly limited to holidays and special occasions.

Religion

Although some people are drifting away from religion, it is still a major force in America. The Moral Majority, a political and religious group supported by the right wing of a powerful faction within the Republican Party, has found a large following by attacking abortion, pornography, and teenage sexuality.

Government

For almost a decade, Democrats have controlled the U.S. Congress, while Republican presidents have dominated the executive office. Presidents Ronald Reagan and George Bush have supported industry interests and large military spending. The Democratic Congress, on the other hand, has favored smaller military expenditures and increased industrial regulation. The result has been policy gridlock on these and other issues.

The Telecommunications Industry

The break-up of AT&T in 1984 was one of the largest anti-trust actions since the Great Depression. However, after almost a decade of strict regulation, deregulation has come back into political style. The regional Bell operating companies (RBOCs) are now being allowed to offer information services, and they are lobbying Congress for access to television programming and video services markets.

The Cable Television Industry

The relatively unregulated cable television industry is growing rapidly. Run mostly "by the innovative entrepreneurs who built [them]" (Gilder 1992, 83), cable television companies are continuing to expand their network of high bandwidth cables. Currently, 60 percent of American homes have cable television hookups, and an additional 33 percent could be easily connected to the cable network (Gilder 1992, 80-84).

The Pay-Per-Call Industry

The pay-per-call (900-number) industry has grown rapidly. In 1990, there were approximately 14,000 900-number vendors offering services ranging from astrological readings to sexually-explicit party lines (BNA 1992b).

Chapter 4
ANALYSIS OF ISSUES

It has been nearly three decades since the introduction of the world's first "videophone" in 1964. While communications technology has advanced significantly since AT&T's black-and-white still-picture Picturephone, videophone technology has not shown impressive improvement. In fact, none of the videophones introduced to date have been successful enough to remain on the market for more than a few years (see Appendix A). With at least 25 companies currently working to get videophones on the market, this technology has been given yet another opportunity to succeed.

The purpose of this chapter is to identify and analyze the technological, psychological, social, economic, legal, political, institutional, and environmental issues that will affect the success of the videophone.

TECHNOLOGICAL ISSUES

The technological future of the videophone will be influenced by a variety of factors including the further development of video technologies, the availability of high-bandwidth phone lines, and the development of competing and complementary technologies. Most experts are not expecting video compression techniques to improve substantially over the next ten years. They predict that videophones will undergo only minor improvements unless major changes occur in the availability of high-bandwidth transmission media. In addition, experts say that when enough bandwidth becomes available, all-in-one video workstations are likely to take the place of videophones.

Expert Survey

In order to help forecast the future of the videophone over the next ten years, a survey was sent through electronic mail to four mailing lists read by computer science, electrical engineering, and telecommunications professionals and graduate students. Fifteen responses were received. They are summarized in Appendix C.

The respondents generally feel that the business market will be more receptive to videophones than the home market. In addition, most are unimpressed with current videophone picture quality and are not optimistic that major improvements will take place until copper phone lines are replaced with fiber optics.

Video Technologies

Without the improvement of digital transmission and storage media, only marginal advancements in video technologies are likely to be achieved. Slight improvements can be made in the accuracy of compression techniques and in the compression ratio. According to experts, however, compression technology is almost "maxed out." Some improvement using ISDN can be realized if voice compression is used and some of the bandwidth currently allotted for voice is devoted to video. However, the investment needed for these incremental improvements in significant. Major improvements in video image quality and speed will require a high-bandwidth transmission medium, such as ISDN over fiber-optic cables.

Physical Media

There has been much speculation as to how soon ISDN and fiber-optic phone lines will become widely available. In addition, some experts predict that cable television companies will soon provide broadband services to compete with the phone companies.

According to the Electronic Frontier Foundation (EFF 1992), a non-profit organization lobbying for rapid deployment of narrow band ISDN, "54 percent of all [subscriber phone] lines are expected to be capable of carrying ISDN by 1994." EFF based this prediction on current plans by RBOCs to install digital switching. The price of ISDN will be a critical factor in determining its popularity. If ISDN is not priced at or near the price of analog phone service, ISDN will probably not become widespread for some time. Therefore, tariffs adopted by state public utility commissions could be an important factor in determining how soon ISDN becomes widely implemented (EFF 1992).

Fiber-optic phone lines are beginning to be installed in new construction sites. Because it now costs about the same amount to install fiber as to install copper, Jack Shandle (1991, 29-30) predicted in *Electronics* that fiber-optic phone lines running into individual homes, known

as "fiber-to-the-curb," will soon be widespread. If fiber phone lines were to be installed only where there are currently no phone lines, a mere 10 percent of the U.S. phone network would be fiber by the year 2000. However, if new services requiring the bandwidth of fiber become available over phone lines, 50 percent of copper lines may be replaced with fiber by the year 2000 (Shandle 1991, 30). Raymond Smith, chief executive of Bell Atlantic Corporation, predicts that if phone companies could financially benefit from replacing copper with fiber, the replacement--which would cost an estimated $200 to $400 billion--could be completed by 2010 (Farhi 1992, A1).

Phone companies such as General Telephone and Electronics Corporation (GTE) are already experimenting with the possibilities fiber-to-the-curb would offer. GTE has installed several experimental home telecommunications hookups which provide television, video-on-demand, videophone, and other services. GTE and other companies see such services as potentially lucrative (Farhi 1992, A1).

In addition to financial factors, legal considerations may also affect the speed at which fiber-to-the-curb becomes widespread. The 1984 Cable Communications Policy Act prohibits phone companies with local phone-service monopolies from offering television service. However, the regulations prohibiting RBOCs from offering information services were lifted last year, and phone companies are now lobbying Congress to lift the television restriction as well. RBOCs say this restriction must be lifted for the switch to fiber to be cost effective (Farhi 1992, A1).

Opponents argue that cable television companies are better equipped to provide broadband services than phone companies because coaxial cables used to transmit programs to cable television subscribers is already broadband, while twisted pair phone lines are not. In addition, cable companies are not as highly regulated as the phone companies. If cable companies provide interactive broadband services, videophones could become a part of the televisions of the future (Gilder 1992, 80-84).

Competing technologies

Several technologies compete to varying degrees with videophones. These include traditional telephones, mobile (or cellular) telephones, fax machines, videoconferencing (or teleconferencing), travel, courier services, video tapes, and video workstations.

Traditional telephones are likely to remain the most popular voice communication devices for many years. This no-frills technology is inexpensive and easy to use, and it provides people with a service that they want and need. The popularity of the mobile phone and fax machine have increased greatly in recent years and will probably continue to increase in the future. While more expensive than traditional telephones, these devices offer added convenience and visual communication respectively. Technology professor Linda Rae Markert (1989, 104) calls the mobile phone "one of the hottest options available on luxury automobiles." Furthermore, "like cellular telephones, the use of the facsimile permits people to conduct business without being confined to their offices."

Videoconferencing and videophones share similar functions, but important differences exist. Although videoconferencing offers a larger picture and higher picture quality than a desktop videophone, it is more expensive (about $25,000), bulky, and not as convenient (Johnstone 1991, 62). Some companies use videoconferencing and videophones to reduce travel expenses. Whether or not this is cost effective depends on the size of the company, the frequency of meetings that require travel, the nature of the meetings, and the distances travelled to attend meetings. Markert (1989, 109-111) explains:

> The basic philosophy of teleconferencing has focused on moving electrons rather than people. Advocates of this type of electronic meeting credit teleconferencing for reduced business travel costs and much improved communications. It is estimated that nearly 80 percent of all business meetings that require travel are intercompany conferences between or among people who already know each other. Electronic meetings can replace the necessity of being physically together.
>
> Teleconferencing also allows managers to draw on experts working in various locations to answer specific technical questions that may come up during a meeting. Transmission costs for these teleconferences are still rather high, but this fact alone seems to motivate conferees to arrive at their meetings more well prepared.

Courier services and video tapes, especially when used together, can also be thought of as competition for the videophone. Courier services provide fast (although not instantaneous) service, and video tapes supply video images. Video tapes currently convey a higher quality image than do videophones. However, videophones offer the convenience of nearly instantaneous service and interactive communication.

Perhaps the primary competition for the videophone is the video workstation, especially if fiber-to-the-curb becomes widespread. This all-in-one computer, telephone, and television, could make many technologies including videophones, traditional phones, television, and home videocassette recorder obsolete. Nearly half the expert survey respondents predicted that video workstations will be more widely adopted than videophones over the next 10 years. One expert survey respondent (number 12) wrote:

> Personally, I don't think [the] videophone is useful in [and] of itself. Analog twisted pair is marginal for such use, and ISDN (digital twisted pair) requires changes in switching equipment that don't justify the slight bandwidth increase. If the physical plant is to be modified, then copper could be replaced at the same time, and a lot of videophone-unique issues disappear.
>
> Once HDTV is installed, and cable accommodates return channels, the videophone can be incorporated readily. I see that as a more likely path than the existing videophone-for-telephone idea.

In addition, Telemanagement Resources International's managing director Scott Douglas, believes that businesses overwhelmingly prefer personal computer-based videophones to videophone handsets because of their versatility (Messmer 1992). The all-in-one video workstation would be even more versatile.

