

Media in the Digital Age

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In the end, will the public interest be better served by DTV? New technology holds that promise. Will the realities of the television business lead DTV toward a vast but interactive wasteland that Newton Minow once lamented in the analog days of the medium?⁴⁸ Post-Internet economics pose that peril.

2 / DEVICES TO ACCESS DIGITAL MEDIA

The term *digital convergence* refers to the coming together of all media types in a computer-based form, typically including wired or wireless connectivity to the Internet or a LAN. Nowhere is digital convergence more apparent than in the devices used to access, display, consume, experience, interact with, and create digital content. Since the 1990s, a wide range of digital devices have emerged to give consumers and content creators alike increasingly powerful, portable, and productive tools for experiencing or producing media in the digital age. At the same time, although convergence is apparent, there are still many diverse types of digital media devices, some of which are highly specialized in their functionality. This chapter examines the digital devices for accessing and interacting with digital media content, including both those highly converged as well as those highly specialized. Chapter 9 examines the digital technologies involved in the production of media content.

TYPES OF DIGITAL DEVICES

Although computers are often thought of as among the most modern of technologies, computational devices have been around for many centuries. As early as the first century B.C., the ancient Greeks invented perhaps the first computer, an astronomical calculator known as the Antikythera Mechanism.¹ In 2006, researchers exploring off the coast of Greece found gears and other parts of the Antikythera in a sunken Roman ship.² Yet it was not until the age of the digital computer, in which data are processed in binary form as 1s and 0s, that widespread

media applications became possible.³ Analog computers processed data in physical measures or quantities along a continuum and had limited capability to process or display media content such as audio and video.⁴ Invented in the late 1930s and early 1940s, electronic digital computers were used by the media as early as 1952 for reporting election results.⁵ In the 1960s, the development of precision journalism, or the application of scientific methods to journalism, was based largely on the use of digital computers to process large sets of data.⁶ These early media utilized punch cards to input data and printouts to see the results. Computer displays were monochrome cathode ray tubes (CRT) and were limited to the display of text and simple graphics. The limited processing power of early computers and CRT technology prevented them from having any significant use in the display of media content such as photographs and motion pictures or in the projection of sound. Rapid and significant advances in the digital computer and related technologies since then have transformed media, including access and display devices. In the 1970s and 1980s, as teletext (one-way text and graphics transmission) and videotext (two-way text and graphics) trials developed, computer displays were used to present text and simple graphics.⁷ Now, in the first decade of the twenty-first century, computer-based devices for accessing and displaying media content have become widely available and used in the United States and around the world. Digital devices in 2007 can display or present virtually all forms of media content, whether audio, video, text, graphics, or photos.

Digital media access and display devices come in at least two basic forms: fixed location and mobile. Each of these forms includes several alternatives. Fixed-location devices are primarily desktop personal computers; television sets; displays that are either digital or analog and connected to a digital set-top box enabling access to digital data, whether cable or satellite television or the Internet; as well as various peripheral devices such as DVD players, digital video recorders (DVRs), and video game consoles. Desktop computers typically provide a wide range of media access capabilities through a combination of various hardware (e.g., central processing unit, mouse, keyboard, flat-panel display, and speakers), software applications, and high-speed Internet delivery. Among these access capabilities are: browsing the Web, particularly for media content of all types, such as online news and entertainment, photos,

graphics, and animations; searching for, downloading, sharing, viewing, and listening to audio and video; playing video games (both online and off); and accessing blogs and podcasts.

DTV DISPLAYS: THE VANISHING PICTURE TUBE

Familiar to most American homes is the fixed-location media device known as the television set. Since the 1950s, most U.S. homes have had at least one television set and often two or more. Not only are television sets or displays growing in screen size, quality, cost, and ubiquity, but the form they take is undergoing a digital transformation. Fewer and fewer households watch television on a set with a CRT, a device that was for six decades a mainstay of the television set industry and the American home. Fewer and fewer CRT devices, the central component of the analog TV set, are being manufactured and sold. The CRT was also used as the primary display device for personal computers until the advent of flat-panel screens. Now, the cube-shaped heavy picture tube is fading from the marketplace. "After the holidays, the days of picture-tube TV's are gone," said Geoff Shavey, the TV buyer for discount warehouse chain Costco, in late 2006. "One year from now, we will not sell picture-tube TV's."⁸

Costco had already reduced its picture-tube products to three models in 2006, down from ten in 2005. Like most other retailers, Costco is selling greater numbers of wide-screen plasma and liquid-crystal display (LCD) flat-panel TVs as well as projection video systems. Although more expensive than traditional TV sets, these digital display devices take up less cubic space (a 40-inch CRT analog set can weigh several hundred pounds and have a footprint in excess of 9 square feet), can be hung on a wall or from the ceiling, and offer superior picture quality and better audio. Flat panels also generally emit less electromagnetic radiation than CRTs, thereby reducing a possible health concern, although certain high-frequency emissions persist.⁹ Prices for plasma and LCD sets are dropping. A 42-inch plasma TV set can cost less than \$2,000, and the 32-inch flat-panel sets are only slightly more expensive than CRT alternatives, or about \$700. Fueling the transition to digital sets is the federal government mandate that all TV sets include a built-in digital tuner to

receive over-the-air digital broadcasts as well as other components for parental controls.

Like many other set manufacturers, Panasonic is leaving the picture-tube business. As recently as 2005, Panasonic sold only thirty picture-tube models in the United States. By 2006, its only offering was a 20-inch analog set. In 2007, it has offered none. Picture-tube TVs were 78 percent of the market in 2004, but just 54 percent in 2006, reports the Consumer Electronics Association.¹⁰ Sales of CRT sets have gone flat, so to speak. In contrast, flat-panel TV set sales increased from 12 percent of all TVs sold in 2005 to 37 percent in 2006. Front- and rear-projection TVs represented 9 percent of sales in 2006, and the sale of plasma screen sets is also growing. It is worth noting that the new devices also have a new shape: rectangular. This more cinematic display coincides with the rise of HDTV, which features not just better picture quality and sound, but a wider aspect ratio (ratio of screen width to height), 16:9 versus 4:3 in the old analog CRT days. At the same time, more programs are being produced in the cinematic wide-screen frame. One significant advantage offered by CRT sets, however, is durability. Some CRT sets have lasted for decades, but it remains to be seen whether the new digital displays will last nearly as long.

Motivating much of the conversion to the newer digital displays is the enhanced visual and sound quality of HDTV, which displays 1,080 lines of detail in contrast to the 480 lines on a standard set. This means an HDTV set has a considerably sharper picture. Some set manufacturers also make a low-end high-definition model with 720 lines. Not all flat-panel sets are high definition, at least not at the 1,080 line level. Those that operate at the 720-line resolution automatically downgrade a full high-definition signal to the lower level. The same is true of rear projection and other types of DTVs. These sets are called enhanced-definition television, which is better than standard television, but not improved enough to be considered HDTV. The HDTV sets are more expensive, up to \$6,500 or more in 2006. They also come with a label of either *i* (interlaced scanned video) or *p* (progressive scanned). Interlaced scanning means every other line is displayed, and a moment later the other lines are added to the image. This is how analog sets work, and it allows the picture to be displayed quickly but somewhat fuzzily, sometimes showing jagged edges when there is fast motion on the screen, such as in sports coverage. Progressive scan is a newer digital technology and is

how computer displays work, as well as many DTV sets, including flat-panel displays. It draws each line separately and virtually instantly because of fast computer-processing chips. Thus, a 1080*p* set has a clearer picture than a 1080*i* set and has no jagged edges when there is on-screen motion, so of course high-definition *p* sets cost more.

There are also two types of high-definition DVD players: HD DVD and Blu-ray DVD. Both offer substantially higher resolution than conventional DVDs, which have 650 lines of resolution, although it is not clear whether viewers will see enough of a difference to warrant the cost differential. HD DVD players are entering the marketplace slowly, largely because of the high price, but also because of the lack of a common standard. An HD DVD player costs about \$500 and a Blu-ray player about \$1,000. A DVD made for the HD DVD will not play on the Blu-ray player and vice versa. Consequently, only about 1.5 million homes in the United States have high-definition DVD players. As of 2006, there were about one hundred HD DVD and fifty Blu-ray DVD titles in the marketplace. Both systems incorporate Advanced Access Content System copy controls to limit illegal copying of DVDs or music files. Blu-ray has a storage capacity of 50 GB for dual-layer discs, whereas HD DVD has an upper limit of 30 GB on a dual-layer disc. This difference enables the Blu-ray system to play back DVDs encoded at a higher level of resolution or of a longer length, but it is not yet clear whether viewers will discern a difference. As of 2006, it was also not known how many titles will top out beyond the 30 GB capacity. A sampling of movies on DVD gives an idea of general storage requirements: *The Last Samurai* (27.3 GB), Mel Brooks's *Blazing Saddles* (25.4 GB), *The Phantom of the Opera* (24.8 GB), *The Bourne Identity* (22.7 GB), and *The Fugitive* (18.2 GB). Time Warner is hoping that consumers will be more inclined to buy high-definition DVDs and players if the studios release movies encoded in both the Blu-Ray and HD DVD formats. At the Consumer Electronics Show in Las Vegas in January 2007, Warner Bros., a division of Time Warner, announced its new dual-format high-definition disc, dubbed the Total HD disc.¹¹ Some high-definition DVD players also offer the option to record video. Blu-ray vendors offer disc burners for desktop computers and mobile burners for notebooks.¹²

Regarding the high-definition DVD technology, it is important to emphasize that it is an unsettled technology. Because the HD DVD and

Blu-ray DVD are still competing for marketplace dominance, there is no universal standard yet. Either of the competing platforms may ultimately go the way of Betamax, which lost out in the 1970s to VHS-format videotape, an inferior (i.e., lower-resolution) television video recording and playback technology that gained an advantage in the marketplace and wound up becoming the standard. It is not yet clear whether HD DVD or Blu-ray is superior technologically, but consumers have shown a reluctance to buy either device because both are expensive and there is no guarantee which will last or dominate the market. In January 2007, South Korea's LG Entertainment announced its plan to introduce a dual-format high-definition DVD player.¹³ At the same time, Time Warner announced that it would manufacture DVDs that contained both formats. However, each strategy will increase costs and may not resolve consumers' confusion.