On the other hand, Ken Goodgold (1992) of the Advanced Technology Laboratory claims that videophones must be easy to use to be widely accepted. Market tests showed that most consumers prefer videophone handsets to computer-based phones because they are intimidated by computers. However, as personal computers become more popular and user friendly, consumer preference may shift to the more versatile device.

Complementary Technologies

The physical media discussed in Chapter 2 are the most obvious complementary technologies to the videophone. One can only speculate about the other kinds of complementary technologies that may arise if videophones become widely adopted. These include video answering machines, videophone information services, and video entertainment services. All are extensions of existing audio-only technologies.

The video answering machine of the future may work in much the same way as current audio answering machines. However, it would use a video storage medium instead of an audio tape. Videophone information and entertainment services may include both free and pay-per-call services including news, weather, directory assistance, music videos, how-to videos, and sexually-explicit videos.

PSYCHOLOGICAL AND SOCIAL ISSUES

There are two videophone markets: home and business. Although business and residential customers may have different reasons for purchasing videophones, many of the following psychological and social considerations are issues for both groups. The first part of this section provides an assessment of the videophone's potential success due to psychological and social factors. The next several subsections describe psychological and social issues that will influence whether people will purchase videophones.

Estimated Popularity

Like most other technologies, predictions of the videophone's popularity range from total success to complete failure. A recent front-page article in *The Wall Street Journal* claimed that "the videophone era is at hand. Like many earlier inventions, it may change our lives" (Bulkeley 1992, A1). Indeed, AT&T claims that the videophone will cause "a revolution more far-reaching than fax machines and more profound than the invention of the colour [sic] television" (Bremner 1992). Other predictions are not so positive: a marketing survey conducted by The Yankee Group reports that only 34 percent of Americans are interested in owning a videophone, but those polled were not willing to pay more than $225 for the device (Quittner 1992). As the current retail price is $1,500, the success of the videophone is far from guaranteed.

A public survey conducted in conjunction with this assessment (see Appendix D) reached similar conclusions. Although 43 percent of those surveyed described themselves as "highly likely" or "likely" to use a videophone, less than 20 percent of this group would pay over $999 for one. Fewer than 23 percent would pay more than $499 for the device.

Perhaps the most interesting result of the survey is that few people are ambivalent about the device. Typically, results take the form of a bell curve, with the greatest number of responses in the middle. Yet responses to "How likely are you to use this product?" were most frequently at the extremes, i.e., over 50 percent said "highly likely" or "highly unlikely." Males and individuals below age 30 responded "highly likely" or "likely" more frequently than females or people over 30, respectively.

Privacy

A common complaint about the videophone is that it intrudes on the privacy of one's home or office. According to political sociologist James Katz (1990), "we treasure it [privacy] so much that we willingly forfeit many other benefits to sustain it." Americans generally do not like the idea of strangers and friends alike seeing their homes, offices, faces, and bodies. In addition, the idea of giving obscene callers the means to visually shock is alarming to some (Bremner 1992).

In a scathing article attacking the videophone, syndicated *Los Angeles Times* columnist Michael Schrage (1992, G3) argues in favor of "the visual anonymity" of voice-only telephones:

> The telephone is a medium that lets us converse meaningfully without shackling us to the protocols of eye contact and body language. In the real world--where people are busy and time is short--video and telephones are about as compatible as blackboards and fingernails.

Schrage points to voice mail and answering machines as similar technologies that are used to screen calls to "preserv[e] our privacy and our time [so] as to maximize our interactions and intimacies." University of Toronto professor Marilyn Mantei claims that the videophone may make users more intimate than they want to be (Schrage 1992, G3).

Videophones have features to protect user privacy loss: lens shutters and buttons to turn the video on and off (PR Newswire 1992). Still, users loose some degree of privacy just using these features. "The decision to use it [the video transmission blocking device] will, of course, amount to a statement" (Bremner 1992). This issue may cause the evolution of videophone manners. Steve Grady, sales and marketing manager for British Telecom's Visual Communications Unit, suggests that people will eventually develop rules of videophone etiquette in the same way that they developed telephone manners (Quillinan 1991). Society will have to develop rules regarding who will turn the video portion on first--the caller or callee. This may be influenced by social standing.

The privacy issue surfaces when one user chooses not to appear to another. How will this choice of visual anonymity be interpreted? A person who is refused visual transmission will wonder if the other user is unkempt, dirty, or indecent. In some instances, individuals may not wish to explain their nudity or filthiness. There is likely to be substantial pressure to remove the lens cap when one person transmits his or her image.

Apprehension

Despite the variety of complex technologies that individuals encounter on a daily basis, people are often apprehensive about using new technologies. With regard to the videophone, Grady claims that "there's bound to be resistance at first," but "feelings of self-consciousness tend to evaporate after the first few minutes and they treat it like a normal face-to-face conversation" (Quillinan 1991). This issue may determine the relative success of the videophone handset and the computer-based system in home and business markets. Southwestern Bell's Ken Goodgold (1992) notes that in laboratory research, people generally were confused and intimidated by the computer-based videophone system. By contrast, they felt no such apprehension when using the AT&T VideoPhone 2500. Professionals who use computers daily would probably be less apprehensive about a computer-based system.

Entertainment System

Much has been written in the popular media about pay-per-call pornography lines. An article by Malcolm Forbes, Jr. (1992) claims that "only 900-number purveyors of pornography will welcome videophones." This may be an exaggeration, but it calls attention to the

entertainment potential of the videophone. In addition to pornography lines, future videophone services might include home shopping, video dating (Quittner 1992), dial-a-doctor, traffic and weather reports (Quillinan 1991), and television programs (Farhi 1992, A1).

A negative aspect of this entertainment potential may be that parents who want to censor their childrens' access to sexually explicit images could opt against purchasing videophones. *The Times* reports that "thousands of under-age callers [have] become addicted to the dial-a-porn lines" (Cash 1992). Furthermore, many of these under-age callers are not financially responsible for their actions. United Press International (UPI, 1992) reports that "in some cases minors have run up thousands of dollars in charges on 900 numbers they dialed without permission of their parents."

Novelty

A videophone might be purchased for home use because of its novelty and status-symbol value. A front-page *Wall Street Journal* article claims that AT&T "dropped the idea of a fold-down screen because consumers said they would want visitors to see that they had a videophone" (Bulkeley 1992, A1). Although AT&T chose to keep the fold-down screen, the fact that the company considered dropping the design based on this vanity issue is relevant. The market for novelty goods suffered in 1991; however, it appears to be improving, as indicated by The Sharper Image's increased quarterly earnings over the past four periods (Disclosure Online Database 1992).

Appeal to Hearing Impaired

Videophones might be particularly popular among the hearing impaired, who comprise nine percent of the U.S. population (U.S. Bureau of the Census 1991, 120). Videophones could become a substitute for the teletypewriters (TTY) presently in use. Joshua Gendel (1992), director of the technical services department of the New York League for the Hard of Hearing, claims that teletypewriters are slow and "do not necessarily transmit nuances of expression easily conveyed by spoken, lip-read, or signed language." By contrast, "a videotelephone system would enable hearing-impaired people to communicate with one another, or with normal-hearing individuals, over a distance as easily as if they were in the same room."

ECONOMIC ISSUES

This section reviews economic reasons why videophones may or may not become widespread. Both consumer and producer issues are discussed.

Consumer Issues

General issues. There are several economic factors that consumers may consider when deciding whether to purchase a videophone. First, most consumers presently have a standard phone that has already been paid for. Upgrades and changes are an additional investment. Second, the current prices for videophones are much higher than the prices of standard telephones, although the price of a videophone call is the same. Third, some models require ISDN lines for high-quality video. Since most of today's telephone lines are analog, conversion to digital would cost both the consumer and the telecommunications industry money. Fourth, if ISDN service becomes widely available, analog videophones may soon be obsolete; for this reason, consumers may benefit from a wait-and-see strategy.

Business issues. In addition to the issues cited above, other economic issues apply specifically to business. As noted in Chapter 2, videophones are much cheaper than teleconferencing systems. Also, videophone calls may be substituted for business travel. Although some business meetings are best conducted in person, in many cases a videophone call may be sufficient, thus reducing costs and increasing productivity. Videophones may also be an asset to sales representatives and telemarketers. Consumers may be less likely to hang up on a salesperson when talking face-to-face, and visual contact may make sales transactions more friendly.

Home issues. Substituting video visits for travel is the primary economic incentive for residential consumers to purchase videophones. For example, Robert Kavner, head of AT&T's consumer-products operations, says he will decrease his visits to his mother and call her on a videophone instead (Bulkeley 1992, A10). However, this could serve as a disincentive for Mr. Kavner's mother to purchase a videophone, if she prefers to see her son in person.

Producer Issues

There are several economic issues a company should consider when deciding whether to manufacture videophones. First, there may be only a small consumer market for this type of novelty product, and the price which consumers are willing to pay for the product is low. However, a company may wish to manufacture videophones simply to gain a share of the niche market by introducing the best product first. This would give a company a head start in the manufacture of videophone products.

Second, the production of a videophone requires large sunk costs for research and development, marketing, and production. The substantial investment could result in large profits or debilitating losses. Third, legal fights over patent rights and disputes over standards are also possible. Finally, competing communications mediums and other videophones on the market may limit sales.

Videophone manufacturers contacted refused to disclose expense, profit, and market projections.