VIDEO GAME CONSOLES

Transforming the fixed-location media device marketplace is a new generation of video game player consoles, including the Sony Playstation 3 (PS3), Microsoft Xbox 360, and Nintendo Wii. The PS3 combines both powerful video game technology and DVD Blu-ray technology, and the Xbox 360 includes HD DVD technology. One of the biggest drawbacks of these devices is the cost, about \$500 each. "The PlayStation 3 will look very inexpensive [compared] to the Blu-ray (DVD) player," said Van Baker, an analyst at research firm Gartner. But it is still an expensive device. "You're paying 100 bucks for the privilege of having a Blu-ray player [built in]. It is a very aggressively priced movie player."¹⁴ Video game consoles require a television or computer display to play the game as well as speakers for audio playback. By combining the Blu-ray DVD technology with the PS3 and the HD DVD technology with the Xbox 360, Sony and Microsoft are betting on the consumer's finding value in the combined functionality of the single device. These game players also include high-speed Internet connectivity to enable online game playing and downloading of software and movies. Nintendo's Wii has a unique feature in which the device that the user operates to play the games is a wireless handheld remote control embedded with a miniature,

micron-size infrared sensor.¹⁵ Through this image sensor, the Wii lets the user play a variety of physical games such as swinging a virtual baseball bat or firing a virtual weapon.

PERSONAL DIGITAL VIDEO RECORDERS

TV programming may sometimes start out analog, but a personal DVR, such as TiVo (a name created incorporating "TV" and the letters *i* for interactive and *o* for *vox*), can convert and record it digitally, giving the viewer greatly expanded control over the time and content of the viewing experience. Because DVRs were initially sold as an alternative to videocassette recorders, the market for them grew slowly at first, when the technology required the purchase of an expensive and separate box. The adoption of the DVR has paralleled the growth of digital cable and satellite TV, though; both services have begun to offer consumers a low-cost option to introduce a DVR device and service into the home. In these cases, the television signal is delivered in digital form to the home, where it is processed digitally by the DVR, and then can be displayed on either a DTV set or an analog one.¹⁶

John Carey, Fordham University professor and authority on telecommunications and interactive technologies, says DVRs have been slow to take off owing in part to "early high prices and in part to consumers not understanding what the technology can do."¹⁷ Yet, Carey adds, "those who do have these devices report that they love them." DVRs can perform a number of functions, including automatically record programs without requiring a complex set up by the user. A typical DVR can record up to about thirty-five hours of high-definition programming or two hundred hours of standard-definition programming, but this capacity is purely a function of storage, and as storage prices fall, capacity will increase in future generations of DVR technology. DVRs also permit the viewer to pause live television, get instant replays of a program (e.g., during a game or a Super Bowl half-time show), access interactive program guides and other interactive features, and output recorded programs to portable media such as DVD or VHS tape. Some DVR systems notably include a popular "fast forward" feature that enables viewers to avoid watching commercials. The viewer navigates all these various features

via a sophisticated wireless infrared remote control that permits not only channel surfing and volume control, but also program recording, playback, and other video management and interactivity such as home shopping.

DVRs cost about \$300 to \$800 for the set-top box. This cost is often covered by cable or satellite providers who subsidize the initial cost in order to obtain a monthly subscription fee. Monthly fees range from about \$10 to \$20. TiVo charges a monthly fee of \$10 per month or \$200 for a lifetime subscription. TiVo set-top boxes and video recorders are manufactured by a number of companies, including Sony and Phillips. As of January 2001, TiVo's subscriber base was 154,000, but by 2005 the number had topped 3 million.¹⁸ With the integration of DVR boxes and service with DTV delivery such as cable or satellite, the adoption of DVRs in U.S. households is growing, according to "On-Demand TV 2006: A Nationwide Study on VoD [video on demand] and DVRs," a study by the Leichtman Research Group.¹⁹ A study released by Mediamark Research reports DVR users are more affluent and consume more media.²⁰ These studies show that 12 percent of, or 18 million, U.S. households had a DVR as of 2006, a fourfold increase since 2004. DVR households record on average about eleven programs a week, a 23 percent rise from 2005.²¹ It is expected by 2009 that more than 47 million U.S. households will have a DVR.²² Adoption of DVR technology has grown rapidly internationally as well. A January 2007 report from B-Sky-B indicates that its subscribers had purchased more than 2 million DVRs.²³ With at least 20 million DVR users worldwide in 2006, the number is expected to reach 250 million by 2011.²⁴ Apple's DVR-type device, the AppleTV, combines DVR functionality with a wireless network capability to transmit multimedia such as movies, songs, and photos to other digital devices (television sets or computers) within the network range. AppleTV was selling for \$299 in 2007.²⁵

MOBILE ACCESS DEVICES

Mobile access, display, or playback media devices include at least three types of digital appliances: portable computers, digital cell phones, and specialized mobile digital devices. Portable computers come in laptop,

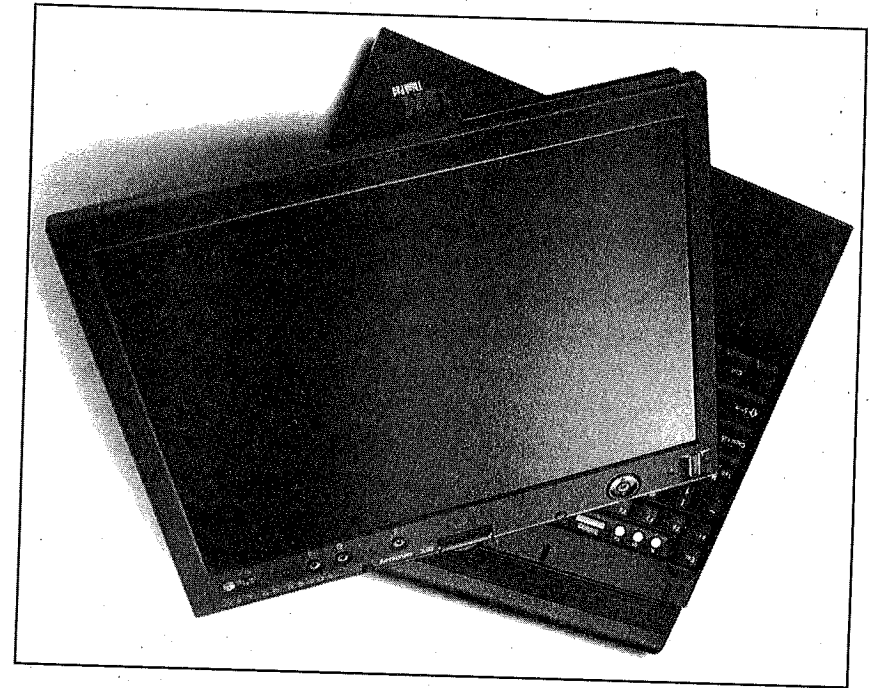


Figure 2.1 Lenovo ThinkPad X60 Tablet PC has a touch-sensitive screen that rotates. Photo used with permission of Lenovo.

notebook, tablet, and even pocket-size forms. Laptops are portable but slightly larger than notebooks, and they often have more functionality, such as a built-in DVD player. Notebooks are optimized for efficiency and lightweight portability. They are usually somewhat cheaper than laptops. Tablet computers are all-screen devices (sometimes with small keypads on the side) or hybrid laptop/tablets, such as the Lenovo X60 ThinkPad Tablet (see fig. 2.1), which has a keyboard as well as a 12-inch screen that flips around to fold flat.²⁶ Some tablets are lightweight, but others, such as the X60, can weigh four pounds or more. The screens on tablet computers are touch sensitive and are designed for rugged outdoor use. Some laptops, notebooks, and tablet computers are capable of playing video and of running a variety of media applications, and they may be used for media production such as video or audio editing. Increasingly, they have built-in broadband wireless capability, such as Wi-Fi. Although some laptops and notebooks are as cheap as \$500, most run more than \$1,000. Tablets typically start at about \$1,500, but can run more than \$4,000.

Even smaller are pocket-size computers. One notable example is the Oqo Model 2, a pocket-size computer with a slide-out keyboard and running the Windows Vista operating system.²⁷ Weighing less than a pound, the Oqo Model 2 measures 5.6 by 3.3 by 1.0 inches, has a 60 GB hard drive and a 5-inch display. It has many of the features of other mobile computers, including a Wi-Fi Internet connection, and sells for \$1,499.²⁸ For size reasons, it does not have a DVD drive.

The high price of notebooks, laptops, and tablet computers has put them out of the range of many consumers, especially the economically disadvantaged. The problem has been especially acute in many developing nations. In response, MIT Media Lab founder Nicholas Negroponte and media research scientist Walter Bender have developed a fully functional \$150 laptop computer for the developing world. The innovative laptop has a variety of features that make it possible to produce it for far less than the standard price. Among the adaptations is a low-power approach. The normal laptop requires about 45 watts of electricity and a powerful, heavy, and expensive battery that needs electricity to recharge. The \$150 laptop runs on just 2 watts and gets its power from a hand crank. One minute of cranking gives the laptop ten minutes of use. Power is saved in an unconventional LCD display just 7.5 inches in size and illuminated with either backlighting or in low-power monochrome form (i.e., black and white). As a fortunate by-product, the display is easily visible in natural-lighting situations where the display of many conventional laptops is difficult to see because of glare and the bright illumination of sunlight. The \$150 laptop has no hard drive. Rather, it relies completely on flash memory (solid-state computer memory), which is cheap, powerful, and uses little power. Moreover, flash memory means there are no mechanical or moving parts in the laptop, thereby saving even more money and power.²⁹ The use of flash memory has grown dramatically in the early years of the twenty-first century. In 2006, devices with flash memory amounted to 68 percent of all sales, according to the NPD Group, a research firm; flash memory was little used a decade earlier. Primary producers of flash memory are SanDisk, Creative, Samsung, and iRiver. Flash memory is significant in portable devices not only because it does not require any moving parts, but also because it can increase the speed of data recall compared to standard hard drives or CD-ROM drives. It also improves product durability and reduces cost and battery power needed.