LEGAL ISSUES

Privacy, consumer protection, and discrimination are legal issues in which the videophone is likely to become entwined. These issues and the applicability of current laws are discussed below. Patent and copyright protections are also briefly addressed.

Privacy

Even though privacy is not explicitly mentioned in the U.S. Constitution, political sociologist James Katz (1990) notes that some amendments implicitly protect this "well-established legal principle." He predicts that concerns about privacy "will most likely intensify in the years ahead." Because videophone lens caps are removed only at the discretion of users, current privacy-protection laws related to telephone usage are likely to be legally adequate if interpreted to extend to video images transmitted by phone line. Still, there may be a movement toward higher penalties for videophone wiretaps and obscene or harassing videophone calls because video adds another dimension to the perceived invasion of privacy.

Current laws and trends may retard the development of videophone telemarketing, which some people may consider--along with regular telemarketing--to be an invasion of their privacy. The Telephone Consumer Protection Act of 1991 bans most automated telemarketing calls to residences, emergency lines, and hospital or health care institutions. Individuals are allowed to sue telemarketers for actual monetary losses, and states can initiate action to recover up to $500 per violation. The FCC may also give businesses a way to avoid automatically-dialed calls (BNA 1991). The House of Representatives' version of this bill called for creation of a database listing people who do not want to receive unsolicited sales calls (BNA 1991). Although this provision was left out of the compromise bill, it would not be surprising to see such a measure passed within the next 10 years.

Consumer Protection

The growth of videophone telemarketing may also be slowed by recent legislative actions designed to crack down on telemarketing fraud. The Senate and the House have passed similar Telemarketing and Consumer Fraud and Abuse Acts (S1392 and HR3203) requiring the Federal Trade Commission (FTC) to develop rules for the telemarketing industry. States would be allowed to enforce the law by bringing federal court suits against violators (BNA 1992a). Considering the high level of publicity surrounding these legislative efforts, passage of a law by the full Congress seems likely.

Another consumer protection issue relevant to videophone usage is opportunism in the booming 900-number, or "pay-per-call," industry. Although pay-per-call services are likely to develop for videophones, new legislation may have a dampening effect on the industry as a whole as the potential for fraud is diminished.

The House and the Senate have passed Telephone Disclosure and Dispute Resolution Acts (HR3490 and S1579) that would regulate the 900-number industry through the FCC and the FTC. Cost disclosure mandates for calls over $2 and parental consent notice requirements for child-targeted services are likely provisions (BNA 1992b). The FCC is also likely to require that customers be given a way to prevent their phones from being used to make 900-number calls (Santiago 1991). Additional legal steps to defuse concerns about X-rated videophone

pay-per-call services are unlikely to be a high priority unless and until videophone technology improves and becomes widespread.

Disability Discrimination

The American Disabilities Act (ADA) of 1990 is a comprehensive law which prohibits employment bias on the basis of a disability. It also contains broad, equal access requirements and mandates "reasonable accommodation" for otherwise-qualified, disabled job applicants and employees unless this imposes an "undue hardship" (Franklin 1992). This law, which will not entirely take effect until mid-1992, may affect the videophone in two ways: first, in the issue of appearance discrimination, and second, in issues requiring equal access and accommodation for the hearing impaired.

The introduction of the videophone, as discussed in Chapter 6, may tend to fuel societal obsession with physical appearance. This increased concern could lead to clear cases of job discrimination in occupations requiring videophone use. In 1987, the Harvard Law Review published a note proposing that courts "accord handicap status to appearance discrimination victims" (Helldorfer 1987). If such an interpretation were widely accepted, this status might provide appearance discrimination victims protection under Title I of the ADA, which is enforced by the Equal Employment Opportunity Commission (Franklin 1992).

Currently, the ADA is interpreted much more narrowly: a disability must "substantially limit one or more major life activities." This conservative trend is expected to continue in federal courts (Fleury 1991). However, a liberal New Jersey court recently found obesity to be a handicap under the state Law Against Discrimination, following a precedent disallowing discrimination based on perceived as well as actual handicaps (Fleury 1991). Such trends at the state level could open the door for other appearance discrimination law suits.

If videophones become the preferred means of communication for the hearing impaired and are determined to be a "reasonable accommodation," suits could be brought under the ADA against businesses or public services which fail to provide this amenity. Currently, the limits of the ADA are still being tested, and voluntary compliance is the preferred method of

enforcement (Samborn 1992). However, if the price of the videophone declines, it is less likely to be judged to be an "undue hardship" to provide.

Patents and Copyrights

Patent and copyright laws are also videophone considerations. Data compression algorithms and codecs (discussed in Chapter 2) are proprietary technologies critical to the videophone. In the United States, Compression Labs, Inc., manufactures codecs for both AT&T's and its own videophone. Videophone-related patents have not generated controversy to date, and it is unlikely that they will set any legal precedents within the next ten years. Although pictures of copyrighted materials could be easily transmitted via videophone, it is unlikely that this would be a major concern to copyright holders. They face much more urgent threats from the illicit use of copiers, fax machines, and computers (Samuelson 1991, 23).

INSTITUTIONAL AND POLITICAL ISSUES

A variety of institutions may affect or be affected by the videophone. The most important of these are discussed below.

Family

As explained in Chapter 3, family members today tend to live farther apart. Videophones may help connect distant relatives. The Economic Issues section of this chapter describes how videophone calls may serve as substitutes for in-person family visits.

Religion

A technology complementary to videophones is the video pay-per-call service. Religious groups are already mobilizing to make pornographic video pay-per-call services illegal, as discussed in Chapter 6.

Government

The government regulates the telecommunications industry, the cable television industry, and the pay-per-call industry. Congress could establish laws which affect the videophone. These government issues are discussed throughout this assessment.

The Telecommunications Industry

Since July 25, 1991, RBOCs have been allowed to offer information services (Skrzycki 1991, A1). They are currently lobbying Congress for access to television programming and video services markets, as discussed in the Technological Issues section of this chapter.

The Cable Television Industry

The relatively unregulated cable television industry is lobbying against allowing RBOCs into television programming markets. Cable television companies fear that such competition could drive them out of business. They hope to develop interactive video services which could compete with videophone services offered by the phone companies.

The Pay-Per-Call Industry

The pay-per-call industry is poised to exploit the new medium offered by videophones. However regulations discussed in the Legal Issues section of this chapter may limit their profit potential.

ENVIRONMENTAL ISSUES

As described in Chapter 3, environmental concerns are beginning to influence the actions of both consumers and producers. If videophone calls are substituted for travel, energy savings could translate into environmental benefits. In this section, two comparisons of energy consumption are calculated: a long-distance videophone call versus a round trip flight, and a telecommute by videophone versus an automotive commute.

Long-Distance Travel

The power consumption of the AT&T VideoPhone 2500 was unavailable. However, comparing it to other household electronic appliances, a value of 100 watts (W) seems reasonable. An Apple Macintosh IIci with a modem and codec uses about 1 kilowatt (kW). These approximations are dwarfed, though, by the power consumed by equalizers and radio relay stations needed to transmit the signal across long-distance phone lines. Stanford physicist Edward Dickson (1974, 232) calculates this to be 44 kW for a coast-to-coast conversation. Jonathan Turner (1992), professor of Washington University's Computer and Communications Research Center, believes this estimate to be too high. Furthermore, he

predicts that once fiber optics lines are installed, the power consumed by transmission will be several orders of magnitude less. Assuming an electric-generating efficiency of 30 percent (Gibbons, Blair, and Gwin 1990, 94), a videophone system will consume about 150 kW for a coast-to-coast conversation.

Using 1990 data from *AMR/American Airlines Corporate Facts* (1992, 2, 12), an average commercial airplane fuel efficiency of 32 passenger miles per gallon was calculated. Based on round-trip travel between New York and Los Angeles and an energy content of kerosene of 40 kWh/gallon (Dickson 1974, 231), the energy consumed per passenger is about 6,160 kWh.

Comparing the energy used for these two methods of long-distance communication, the videophone conversation consumes less energy for conversations of less than 42 hours. For a five hour meeting, the videophone conversation uses 8.5 times less energy than the round-trip transcontinental airplane flight.

Local Commute

The fuel efficiency of the average automobile is 18 miles/gallon (Gibbons, Blair, and Gwin 1990, 91). Assuming a commuter does not carpool and the energy content of gasoline is 37 kWh/gal (Dickson 1974, 232), the energy consumed by this person is about 2 kWh/mile. This energy consumption is compared to the energy consumed during a conversation using one videophone handset and one Macintosh-based system. For a local conversation, the transmission power used is negligable compared to the power used by the Macintosh (Dickson 1974, 232). Assuming both videophones are used for the entire eight-hour work day, a video commute uses less energy than an automotive commute for distances over 2 miles (each way).

Chapter 5
FORECASTING THE FUTURE OF THE VIDEOPHONE

The purpose of this chapter is to integrate the material of the past three chapters so that some evaluation of the success of the videophone can be made. Without this evaluation, analyzing impacts or making policy options would be futile. In essence, this chapter serves as a bridge between the analysis of the issues that will determine the success of the videophone and the analysis of the impacts that society could face if the videophone is successful. This chapter connects the questions "will the technology succeed?" and "what if it does succeed?" In order to provide such a bridge, four scenarios are shown in Table 1 and described in the following paragraphs.

SCENARIO	HOME USE	BUSINESS USE
I	limited	limited
II	limited	widespread
III	widespread	limited
IV	widespread	widespread

Table 1. Videophone Success Scenarios

SCENARIO I

In this scenario, the videophone follows the same route as its predecessor, the picture phone, or enjoys only short-lived success. Perhaps a few videophone handsets or computer-based systems are sold to families who are dispersed or to companies with corporate headquarters in different regions. Perhaps the videophone is quickly replaced by a new technology. Four reasons for this limited success are: (1) society is content with existing technology, (2) individuals dislike or find no use for videophones, (3) videophones are too expensive, or (4) legal and/or technological advances allow cable television, video workstations, or another

technology to be preferred. Regardless, the videophone is a failure, and after 10 years there are few models on the market.

SCENARIO II

This scenario is characterized by widespread videophone use in business and limited use in homes. Several market conditions could result in this polarization. First, businesses invest in personal-computer-based systems, reducing the price to within the reach of home consumers. However, the technology is thought to be too intimidating for mass market acceptance. Second, businesses invest in videophone handsets, but the price does not fall enough to make the devices affordable for most home users. Lastly, regardless of the system that businesses use, home users choose either an existing or a newly-created alternative.

SCENARIO III

Videophones become a common household appliance, but businesses choose not to invest in the devices. Since affordability is a primary consideration for home users, this scenario is dependent upon videophone price decrease or disposable income increases. Because this scenario presupposes that businesses choose alternative technologies and therefore do not help drive down videophone prices, an economic recovery may be a necessary antecedent to this scenario.

SCENARIO IV

In the final scenario, videophones are widespread in both businesses and homes. This would most likely occur if businesses begin to purchase the devices, the price falls, and then residential customers start to buy them. Economic recovery would be necessary as explained above if the systems used in homes and businesses are different.

Chapter 6

IMPACT IDENTIFICATION, ANALYSIS, AND EVALUATION

My department is in possession of full knowledge of the details of the invention [the telephone], and the possible use of the telephone is limited.

--Engineer-in-Chief, British Post Office, 1877
(Rutter 1987, 1)

Predicting the impacts of a new technology can be difficult. Data communications consultant Gary C. Kessler points out that in the 1870s many people were skeptical of the practicality of the telephone. According to Kessler (1990, 243), a newspaper editor wrote "carrying human voice over copper wires is impossible and even if [it] was possible, the thing would have no practical use." Nevertheless, Kessler writes, "telephones were developed and did find many applications....What did occur was a huge growth in the amount of communication between people and the way in which it occurred."

Like the telephone, the videophone could change the amount and type of communication that occurs between people. It could have a variety of other impacts as well. This chapter discusses potential technological, psychological, social, economic, legal, political, institutional, and environmental impacts of the videophone on society. The probability and possible magnitude of these impacts occurring are qualitatively evaluated in Table 2: Evaluation of Impacts.

TECHNOLOGICAL IMPACTS

The primary technological impact of the videophone may be to increase demand for high bandwidth transmission media. The main reason high bandwidth transmission media are not yet widespread is economic. Phone companies must be certain that sufficient demand for high bandwidth services exists before they invest in ISDN switches or fiber-to-the-curb. If the videophone is successful, as in success scenarios II, III, and IV, it could lead to the development of a high bandwidth communications infrastructure.

Another potential technological impact of the videophone is the advancement of the state of the art of video, compression, and other related technologies. Because there had been much research on technologies requiring similar knowledge, including HDTV, high-speed computer networks, and videoconferencing, little basic research was needed to develop videophones. Further development of the videophone is not likely to substantially increase knowledge of related technologies.

PSYCHOLOGICAL AND SOCIAL IMPACTS

Eli Noam, director of Columbia University's Institute for Tele-Information, claims the videophone "will lead to very different ways to communicate with each other" (Bulkeley 1992, A1). Indeed, some of the most important impacts of the video telephone will be the product's effects on the individual and on society. This section describes the most important and most likely of the primary and higher-order psychological and social impacts.

Each primary impact can be described as a potential behavioral change. "Social psychologists agree that attitudes and actions have a reciprocal relationship, each feeding the other" (Myers 1987, 72). In other words, each of these possible behavioral changes has the potential to cause an attitudinal (or value) change. These changes in attitude could then cause additional behavioral changes, which could either reduce or exaggerate the original behavioral change.

Many impacts, especially value changes, are mentioned as "changes," without specifying the frequency, direction, or degree of change. This is due to the complexity of the issues and the difficulty in predicting societal changes. However, simply because the direction of change is difficult to predict does not mean that the potential impact is negligible.

Appearance

The introduction of the videophone to homes and businesses means that individuals will be seen in situations where they were previously only heard. Research shows that this causes videophone users to become more self-conscious about their own appearance and that of their surroundings. In tests conducted by AT&T, users let the videophone ring 11 times on average before answering it. During this time, the users adjusted their hair, fixed their clothing, and straightened their desks (Williard 1990, D3). Immediate behavioral changes

could consist of videophone users dressing more stylishly, wearing make-up more frequently, and keeping their surroundings tidier. This impact seems likely under scenarios II, III, IV.

As a corresponding attitudinal change, society could place a greater emphasis on appearance. Three psychologists from Old Dominion University conducted a study in 1985 and compared the results to those of a similar study performed in 1972 to see if Americans' feelings about their appearances had changed over time. They concluded that "the pressure to look good seems to have intensified, particularly among men" (Cash, Winstead, and Janda 1986). In an article that spans 20 years of research, psychologist Judith Rodin (1992) writes: "I have witnessed growing concern with appearance...among women of all ages. Men, too, no longer seem immune."

Richard Kurtz, director of clinical training in psychology at Washington University, claims that image has been increasing in importance in Western cultures since the beginning of the industrial revolution (Berstein 1990). Although causation would be impossible to prove, he speculates that technology influenced this increase in the importance of appearance. "If the seed was a preoccupation with image, the fertilizer had to be technology" (Bernstein 1990). In a personal interview, Dr. Kurtz (1992) said that the videophone could make our conversations more superficial: "all of us will become actors." In addition to the immediate appearance changes mentioned above, some consequences of increased preoccupation with appearance might be people trying to improve their image through physical fitness and dieting, improved dental hygiene, and increased use of plastic surgery or other medical means. This impact could occur as a result of scenarios II, III, or IV; however, scenario IV is the most likely catalyst.

Sexual Violence

Columnists in the popular media seem to find it impossible to write articles on the videophone without speculating on pay-per-view pornography services. In addition, a Chicago Alderman, who is running for the U.S. House of Representatives, has built censoring videophone pornography services into his platform (UPI 1992).

The relationship between pornography and sexual violence is controversial. In 1986, the U.S. Attorney General's Commission on Pornography (the Meese Commission) concluded that "substantial exposure to sexually violent materials...bears a causal relationship to antisocial acts of sexual violence and, for some subgroups, possibly to unlawful acts of sexual violence" (U.S. Department of Justice 1986, 326). The Meese Commission also suggests that nonviolent but degrading sexual material is causally related to "the level of sexual violence, sexual coercion, or unwanted sexual aggression [in society]" (U.S. Department of Justice 1986, 333-334). The Commission failed to reach a conclusion with regard to "sexually explicit material [which] is neither violent nor degrading," but it stated that only a "small amount" of such material is currently available (Department of Justice 1986, 336). These findings directly oppose those of the 1970 President's Commission on Obscenity and Pornography.

The Meese Commission report was controversial because many scientists, including some whose research was examined by the committee, claim that no causal relation exists, only correlation (Austen 1986, 42). Some laboratory and histological evidence even suggests that "viewing non-violent sexually explicit material actually reduces aggressive tendencies" (Goldstein 1989, A29). It is beyond the scope of this project to solve this dilemma.

The emergence of sexually-explicit pay-per-call services could cause an increase or a decrease in instances of sexual violence. Regardless of whether or not these services cause a behavioral change, they could alter the way pornography is regarded by society. Scenarios III and IV are most likely to cause these impacts.

Hearing-Impaired Users

As discussed in Chapter 4, videophone use among the hearing impaired could enhance their ability to communicate. This could provide them with better social and business opportunities. John Yost (1992), a social psychology lecturer at Washington University, predicts that the videophone will make conversations among hearing-impaired users more personal.

Value changes that hearing-impaired videophone users could experience include increased self-confidence and self-esteem. The potential for telecommunications technology to improve

feelings of self-worth among the handicapped can be observed in other media formats. Barbara Clements, who has severe cerebral palsy, feels she is "an equal human being on any [computer] bulletin board system" because it allows her to communicate in the mode she prefers (Bertelson 1991, 1D). Likewise, videophones allow hearing-impaired persons to communicate in their preferred modes: sign language and lip reading. Any scenario might cause these impacts, as even in scenario I, hearing-impaired users could be among the few people who purchase videophones.

Population Distribution

Approximately 100,000 corporate employees telecommute regularly (Falbowski 1987). According to technology professor Linda Rae Markert (1989, 116), "some observers project that by the turn of the century as much as 20 percent of the entire [U.S.] population could be involved with computerized home work." Videophones, including personal-computer-based codec boards, could be a necessity for this increase in telecommuters to occur. Potential impacts on telecommuters include greater freedom, more satisfying family lives, increased opportunities for the handicapped, an increased "sense of imprisonment and isolation," and more distractions and interruptions (Markert 1989, 117-118).