The \$150 laptop has a Wi-Fi connection and automatically builds a peer-to-peer mesh wireless network with other \$150 laptops in the vicinity. The laptop also features a child-friendly intuitive design requiring little in the way of specialized training to use. A sealed rubber keyboard helps prevent against spillage problems. It runs on a slimmed-down version of the open-source Linux operating system.³⁰ This new laptop does not run the Windows operating system, and perhaps for this or other reasons Microsoft's founder Bill Gates has been critical of it.³¹ Undeterred, Negroponte and his partners have won agreements from leaders of a variety of nations to purchase the laptop, including Argentina, Brazil, Libya, Nigeria, and Thailand. The goal is to have one laptop per child in those countries.³²

Digital cell or mobile phones come in two basic forms. Most common are those designed primarily for voice communication but with limited additional media functionality. In addition are the so-called smart phones (some versions running Windows software are called a *pocket PC*), which feature not only voice communications, but also a wide range of other media capabilities, including Internet access. Cell phones designed mainly for voice communications but with limited media services typically include text messaging, picture taking, and image viewing. Wireless network access is relatively slow via services such as GPRS and is relatively expensive. Newer devices have added increasing capabilities, including downloading and playing MP3 music files, taking pictures, shooting video, and downloading and viewing video files. As such, these mobile phones represent a transitional form to the smart phone. One thing these devices typically lack is a full QWERTY keyboard (QWERTY refers to the upper-left top row of alphabetic keys on a keyboard). Instead, they have a standard twelve-key telephone keypad, with limited alphanumeric key entry.³³ The QWERTY keyboard was designed in the 1860s by Milwaukee newspaper editor Christopher L. Sholes, who also invented the first modern typewriter and used the QWERTY keyboard in his invention.³⁴ Sholes designed the QWERTY keyboard as an alternative to the then standard alphabetic keyboard, which often resulted in stuck keys during high-speed typing. The QWERTY design slowed down typing by spacing often-used keys far apart and thereby avoiding the stuck-key problem. Once established as the standard for all typing interfaces, including the computer, the QWERTY keyboard

has itself stuck in the marketplace, despite the fact that its purpose is no longer relevant in that there are no mechanical or moving parts to get stuck while typing on a computer, cell phone, or other digital device. Nevertheless, absent reliable voice command or other methods for inputting complex information or instructions to computers, a keyboard of some sort is an essential tool for digital media devices.

Smart phones are convergent digital media devices that provide voice capability and a wide range of other media capabilities, for both consuming and producing media content. They also have full QWERTY keyboards, although the keyboards are usually small and require thumb typing. Smart phones are usually larger, thicker, and heavier than limited-function digital cell phones. Among the media applications available on most smart phones are playing MP3 files, recording audio, taking photographs, shooting and watching video, surfing the Web, sending and receiving e-mail, playing video games, and accessing the Internet via high-speed wireless connectivity. Broadband Internet access is sometimes provided via Wi-Fi or Bluetooth technology, although other options are also available.

As a veteran Treo user, I have extensive personal experience with a multifunction smart-phone device. Early Treo models ran exclusively the efficient and reliable Palm operating system. More recent Treo models also run Windows CE, a limited Windows operating system for mobile devices. In addition, the Treo has a camera and various other functions such as a Web browser and organizer; and users can install various functions such as an electronic book (eBook) reader. In early 2007, the Treo 750 was introduced as the first Treo offering Wi-Fi service. Previous models included only Bluetooth, a limited broadband wireless LAN technology that facilitated communication with other Bluetooth devices located within a few feet of each other. Bluetooth is not a primary means of high-speed wireless Internet access, but Wi-Fi provides this capability. Wi-Fi access also often costs little or is free to the user. It permits broadband wireless communications within about 200 feet of the base station. Bluetooth is typically limited to about 30 feet, although some services can reach up to about 330 feet.³⁵

As an experiment for this book, I purchased on a two-week trial basis a T-Mobile mobile digital appliance (MDA) in August 2006. The T-Mobile MDA runs as its operating system Microsoft Windows CE. Equipped

with various advanced features, it includes a high-resolution camera; Real Player for multimedia, including MP3s and video; IM capability; e-mail via GPRS; and (in comparison to the Treo) broadband wireless via both Bluetooth and Wi-Fi. Two weeks was long enough to evaluate the T-Mobile MDA fairly. Its advanced features, especially the Wi-Fi Internet access, are intriguing and promising. Unfortunately, compared to the Palm operating system, which boots up instantly, the Windows CE system is slow, clunky, and unstable, requiring at least five to ten seconds and sometimes much more time to start up. With a handheld device, this amount of time seems like an eternity and is simply far too slow. Also, the keyword search feature is slow. Synchronizing requires Outlook, which has both pros and cons. On the plus side, it means easy coordination with desktop e-mail, if one uses Outlook for e-mail. On the minus side, because I had been using the Treo device with the Palm system for several years, I had assembled a large and valuable database of contacts and a full datebook. Converting it was technically possible onto the MDA via Outlook, but after many hours and several days of work, only part of the address book and portions of the calendar had ported over, and large portions failed to synchronize. Synchronization was often slow and unreliable; the device would sometimes freeze and at other times would synchronize quickly. Whether it would synchronize was also uncertain. On both the T-Mobile MDA and the Treo, one can install and utilize eReader software, which is available for both Windows and Palm and is a smoothly operating piece of software. It allows users to access and display eBooks and other documents on their hand-helds. For me, this is a valuable tool. Available exclusively on hand-helds running Windows, Powerpoint is a nice application as well. Unfortunately, the T-Mobile MDA does not permit the user to project from the device onto a screen or to edit or create a Powerpoint file. Powerpoint is available only for viewing on the MDA, which is of limited utility. Certain devices can be attached to the MDA to permit the projection of a Powerpoint file from the MDA, but this approach defeats the purpose of utilizing a compact hand-held. Otherwise, one may as well use a compact laptop or notebook computer. Also worth considering are the Motorola Q, the Blackberry Pearl 8100, and the Cingular 8125 Pocket PC smart phones. All these devices include a full QWERTY keypad, e-mail and Web access, megapixel digital camera, media player, and mobile phone. Both the