Perhaps most importantly, telecommuting could change population distributions. People who no longer need to commute to the office would have less incentive to live near their office. A substantial proportion of white-collar workers could choose to live further from cities and research parks. Scenarios II or IV could cause these impacts.

Privacy

Since privacy is an attitudinal issue, only potential value changes can be identified. It seems likely that videophones could change the importance of privacy in society. John Yost (1992) speculates that because users must consciously choose to see each other, they may be more inclined to think about privacy. This may carry over into other aspects of their personal lives. Scenarios III and IV are most likely to lead to this impact, but scenario II could cause is as well.

Socializing

In so far as videophone calls could become substitutes for in-person interactions, the device could change patterns of socializing. Although parties, bars, and other places where people socialize in groups are not likely to be affected, one-on-one visits could decrease in favor of "video visits." This impact would be caused by scenarios III or IV.

Lying

Widespread videophone use could change habits of lying. "Most people have learned to control their aural image to some extent, but few people are similarly adept at controlling visual image" (Dickson 1974, 101). Yost (1992) claims that lying over the videophone will be more difficult than lying over the standard telephone. Microexpressions, short facial expressions that reveal deceivers' true feelings, and unnatural eye-contact are nonverbal clues that expose liars. Because of this loss of visual anonymity, users could become better at lying "face-to-face" or they could become more honest. Dr. Kurtz (1992) thinks that the former is more likely. Either of these scenarios has a potential value change associated with it: lying could become more or less accepted in society. Scenarios II, III, or IV could cause these impacts.

Discrimination

Dickson (1974, 110) describes telephones as anti-discriminatory. Unless the person one is speaking to has a noticeable accent, one cannot tell the race, religion, or ethnic background of a stranger on the telephone. John Yost (1992) posits that increased contact between races could actually cause people to become less discriminatory or prejudiced. However, the opposite could also occur. The ability to see strangers gives videophone users the capability to discriminate and form prejudices where opportunities were formerly unavailable (Kurtz 1992). Receptionists, telemarketers, and others who previously needed only to sound good could be discriminated against based on their appearances (Dickson 1974, 110). These impacts could be caused by scenarios II, III, and IV.

Body Language

Videophone users will create rules of etiquette for their conversations. Some of these mannerisms could carry over into standard in-person contacts. For example, typical

distances that people stand apart from each other could change. Anthropologist Edward Hall (1966, 107-122) has identified four "distance zones" that characterize different social situations: the intimate distance (less than 1 1/2 feet), the personal distance (between 1 1/2 and 4 feet), the social distance (between 4 and 12 feet), and the public distance (greater than 12 feet). However, regardless of one's relationship, videophone users perceive each other as being about 3 feet apart--the personal distance. This could create awkward situations when speaking with someone who does not belong at the personal distance, whether it is one's spouse or one's superior. Furthermore, Hall (1966, 114) claims that "the boundary line between the far phase of personal distance and the close phase of social distance marks...the limit of domination." Supervisors forced into the personal distance could loose some degree of authority. Dickson (1974, 106) suggests that "in the long run, video telephones may somewhat level status distinctions." Scenarios II, III, and IV may cause these impacts.

ECONOMIC IMPACTS

Videophones may have several impacts upon U.S. macroeconomics. First, if the videophone is successful, it may improve America's manufacturing competitiveness. In the past decade, a substantial percent of the U.S. workforce has shifted from manufacturing-based occupations to service-based occupations. The trade deficit has grown as consumers have bought more foreign goods. American manufacturing of videophones could help to offset this trend if scenario IV occurs.

Second, videophones could affect the GDP through increases in telecommunications, textiles, and cosmetics sales. If scenario II, III, or IV occur and people become more image conscious, sales in these areas may rise. GDP could also grow if videophones improve telemarketing effectiveness. Only scenario IV would cause this.

Third, videophones may increase efficiency when used in place of travel, which may occur in scenarios II and IV. For example, engineers and managers could visually see and fix problems by video, rather than making expensive trips or shipping parts back and forth. This could speed the production process and reduce production costs.

Finally, in scenarios III and IV, videophones could diminish the popularity of shopping malls. Because shopping by videophone would be more convenient, decentralization of shopping activity could eventually occur.

LEGAL IMPACTS

Considering the precedent-following nature of the United States legal system, the videophone is unlikely to break new legal ground unless and until the current network of laws is perceived to be inadequate to accommodate expanded interpretation. Still, there are two areas in which the videophone could have potentially far-reaching legal impacts: discrimination and censorship.

Unattractiveness is not likely to ever be judged a disability because of the normative complexities involved. However, other types of discrimination, such as gender and race, have visual elements. If scenario II or IV occurs and appearing on a videophone is determined to be an "essential function" of a job, it may be simpler to prove that an employer dismissed a qualified applicant or employee because of their appearance.

If a significant pornographic "pay-per-call" industry develops, making X-rated visual material available at the touch of a few buttons, it could help fuel the fire of anti-pornography crusaders. Chicago alderman and 1992 Congressional candidate Bobbie Rush is already proposing a legal ban on videophone sex lines. If censorship laws are passed for this medium, it could set a precedent for similar laws across other media. This could happen if scenarios III or IV occur.

Two other ways in which the videophone could have minor effects upon the law or legal practice are in the professional use of videophones by doctors and lawyers. If doctors were to make a practice of diagnosing patients by videophone, they might need extended medical malpractice insurance. Lawyers might find it convenient to take legal depositions by videophone. Scenarios II and IV could cause these impacts.

INSTITUTIONAL AND POLITICAL IMPACTS

Videophone impacts may affect a variety of institutions. The most important of these are discussed below.

Family

The videophone may promote more communication between family members, thus strengthening family ties. Arno Penzias, Nobel-laureate vice president for research at AT&T's Bell Laboratories explains "when you have a parent in a nursing home, you can't see her [sic] everyday. When you have a child in college, you want to look the kid in the eye when you ask if he's [sic] on drugs." On the other hand, videophones may make it emotionally easier for family members to live farther apart. These impacts could occur with scenarios III and IV.

Religion

As described in the Legal Impacts section of this chapter, fundamentalist religious groups are likely to oppose videophone sex lines, which could carry over into other forms of censorship. This impact could occur with scenarios III and IV.

Government

If scenarios II, III, or IV, occur, Congress may be pressured to establish laws which affect the videophone, as described in the Legal Impacts section of this chapter. Congress may mandate the FCC and FTC to further regulate use of videophones. Additional funding may be required for these tasks.

The Telecommunications Industry

Some impacts on the telecommunications industry are explained in the Technological Impacts section of this chapter. Widespread use of videophones could increase competition among videophone manufacturers. If scenarios II, III, or IV occur, the telecommunications industry could profit. However, if scenario I occurs, the telecommunications industry could face large loses. Further, if the analog videophone becomes popular, it may slow the implementation of ISDN service.

The Cable Television Industry

The cable television industry will be affected by the rate at which ISDN and fiber-optic networks proliferate. If videophone popularity in scenarios II, III, or IV promotes the spread of high-bandwidth services, cable television companies may have trouble competing.

The Pay-Per-Call Industry

The pay-per-call industry could profit from widespread use of videophones in scenarios III and IV.

ENVIRONMENTAL IMPACTS

As discussed in Chapter 4, the primary environmental impact of videophones may be a decline in energy use if videophone conversations are substituted for automobile or airplane travel. However, such substitutions will switch the source of energy production from oil combustion to electricity generation. Scenarios II, III, and IV could be responsible for these impacts.

Automobiles and airplanes are powered by petroleum-based fuels. Emissions from these fuels include nitrogen oxides and hydrocarbons, principle components of smog, and carbon dioxide, the most common greenhouse gas. Extracting and transporting oil can also lead to environmental degradation.

Electricity is primarily generated by combustion of coal or natural gas or by nuclear fission. Mining associated with these energy sources has negative environmental impacts. Burning coal and natural gas also releases carbon dioxide. Furthermore, coal emissions contain sulfur oxides, which cause acid rain, and nitrogen oxides, another greenhouse gas. Nuclear power plants generate hazardous radioactive waste and have the potential for catastrophic accidents.

Increases in telecommuting may lead to demographic shifts from urban to rural areas. This could lead to increased automobile use due to decentralization, urban sprawl, and the impracticality of mass transit. Dickson (1974, 145) presents Los Angeles as an example of a "low density cit[y] with almost complete reliance upon the private automobile for transportation." Dickson (1974, 146) also claims that low-rise buildings typical of suburban

areas are as much as 100 times less energy efficient as tall office buildings of equal floorspace.

SUMMARY

Table 2 summarizes the impacts described above and the likelihood of their occurrence. Likelihood is rated on a scale of 1 to 5, with 5 being very likely to occur. These ratings assume that one of the corresponding scenarios transpires. Primary groups affected and potential policy actors are also listed.

IMPACT	SCE-NARIO	LIKELI-HOOD	PRIMARY GROUP(S) AFFECTED	POTENTIAL POLICY ACTOR(S)
telecommunications and video technologies improve	II, III, IV	1	telecommunications and electronics industries, all members of society	none
ISDN becomes widespread/remains limited	II, III, IV	3/1	telecommunications industry, cable television industry, all members of society	government, telecommun ications industry
fiber-to-the-curb becomes widespread	II, III, IV	1	telecommunications industry, cable television industry, all members of society	government, telecommun ications industry
individuals try to improve daily appearance/importance of appearance increases	II, III, IV	3/2	videophone users, all members of society	government
sexual violence increases/decreases	III, IV	2/1	all members of society	government
socializing patterns change	III, IV	2	videophone users	none
increased opportunities for hearing impaired	II, III, IV	5	hearing impaired	government
increase in self-esteem for hearing impaired	II, III, IV	3	hearing impaired	none
population shifts due to telecommuting	IV	3	all members of society	government
importance of privacy increases/decreases	III, IV	2/3	all members of society	none
people become better at lying/more honest	II, III, IV	3/2	videophone users	none
discrimination increases	II, III, IV	2	videophone users	government
body language changes	II, III, IV	1	all members of society	none
U.S. manufacturing trade deficit decreases	II, III, IV	2	all members of society	industry, government
telemarketing sales increases	IV	3	industry	none
sales of cosmetics, textiles, etc. increase	II, III, IV	2	industry	none
business efficiency increases	II, IV	5	industry	none
employment discrimination suits become easier to win	II, IV	4	disabled persons, women, minorities, employers	none
sexually-explicit pay-per-view services incite censorship-law advocates	III, IV	3	pay-per-view service providers, customers	government
energy consumption decreases because videophone calls become substitutes for travel	II, III, IV	5	all members of biosphere, energy industries	government
energy consumption increases due to urban sprawl from telecommuting	IV	2	all members of biosphere, energy industries	government

Table 2. Impact Summary

Chapter 7
POLICY OPTIONS

Federal, state, and local governments and members of the telecommunications industry may choose to adopt policies related to videophones. Lobbying and consumer advocacy groups may also be interested in policy issues. The following policy options are alternatives to maintaining the status quo.

ISDN AND FIBER OPTICS

Higher bandwidth transmission media, such as ISDN or fiber optics, will be required for improvements in videophone picture quality. RBOCs may want to install ISDN switches and fiber optics to guarantee their place in television programming and information services markets. They may choose to incur short-term losses in anticipation of long-term profits. Governments may want to encourage the installation of ISDN and fiber optics to improve national and local infrastructure. They could keep tariffs low or invest in research and development of these networks. The most far-reaching policy action governments could take would be to allow RBOCs to compete with cable companies for television programming markets, as explained below.

SERVICES

If the federal government wants to stimulate development of the telecommunications infrastructure, it could give RBOCs the opportunity to provide television programming. In addition, it could regulate cable television companies or place high tariffs on cable services. Cable television companies and some consumer rights groups oppose these actions.

Consumer rights groups claim that these actions could put cable companies out of business and leave RBOCs with a natural monopoly on access to fiber-optic networks. They also argue that the cost of establishing fiber-optic networks could be illegitimately passed on to RBOCs' telephone customers (Farhi 1992). If the cable industry sees this competition as a threat to their currnet monopoly, they may want to expand their own infrastructure. They could also choose to invest in infrastructure to compete with RBOCs in the telecommunications market.

Members of the pay-per-call industry may try to exploit the new opportunity offered by the videophone. They may offer a variety of services including sexually-explicit video 900-lines. Consumer rights and anti-pornography groups may pressure governments to regulate these services. Consideration should be given, however, to the precedence-setting potential of what may be construed as censorship.

MARKETING STRATEGIES

For the analog videophone, effective marketing is the key to technology implementation. Ubiquitous video pay-phones could increase product visibility, and a well-publicized rental program could entice potential customers to "try before they buy." Product price is a critical factor, and manufacturers may choose to settle for a low profit-margin to increase demand. The telecommunications industry may also want to monitor videophone acceptance and patterns of use as a form of market research.

If a manufacturer plans to offer a computer-based videophone, the hardware and/or software should be designed or modified so as to be technologically unintimidating to computer-shy users. Furthermore, manufacturers may want to offer both analog and digital products as insurance against infrastructure changes.

MISCELLANEOUS POLICY OPTIONS

If governments want to reduce traffic congestion, decrease spending on roads, and reduce pollution, they may want to encourage telecommuting. If they believe videophones could be a catalyst for this trend, they could consider offering tax incentives or subsidies to businesses that purchase videophones for telecommuting employees.

As discussed in Chapter 4, if current privacy, disability discrimination, and consumer protection legislation proves to be inadequate to cover videophone-related contingencies, lawmakers may choose to develop laws that address these issues more explicitly.

The videophone is essentially a benign technology in the sense that it does not pose any explicit threat to human or ecological health. Social scientists, however, may be interested in monitoring the impact of videophones on human interactions. If, for example, videophone

usage is linked to appearance-related self-esteem problems among children, governments may want to implement educational programs to counteract this trend.

Appendix A
VIDEOPHONE HISTORY

Picture telephone products have had a history of failure as illustrated by the selected chronology below (Bulkeley 1992, A10; CLI 1992).

1964 AT&T Picturephone unveiled at New York Worlds Fair.

1970 AT&T Picturephone made available for $160 per month.

1973 AT&T Picturephone taken off the market.

1987 Mitsubishi markets $1,500 still-picture phone for home use.

1989 Mitsubishi still-picture phone dropped.

1991 Personal-computer based videophone demonstrated by IBM and PictureTel Corporation.

1992 AT&T $1,500 VideoPhone marketed for home use.

1992 CLI $1,600 Macintosh-based videophone marketed for business use.

In the early 1960s, AT&T spent $500 million to develop and manufacture a picturephone for home use. Sales were so poor that the Picturephone became known as the Bell System's Edsel. It was eventually dropped in 1973, and AT&T began to focus on videoconference services for business markets. In 1992, AT&T is again venturing into the home market. The company hopes that use of a codec developed by CLI will make transmission of moving color pictures cost effective (Bulkeley 1992, A1; Noll 1992, F13).

Appendix B

LIST OF ABBREVIATIONS AND ACRONYMS

ADA - American Disabilities Act

AT&T - American Telephone and Telegraph

BRI - Basic Rate Interface

CCITT - Telephone and Telegraph Consultive Committee

CIF - Common Intermediate Format

CLI - Compression Labs, Incorporated

codec - coder/decoder

DCT - Discrete Cosine Transform

EEC - European Economic Community

EFF - Electronic Frontier Foundation

FCC - Federal Communications Commission

FTC - Federal Trade Commission

GDP - Gross Domestic Product

GTE - General Telephone and Electronics

HDTV - High-Definition Television

ISDN - Integrated-Services Digital Network

JPEG - Joint Photographic Experts Group

kb/s - kilobit per second

kWh - kilowatt hour

LCD - Liquid Crystal Display

LED - Light-Emitting Diode

Mb/s - Megabit per second

MPEG - Moving Picture Experts Group

QCIF - Quarter Common Intermediate Format

RBOC - Regional Bell Operating Company

W - Watt

Appendix C
EXPERT SURVEY

SURVEY PROCEDURE

A survey (shown in Figure A-1) was sent through electronic mail to four electronic mailing lists read by computer science, electrical engineering, and telecommunications professionals and graduate students. These mailing lists were: f-troup@dsi.cis.upenn.edu, comp.dcom.telecom, rem-conf@es.net, and vidtec@csa.lbl.gov. Fifteen responses were received. The responses are summarized below.

We are surveying computer science, electrical engineering, and telecommunications professionals and graduate students in order to assemble a technology forecast for the video telephone. This forecast will be a part of a technology assessment that we are preparing for a graduate course at Washington University. We would appreciate if you would take the time to fill out this survey and return it to Lorrie Ackerman (lfa1@cec1.wustl.edu). All responses will be kept confidential. Feel free to forward this to other people who may be knowledgeable about video phones.

Thank you for your time.

Lorrie Ackerman, Gang Chen, Greg Griffin, Huong Nguyen, and Linda Witt

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Employer:

Job title (if you are a student, list university and department):

Have you done research related to video phones? If yes, please describe it briefly.

What percent of American businesses do you predict will own videophones by the year 2002?

What percent of American households do you predict will own videophones by the year 2002?

In your opinion, are there competing technologies that will be more widely adopted than videophones over the next 10 years? If yes, please explain.

What level of picture quality (as compared to current television picture quality) do you think video phones will be able to achieve by the year 2002?

What do you predict the list price of a videophone will be in the year 2002 (in 1992 dollars)?

Additional comments about videophones:

May we contact you for additional information? If so, please list your name, phone number, and e-mail address.

Figure A-1. Expert Survey

RESPONDENTS

1. Engineering Physicist at Fermi National Accelerator Laboratory, has done some "history-of-technology research for popular lecture"

2. Member of technical staff at AT&T, no videophone-related research

3. Systems Engineer in Training, Electronic Data Systems, no videophone-related research

4. Director of Communications Research, USC, has done research on "teleconferencing on packet data networks"

5. Electrical Engineer, Institut for Communication Networks at the University of Technology in Aachen (W-Germany), works on European mobile broadband system project (mobile video telephone could be possible application)

6. Computer Scientist, Netrix Corporation, VA, no videophone-related research

7. Researcher, has done "investigation into the problems of transmission of video over packet switched networks"

8. Systems Research Programmer, University of Michigan, has "looked at network considerations to support [videophones] over circuit and packet mode"

9. WAN editor, Data Communications magazine (also an electrical engineer)

10. Associate Director, Centre for Policy Research on Science and Technology, Simon Fraser University at Harbour Centre, Vancouver, Canada, "worked on an 'imaging' task force, examining the potential for imaging technology over the next 5 years"

11. Assistant Professor, University of Michigan, "have used televideo conferencing as a research tool"

12. Student, University of Pennsylvania Department of Computer and Information Science, no videophone-related research

13. Communications Technician (long distance telephone test board technician, 24 years)

14. Director of Research, "designing an H.261 silicon chip set over the next year. MPEG as well. Nearly complete with the JPEG project."