Motorola Q and Cingular 8125 Pocket PC run Windows CE, whereas the Blackberry Pearl 8100 runs the Blackberry operating system. The Cingular device includes Wi-Fi, but suffers from some of the same flaws as the T-Mobile MDA.

Associated with these hand-helds are a variety of peripheral devices, including mini portable storage devices offering increasingly massive memory at low cost. The Treo, the T-Mobile MDA, and other similar smart phones incorporate expandable storage or memory slots in the form of mini standard flash memory storage disks (less than an inch in size and wafer thin) with up to 2 GBs of storage for as little as \$69 in 2006. Costs for storage have been steadily dropping over the past fifty years, and there is no indication the trend will slow or stop in the coming years. Among the particularly useful portable storage devices for mobile media are Universal Service Buss (USB) sticks, which can plug into just about any standard digital device and can store one or more GBs of data for less than \$100. USB sticks with 128 MBs of storage capability—enough to store thirty songs, ten or more digital books, one hundred photos, or ten minutes of digital video—are given away at trade shows. The Poynter Institute for Media Studies, for example, gave them away as promotional gifts to educators who attended the 2006 annual convention of the Association for Education in Journalism and Mass Communication and who signed up for Poynter's online journalism school, News University, funded by the Knight Foundation.³⁶ I gave my "bracelet USB stick" to my neighbor, a single parent raising four teenagers and in need of enhanced digital storage capabilities. Like most portable or desktop computers, Negroponte's \$150 laptop features multiple USB ports that are useful for connecting USB sticks or many other USB-compatible devices (e.g., printers, cameras).

Specialized digital mobile devices are also increasingly common. They most often come in the form of an MP3 player for listening to music or other audio content, although increasingly these mobile MP3 players also feature video playback and viewing options via a small 2- or 3-inch LCD screen. Introduced into the marketplace in 2001, Apple's iPod dominated the market with a 70–80 percent market share in 2006.³⁷ However, MP3 players were available long before the introduction of the iPod. I still have and use a very reliable Kazoo MP3 player from RCA, four of which I bought for less than \$100 each in 2000 for my family prior to our trip to

Singapore, where I was headed to be the inaugural Shaw Distinguished Visiting Professor of Media Technology at Nanyang Technological University. Weighing only a few ounces and fitting easily into the palm of one's hand, the Kazoo runs on two rechargeable AAA batteries and accepts an expandable memory card. Its only real flaw is that the software interface required to install music (MusicMatch) is no longer supported by RCA or anyone else. Competing with the iPod in 2007 are a variety of alternative MP3 players, many of them also capable of displaying video and performing other functions, as well as offering greatly expanded memory or music/video storage capability. Devices such as Microsoft's Zune pack 30 GBs of storage. The Zune also permits Zune-to-Zune music file sharing. Both the Zune and the iPod are on the pricey end of the MP3 spectrum, at about \$250 or higher. Another interesting option is the Sansa player MP3 device. It offers only 8 GB of storage, but can play music or video with a nice 1.8-inch thin film transistor color screen in a sturdy package and for a lower price than some of the alternatives, at about \$100. The audio and video run using the Windows Media Player 10. This means it can run any format file off subscription services such as Rhapsody or Napster. The device is not designed to play songs downloaded from iTunes, but with a little code added to a Mac, the iTunes file names can be modified so the Sansa will play the files.³⁸ A related audio device is the XM2Go portable satellite radio listening and recording device. Offered by XM Radio, the XM2Go permits users to access their satellite radio service from anywhere in North America, whether in their car, on foot or a bike, at home or office, with or without Internet access. Yet because the device is an MP3 recording and playback device, listeners have the option to record songs, create playlists, and listen to the music of their own choice rather than those of a central programmer.

Many of these specialized devices, including the iPod, are rapidly converging with cellular technology.³⁹ In June 2007, Apple introduced its new iPhone, a thin (11.6 millimeters) light-weight hybrid device that is both an iPod as well as a mobile phone, with a price tag of about \$500.⁴⁰ It features a two-megapixel digital camera and other applications. The future will likely see more convergent handheld communication and media devices.

One of the interesting devices in the specialized category is the eBook reader. Early generations of eBook devices were of limited audience

interest for several reasons: they were expensive, performed a single function, and were relatively large and heavy. Few consumers could justify spending several hundred dollars for a portable device on which to read an eBook when a paper form would be cheaper, lighter, and less damaged by accidental dropping. The latest eBook device introduced in late 2006 by Sony employs innovative electronic ink made by E Ink of Cambridge, Massachusetts.⁴¹ The technology mimics the quality of regular paper. It is not backlit as are typical screens and requires a light source in the room to see the page of text, graphics, or images. At the same time, because it does not involve a backlit screen, it uses far less battery power. Complementing the eBook, the Sony Connect online bookstore carries about 10,000 books from six publishers, including HarperCollins of News Corporation and Simon & Schuster of CBS.⁴² The Sony eBook, or Portable Reader, sells for about \$350. Whether consumers will find the price tag acceptable for a single-function handheld device remains to be seen. Convergent eBook devices may have greater marketplace potential.

Portable video game players are also included in this category of specialized devices. Nintendo, Sony, and Microsoft are the leading providers of these players. However, none of the new generation of game players, such as the Nintendo Wii, Sony PS3, or Microsoft Xbox 360, includes portable versions, at least as of 2007.

DEVICES FOR VIEWING DIGITAL VIDEO

Viewing video distributed online requires a computer or a handheld device such as a video-enabled cell phone or some other digital video playback device and access to the Internet, typically broadband or high-speed access, either wireless or landline. Video providers are increasingly producing original video designed specifically for either online viewing or viewing on a small-screen mobile device. The screen size mandates special design considerations such as the use of only relatively large text on the screen for easy reading; usually reduced amounts of text; still images that require less bandwidth; and different types of shot selection, framing, and editing of pictures. For example, long shots with small objects are almost useless when displayed on a small screen because the viewer is unable to discern what they are. Close-ups are particularly important,

and limited camera movements are required because excessive or rapid panning, zooming, and other camera movements may result in pixelation when delivered online, especially via wireless delivery media.

The online video explosion is about more than just television. In fact, it forces a reconsideration of just what constitutes television. Listening to satellite radio on May 3, 2006, I heard a decades-old but still funny comedy routine by Bill Cosby about what he called the inherent stupidity of watching golf on television. What made it especially amusing to me, an avid golfer who likes watching golf on television, was Cosby's reference to the plethora of television channels available at the time: a whopping seven. Today, with satellite and cable television systems, most U.S. homes have access to hundreds of channels of scheduled, premium, and on-demand video programming delivered to their "television set." Through broadband Internet access, oftentimes through the same digital network delivering television programming, these same homes can have access to potentially millions of "channels," if that is the right word for it, of video programming, whether scheduled or on demand, free or for purchase, delivered to their computer or another digital device such as a personal digital appliance or cell phone. In terms of video volume, the online video/television offers millions of hours of viewing, and this amount is growing dramatically each day. The biggest challenge for many users or audience members is finding the video they want or might enjoy watching.

Watching video on any digital device requires a software player. These players are usually available for free, although sometimes there are fee-based advanced players with more features or capable of playing video at a higher quality of resolution, frame rate, and size, or capable of offering additional premium content. Video software players sometimes come preinstalled on digital devices or computers, but downloading, installing, and upgrading may be needed or recommended. Upgrades add features for the viewer, but they also can include hidden tools that allow distributors to better track viewing or to restrict viewing based on copyright restrictions. In September 2005, the BBC provided some 5,000 of its viewers with a computer program called the interactive media player, which allowed them to download most of the BBC's television programs for up to seven days. Among the programs available for online viewing were the long-running soap opera *EastEnders*, nightly newscasts, and major sporting events.⁴³

Cell phones typically require additional technology (hardware and software) to view video programs downloaded from the Internet. One such device is the Slingbox, which attaches to a high-speed Internet access device such as a home computer and then uses wireless technology to deliver the video content to a cell phone.⁴⁴ Consumer electronics giant Sharp reports that it will soon introduce an LCD-screen TV for the Japanese market that enables viewers to watch HDTV, use a remote control to access the Internet, and store TV shows on an internal hard drive (or DVR).⁴⁵

DIGITAL AUDIO

Audio playback has also been transformed by digital technology. Not only are portable devices equipped with powerful playback technology, but home entertainment systems feature advanced digital sound systems that were once the exclusive province of movie theaters. Surround-sound systems featuring Dolby Digital high-definition sound or Digital Theatre Systems audio technology are common to new DVD or HDTV systems, and with powerful subwoofers they pack an impressive audio experience into the home theater. Price is still a significant factor because these systems can run up from \$150.

One of the problems inherent in all digital devices is that because they are computer based, they periodically need to be rebooted. From time to time, their internal processors get clogged up with various programming snafus, and even the best-designed devices will slow down or stop working altogether. The only way to get them to run effectively again is to give them a hard reset or restart by powering them down and then up again after a thirty-second or so delay. Some devices will automatically do this when they detect a problem. At other times, the user must do the restart, which may even require an additional digital signal from a cable or other system provider, much to the viewer's annoyance because he or she may have to wait minutes or sometimes hours and may miss a scheduled program or recording. Powering down a device incorrectly or unplugging a device incorrectly can cause internal computer problems, such as erasing the memory or worse, which can of course cause much consternation for the user. The

reboot problem is one new to the digital age and did not plague analog devices.