15. Ph.D. student, Aachen University of Technology, Communication Networks, no videophone-related research

RESPONSES TO QUESTIONS

What percent of American businesses do you predict will own videophones by the year 2002?

1. 7% "on a steep penetration curve, flattening out at 70-80% in the 2012 decade"

2. 0%

3. 30%

4. 10%

5. 5%

6. 60%

7. 50-70%

8. 60%

9. 50% "will have some form of desktop or easily accessible video. The question as to whether it will be a videophone, multimedia window for PCs and workstations, or something else, is still open."

10. 10%

11. "about the same number that now have fax machines plus some that advertise 900 numbers on late night tv"

12. 5%

13. <10%

14. 30%

15. 15%

Mean response = 25%
Median response = 20%
Range of responses = 0 - 70%

What percent of American households do you predict will own videophones by the year 2002?

1. 0.5% "still a luxury item by 2002"

2. 0%

3. 10%

4. 1%

5. 1%

6. 10%

7. 20-30%

8. 15%

9. 15-70% "It depends on which way things go--if multimedia windows become the norm, then perhaps half of all homes with PCs will have videophone, so say 15%. If true, functional, videophones become available, they're likely to be absolutely ubiquitous by then--say maybe 70%. But this is not an exceptionally likely scenario"

10. 1%

11. "Those that call the 900 numbers."

12. <1% "as distinct from HDTV"

13. <1%

14. 5-10%

15. <1%

Mean response = 6%
Median response = 1%
Range of responses = 0-70%

<u>In your opinion, are there competing technologies that will be more widely adopted than videophones over the next 10 years?</u>

1. interactive cable TV and still image transport by electronic mail "may supplant some uses of videophones, making them less cost-effective"

2. pagers, mobile telephones, computer-screen ("smart") telephones, facsimile machines, computer bulletin boards "let us do business in *new* ways and form *new* kinds of organizations. In contrast, the videophone is a dead end."

3. satellite hook-ups "particularly at the Fortune 500 level"

4. video over computer data networks

5. no

6. "do not know"

7. no

8. no "There are competing technologies but videophone will be more widely accepted."

9. ubiquitous videophone/computer/TV "The biggest impact on computing could well be the development of ultra-high-speed networking technologies. If this happens, some people will be able to use their desktop machines to send images, voice, video, and data anywhere in the country as easily as making a phone call. There is a bare chance that this will happen by 2002, and if so it will almost certainly happen in business first, because bandwidth and computers are likely to be pretty expensive, at least at first. Ultimately, however, this will solve the bandwidth problem for home video too; by, say, 2012, we should see a ubiquitous videophone/computer/TV in every house."

10. communicating computer - video on the desktop "approaching 50 percent" adoption in 10 years

11. no

12. HDTV "interactive, possibly incorporating videophones within."

13. computer data via telephone lines "digital delivery"

14. AT&T 9600 bit/sec (1 frame/sec) videophones

15. mobile telephones and mobile data exchange "because mobility of communication is one of the future needs of businesses. Maybe videophones become mobile."

Summary. The number of respondents who listed videophone or competing technology as likely to be more widely adopted over the next 10 years is as follows:

networked computers/ all-in-one computer/phone/tv = 6
videophone = 5
interactive cable TV/HDTV = 2
satellite hookups = 1
pagers = 1
mobile telephones = 2
facsimile machines = 1
computer bulletin boards = 1

What level of picture quality (as compared to current television picture quality) do you think video phones will be able to achieve by the year 2002?

1. 20% of TV picture quality "Spatial, color, and time resolution will be nearly equal to current broadcast video; however, compression techniques will lead to limitations on these so...quality of motion will be affected in a complicated way."

2. poor "transmission rates are very unlikely to rise to the level of television's"

3. 300-400 lines of resolution at 15-20 frames/sec

4. 1/2 as good

5. no response

6. HDTV

7. Better

8. NTSC quality "for many businesses using switched T1. ISDN will limit smaller users to 128K"

9. 56 kbits/sec "Current compression technology is maxed out at about 56 kbits/s and is likely not to do much better. (The AT&T phone cheats by being smaller, which is not going to sell in the long run.)"

10. >200 lines resolution "VCR quality"

11. 1/4 "Same resolution in dots per inch, smaller screen."

12. HDTV "I don't see twisted pair videophone as a realistic device. ISDN videophone is even a bit of a stretch"

13. "The quality of the video is the same. The amount of it that can be delivered is different. One would hope that in ten years it will be possible to run fiber optics to any subscriber location, and if that is the case the delivered video will be also the same."

14. Common Interchange Format (CIF) "With b&W dimensions of 352 columns x 288 rows of samples, 8-bit quantization, 176 x 144 color, and 30 frames/sec. CIF becomes possible at data rates starting around 300kb/s."

15. less than TV quality

Summary. Number of respondents predicting picture quality
better than TV = 3
same as TV = 3
worse than TV = 7

What do you predict the list price of a videophone will be in the year 2002 (in 1992 dollars)?

1. $600 "for the receiver set. For service... probably the same as any business phoneline, as it is desirable to make the video compatible with other voice and data services."

2. "I doubt they'll be around that long."

3. $600 "About the price of a high-end fax machine...plus customer must invest in one or more dedicated phone lines"

4. no response

5. $5,000

6. $300

7. <$500

8. $250

9. no response

10. $500

11. $300 "Same a cheap color TV"

12. "included in the price of an HDTV"

13. "Same as it is now." (surveyor's note: about $1500)

14. $300

15. $1,500

Mean response: $1,032
Mean response without largest data point: $636
Median response: $500
Range of responses: $250-$5,000

Additional comments

1. Technical capability is not the only thing preventing the adoption of videophones. Current phone technology may also provide a high fraction of the things most users need a phone to do. If so, penetration will not follow a steep curve, and the innovation might even bomb if there are not enough other users to talk to. Early videophone use (until 2002) will be spurred by businesses and other users who *need* the capability, helped along somewhat by luxury or prestige markets. Later users will come aboard if (1) there are lots of early users to call and (2) price of service comes down fast enough to make videophones attractive to users who don't have an urgent need....Like fax or e-mail/teletext, videophones are likely to enter the home as attachments to computers rather than as separate appliances. If this is true, then technoculture and home office users will lead the way in home penetration.

2. none

3. I've seen first-hand a video conferencing system at my workplace which used several dedicated telephone line. It looked like there was about 300-350 lines of resolution at 5 frames/sec....I didn't consider the picture quality to be acceptable, and the slow frame rate was especially distracting. I believe any 'videophone' system should provide a reasonably good picture resolution...at at least 20 frames/sec before it'll be widely accepted in the business marketplace.

   As for consumer electronics: There's only so much data that you can pack in an ordinary phone line, and it would seem there would be a considerable amount that you would need to transfer if you are to get synchronized pictures and voice over a single line at any acceptable speed or resolution. That's assuming 1991 telecom technology, but I'm not sure that in a span as short as 10 years we're going to be able to have installed anything of a higher quality (such as ISDN)--particularly in average households. The bottom line, I think, is that the videophone will be a very high-end consumer item, because it seems to me that to get any kind of acceptable quality is going to require one or more dedicated (ordinary) phone lines...or a very sophisticated piece of gear, or both....

4. none

5. none

6. none

7. none

8. Worldwide development of ISDN is a significant requirement for the proliferation of these devices.

9. The problem with videophones today is the same as when they were first introduced in 1964: namely, they take up too much bandwidth and cost too much (for high-quality video) and are of unacceptably low quality (otherwise). The AT&T videophone

is too expensive and too low-quality for most people to be interested. What's needed is a massive increase in bandwidth to the premises, which may or may not happen. If every house got fiber, for example, the bandwidth problem would disappear. Videophones would become devices you connect to your TV like a VCR. The chances of this happening are slim though, because of a) cost b) legal issues--the companies most likely to pull fiber to the curb are not likely to be allowed into the phone business (or vice versa). My guesstimate is that we will see eventual 56/64 kbit/s lines to the home, which means a low-quality, inexpensive video phone might become possible by 2002.

10. Videophones, if you mean by that the type being currently sold by AT&T, are a loser, I think. The more reasonable development is video on the desktop PC. I think a review of current released equipment will give you plenty of examples of the move in that direction. The jump people have made to make their PCs into "Windows compatible" of "System 7 compatible" (for Macs) is enough to get them to the next step, with an add-on board and an ISDN-type connection.

11. none

12. Predicting use patterns and percent population should accommodate mistakes in prior models of the telephone and TV. I.e. the phone was thought to be of use only for group listening of concerts, i.e. wired radio. If this model makes predictions, it should explain these previous errors and describe how they are to be avoided.

    Personally, I don't think videophone is useful in of itself. Analog twisted pair is marginal for such use, and ISDN (digital twisted pair) requires changes in switching equipment that don't justify the slight bandwidth increase. If the physical plant is to be modified, then copper could be replaced at the same time, and a lot of videophone-unique issues disappear.