NEXT-GENERATION TECHNOLOGIES

Future directions in digital display technologies will likely reflect at least three trends. First, display technologies are on a trajectory of increasing miniaturization. As a consequence of Moore's Law, which says that the number of transistors on a computer chip doubles every eighteen months, leading to faster more powerful computing technology in less space, display technologies are getting lighter, cheaper, and less intrusive.⁴⁶ Wireless Bluetooth ear pieces for voice communications are already increasingly prevalent. In addition, the relative portion of users who are finding wearable media technologies acceptable is growing, and as more media applications emerge for wearables, usage will increase. In 2007, most wearable devices involve audio media for listening to music or voice communications. Wearable visual displays are growing in effectiveness and utility and will likely emerge as a next-generation technology. Possible harmful health consequences of long-term use of wearable electronic devices, including cell phones, is a subject of some concern and research.⁴⁷ I examine this topic in further detail in chapter 12, on children and digital media.

Second, the intuitiveness of the devices' design is continuing to improve, especially for human users without advanced training. The devices seem more natural to use, and a wider spectrum of users thus find them more palatable. Their adoption will thus continue to grow toward 100 percent penetration of the marketplace.

Finally, and not unrelated to the previous two trends, more and more devices are capable of multiple functions. Single-function access and display devices are gradually fading in the marketplace as users find that multifunction devices mean less to carry yet expanded capabilities.

BATTERIES

Power is a necessary part of all devices for accessing media. Although in some cases power is available through a wall outlet, mobile devices rely

on batteries, and batteries have historically been a significant complication and constraint in all devices' design and utility. In short, batteries have had a variety of problems. Although they generally will not pose a danger to the user of mobile media devices because of their low amperage, several computer manufacturers were forced to announce product recalls in 2006 (e.g., Dell's recall of 4.1 million laptop batteries in 2006) because a widely used Sony battery was found prone to overheating and catching fire. In addition to this hazard, batteries have been limited by their short life (generally less than ten hours of continuous use without recharging), weight, and size. After several years of use, most batteries will no longer hold a charge and must be replaced. Battery disposal is also an environmental problem, and recycling of batteries (and of computers in general) has been slow to develop. Because of their ubiquitous demand, portable rechargeable batteries constituted a \$6.2 billion market in 2006, a market that will likely continue to grow in the decade ahead and beyond. Companies such as Sony, Sanyo, Matsushita, and Samsung will produce more than one billion batteries in 2007.

One of the difficulties in making batteries that are more powerful in smaller packages is that those batteries become more volatile and potentially unstable, thus the spate of notebook battery fires in 2006. The chemical composition of lithium-ion batteries is the trigger for fire: carbon, oxygen, and a flammable fluid. "The battery is made of a thin layer of lithium cobalt oxide, which serves as the cathode, and a strip of graphite, the anode," note Damon Darlin and Barnaby J. Feder. "These are separated by a porous insulator and surrounded by fluid, a lithium salt electrolyte that happens to be highly flammable."⁴⁸ Lithium ions on a charged battery move from the cathode to the anode to provide the energy as the battery is used. While charged, the cathode is highly unstable without most of its ions. Should a spark happen, the temperature of the cathode can top 275 degrees, hot enough to cause the cathode to release oxygen. "A fire starts, and as heat builds," Darlin and Feder explain, "the battery begins what scientists call a 'thermal runaway.' In the case of the Sony-made batteries recalled by Dell, a microscopic metal particle that contaminated the electrolyte during manufacturing caused the spark."

To avoid flammability, researchers are working on developing batteries that do not contain carbon, oxygen, and fuel, but such power sources are likely years away from the marketplace. An alternative is the

development of miniaturized versions of the fuel cells being created for cars. Fuel cells involve hydrogen rather than oxygen. Such microcells hold great potential for laptops, cell phones, and other portable devices because they can retain up to ten times the power of batteries of similar size.

Nanotechnology, which involves technology manufacturing on a molecular scale, may also help in the development of miniature batteries. "Designer" molecules may serve as catalysts for fuel cells. Intel and IBM have announced a remedy that works from the other side of the problem—battery consumption. They have created a chip that consumes much less power than previous generations of chip sets.

CONCLUSION

Devices for accessing or displaying digital content are undergoing dramatic change. They are becoming more intuitive in design, lightweight, unobtrusive, portable, less expensive, increasingly powerful, and multifunctional. Virtually all types of media content are available through these digital devices, whether text, images, motion pictures, sound, or any combination of these modalities.

One of the problems in this arena is the continually changing technology and lack of uniform standards. Consumers who want to access media using devices with the latest tools face an expensive proposition, not to mention potentially rapidly obsolete devices. Moreover, many devices are customized for particular content distributed by proprietary commercial services. For example, a device optimized for music downloaded from iTunes may not play MP3 files downloaded from Napster, and vice versa, at least not without hacking the software code, a challenge potentially worthy of Robert Langdon of *Da Vinci Code* fame. This topic of *digital rights management*, as it is known, is examined in chapter 8 on regulation of and law for media in the digital age.