    Once HDTV is installed. and cable accommodates return channels, the videophone can be incorporated readily. I see that as a more likely and viable path than the existing videophone-for-telephone idea. I've been hearing that idea for 20 years, and the technology has gotten cheaper but not better in that time (i.e. still frame, effectively).

13. I see no future for video phones. I see very little value, though there is some, in video conferencing. There may be some business interest developed more by marketing dynamics than by need, but I just don't see any real value to video phones.

    I hope that within my lifetime we have at least T3 capability to every household. But I wouldn't waste any bandwidth on a videophone. My impression is that not many others will either until there is so much bandwidth to spare, and the hardware is so cheap, that adding videophone capability is kinda like adding an extension to the bathroom is now.

14. Biggest hurdle is camera shyness for personal communication and the extra intrusion/attention as another sense, namely vision, will be required to communicate.

Appendix D
PUBLIC SURVEY

SURVEY PROCEDURE

A public survey (Figure A-2) was conducted to gage consumer interest in the videophone. This poll was conducted in three cities to obtain a representative sample of national views: Rockville, Maryland; Breckenridge, Colorado; and St. Louis, Missouri. To get a better cross-section of consumers, pollsters sampled areas where people from various backgrounds were present, such as at supermarkets, shopping centers, and recreation areas. One hundred thirty-nine people were surveyed.

VIDEOPHONE SURVEY

In late spring, telephone companies are coming out with a new product called the video telephone (or videophone). This single desktop unit allows you to see moving color images of the caller, to "preview" who you are talking to, and to cover the lens if you wish not to be seen.

Some people are enthusiastic about viewing the person they are talking to while others consider this an invasion of their privacy. If cost is not a factor, how likely are you to use this product?

Highly Likely		Neutral		Highly Unlikely
1	2	3	4	5

Would you be more willing to use it at...

work, home, both, or neither?

The current projected market price is $1,500. If the videophone was on the market now, what is the maximum price that you would be willing to pay for it?

$1500 or more $1000-$1499 $500-$999 $100-$499 under $100

Respondents Background
Male Female

Age range:

Occupation:

Place where survey was taken:

Figure A-2. Public Survey

INTERPRETATIONS

The survey distribution shows that people feel strongly about the videophone. There is a fairly even split between people who say they are likely to use the videophone and those who say they are unlikely to use it; few are neutral. The total percentage of people who responded "Likely" or "Highly Likely" is 43 percent, close to the Noel Dunivant & Associates market study which found that 40 percent of those polled found videophones appealing (Anon. 1991).

Of those people who say they are "Highly Likely" to use the videophone, 32 percent are willing to pay between $500 and $999 for the device. People who say they are "Likely" to use it are willing to pay between $100 and $499. These figures support industry analysts' predictions that the price for videophones must come down to around $250 before many people will purchase them (Grady 1992). This implies that there is little demand for a $1500 videophone.

The survey also indicates that men and younger age groups react more positively towards videophones. Manufacturers may wish to target these markets.

RESPONSES

Question 1: If cost were not a factor, how likely are you to use this product?

Answers	Number of responses	Percentage of total
Highly Likely (1)	32	23.0%
Likely (2)	28	20.1%
Neutral (3)	18	13.0%
Unlikely (4)	23	16.6%
Highly Unlikely (5)	38	27.3%

Question 2: Would you be more willing to use it at work, home, both, or neither?

Answers	Number of responses	Percentage of total
Work	33	23.8%
Home	36	25.9%
Both	28	20.1%
Neither	42	30.2%

Question 3: If the videophone was on the market now, what is the maximum price you would be willing to pay for it?

Answers	Number of responses	Percentage of total
>$1500	4	3.0%
$1000-$1500	9	6.6%
$500-$999	18	13.2%
$100-$499	44	32.4%
<$100	61	44.8%

Respondents' Backgrounds:

Gender	Number	Percentage of total
Male	56	40.3%
Female	83	59.7%

Age range	Number	Percentage of total
under 20	11	8.0%
20s	38	27.5
30s	36	26.1%
40s	23	17.0%
50s	21	15.2%
60s	8	5.8%
70s	1	0.7%

Occupation	Number	Percentage of total
Technical	13	9.7%
Managerial	9	6.7%
Governmental	7	5.2%
Finance/Banking	6	4.5%
Communications	7	5.2%
Travel/Hospitality	5	3.7%
Medical	6	4.5%
Insurance	2	1.5%
Sales/Marketing	10	7.5%
Self-employed	2	1.5%
Education	12	9.0%
Clerical	4	3.0%
Homemaker	4	3.0%
Legal	2	1.5%
Military	2	1.5%
Blue collar misc.	1	0.7%
Retired	4	3.0%
Student	26	19.4%
Unemployed	2	1.5%
Other	10	7.5%

CORRELATIONS

Likelihood of Use vs. Willingness to Pay

Of those who answered Highly Likely (1):

Price	Number of Responses	Percentage of total
>$,1500	3	9.7%
$1,000-$1,500	6	19.3%
$500-$999	10	32.3%
$100-499	8	25.8%
<$100	4	12.9%
Total	31	100.0%

Of those who answered Likely (2):

Price	Number of Responses	Percentage of total
>$1500	0	0.0%
$1,000-$1,500	2	7.1%
$500-$999	6	21.4%
$100-$499	15	53.6%
<$100	5	17.9%
Total	28	100.0%

Of those who answered Neutral (3):

Price	Number of Responses	Percentage of total
>$1500	0	0.0%
$1,000-$1,500	0	0.0%
$500-$999	1	5.6%
$100-$499	11	61.1%
<$100	6	33.3%
Total	18	100.0%

Of those who answered Unlikely (4):

Price	Number of Responses	Percentage of total
>$1,500	1	4.5%
$1,500-$1,000	0	0.0%
$500-$999	1	4.5%
$100-$499	6	27.3%
<$100	14	63.7%
Total	22	100.0%

Of those who answered Highly Unlikely (5):

Price	Number of Responses	Percentage of total
>$1,500	0	0.0%
$1,000-$1,500	1	2.7%
$500-$999	0	0.0%
$100-$499	4	10.8%
<$100	32	86.5%
Total	37	100.0%

Gender vs. Likelihood of Use:

Of those who are Male:

Likelihood	Number of Responses	Percentage of total
Highly Likely (1)	22	26.5%
Likely (2)	17	20.5%
Neutral (3)	9	10.8%
Unlikely (4)	12	14.5%
Highly Unlikely (5)	23	27.7%
Total	83	100.0%

Of those who are Female:

Likelihood	Number of Responses	Percentage of total
Highly Likely (1)	10	17.9%
Likely (2)	11	19.6%
Neutral (3)	9	16.1%
Unlikely (4)	11	19.6%
Highly Unlikely (5)	15	26.8%
Total	56	100.0%

Age vs. Likelihood of Use:

Of those who are under 30 years old:

Likelihood	Number of Responses	Percentage of total
Highly Likely (1)	15	30.6%
Likely (2)	12	24.5%
Neutral (3)	12	24.5%
Unlikely (4)	5	10.2%
Highly Unlikely (5)	5	10.2%
Total	49	100.0%

Of those who are between 30 and 50 years old:

Likelihood	Number of Responses	Percentage of total
Highly Likely (1)	12	20.0%
Likely (2)	14	23.3%
Neutral (3)	2	3.3%
Unlikely (4)	13	21.7%
Highly Unlikely (5)	19	31.7%
Total	60	100.0%

Of those who are 50 years and older:

Likelihood	Number of Responses	Percentage of total
Highly Likely (1)	5	16.7%
Likely (2)	2	6.7%
Neutral (3)	4	13.3%
Unlikely (4)	5	16.7%
Highly Unlikely (5)	14	46.6%
Total	30	100.0%

Appendix E
ABOUT THE TECHNOLOGY ASSESSMENT TEAM

Lorrie F. Ackerman will receive her Bachelor of Science degree in Engineering and Public Policy from Washington University in May 1992. She expects to complete her Master of Science degree in Technology and Human Affairs in May 1993. Her primary research interest is electronic newspapers and news services.

Gang C. Chen received his Bachelor of Science degree in Mechanical Engineering from Zhejiang University, Hangzhon, Peoples Republic of China in 1987. He worked for four years as an assistant engineer for the Shanghai Aviation Industrial Corporation. He expects to complete his Master of Science degree in Technology and Human Affairs at Washington University in 1993.

Gregory M. Griffin graduated from Lafayette College with a Bachelor of Science degree in Mechanical Engineering. He expects to receive a Master of Science degree in Engineering and Policy from Washington University in May 1993. He then plans to continue his education and hopes to earn a doctoral degree in the area of international environmental policy.

Huong T. Nguyen graduated from Rollins College with a Bachelor of Arts degree in Pre-Engineering. She will receive her Bachelor of Science degree in Engineering and Public Policy from Washington University in May 1992. Her interests include information systems, manufacturing, and competitiveness.

Linda A. Witt is a graduate student in Washington University's Technology and Human Affairs program. She earned a Bachelor of Science degree in Aerospace Engineering from the University of Kansas in 1989 and subsequently worked for two years as an F/A-18 flight test engineer at McDonnell Douglas. Her current interests include environmental politics and sustainable development.

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