

CD-ROM: A Primer for Physicians

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Compact disks with read-only memory (CD-ROM) are a powerful storage medium and are rapidly becoming standard equipment on personal computers. Each disk has the capacity to store 680 million bytes (megabytes or MB) of text, graphics, photographic images, audio, animation, and full-motion video. Many medical refer-

ence texts are currently available in CD-ROM format, with the advantage of improved search, retrieval, cross-referencing, and printing capabilities.

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Compact laser disks have largely replaced vinyl disks as the preferred format for recording and playing music. This technology can also be used to store large amounts of text, audio, images, animation, and even full-motion video for access by a personal computer. Called CD-ROM (compact disk—read-only memory), this powerful storage medium is becoming standard equipment on personal computers.

As caregivers, researchers, and/or educators, physicians must have access to a tremendous amount of information. Traditionally, this information has been in the form of books and journals. Although certainly very useful, these media have limitations with respect to size, indexing capabilities, and ease of sharing information among information sources. Placing medical reference information on CD-ROMs not only allows the addition of audio, video, and animation, but also integrates the information with the powerful search, retrieval, cross-referencing, and printing functions of the personal computer.

In this article, CD-ROM hardware will be described in enough detail to enable readers to become informed consumers. Also described are medical and nonmedical applications that may be of special interest to physicians.

Hardware

As the term *read-only memory* indicates, CD-ROM drives can only read information. Drives for CD-ROM cannot write new information on a disk or change the information on the disk. However, new files created using software stored on CD-ROMs, such as a word processing document or spreadsheet, can be stored on the computer's hard drive or on floppy diskettes. The capacity (the amount of information that can be stored on each disk), access time (the time needed to locate a piece of information on a disk), and transfer rate (the rate at which information is moved from the CD-ROM disk to the computer's memory) of CD-ROM technology is compared with other storage media in Table 1.

The chief advantage of CD-ROMs is their storage capacity; each disk holds up to 680 megabytes of data. This is equivalent to 680 million characters, or roughly 390,000 pages of text. Once a master disk is created, each copy of the disk costs approximately \$1.50 to produce, making CD-ROM an extremely cost-effective way to distribute large amounts of information. Although CD-ROM drives have a significantly slower access time than other media, they have a relatively fast transfer rate.

Most CD-ROM drives have an access time of 300 to 500 milliseconds, and a transfer rate of 150 kilobytes per second. Some CD-ROM drives spin the disk twice as fast, thus lowering the access time by 20% to 30%, and doubling the transfer rate to 300 kilobytes per second. Although somewhat more expensive, these double-speed drives are becoming more common and are likely to be the standard by 1994. The added performance is of

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Table 1. Comparison of Different Types of Storage Media for Personal Computers

	CD-ROM	Hard Disk	Floppy Diskette	Floptical
Capacity	680MB	40MB-1200MB	360K-1.44MB	21MB
Access time	265-550 ms	9-40 ms	240-600 ms	65-120 ms
Transfer rate	150K-300K/sec	1000K-5000K/sec	100K-200K/sec	150K-200K/sec
Read/write capability	Read only	Read and write	Read and write	Read and write
Cost (approximate)				
Drive	\$200-\$800	\$140-\$500	\$50-\$150	\$350-\$500
Individual bank disks	\$1.50	\$140-\$500	\$0.50-\$1.50	\$10-\$15

CD-ROM denotes compact disk-read-only memory; MB, megabyte, or 1,000,000 bytes or characters; ms, millisecond; K, kilobyte, or 1000 bytes or characters.

particular benefit to users of specialized multimedia applications, especially those incorporating full-motion video.

Standards

The basic standard, which describes how data should be organized on CD-ROM disks for both IBM-compatible and Macintosh computers, is the ISO 9660/High Sierra specification. Every CD-ROM drive supports this specification, and many CD-ROM titles come with both the Macintosh and IBM-compatible versions of the software on the same disk. To read these disks, IBM-compatible computers also need MSCDEX.EXE (Microsoft Corporation, Redmond, Wash), Version 2.0 or higher, a small program that is usually bundled with the CD-ROM drive itself.¹

Recently, a number of other standards have emerged. The Multimedia Personal Computer (MPC) specification describes the minimum hardware requirements necessary to run multimedia software using the Windows (Microsoft Corporation, Redmond, Wash) operating system for IBM-compatible computers. (Windows is a graphic operating system that simplifies many common computer operations.) This standard extends the ISO 9660/High Sierra standard. MPC Version 1 requires at least an 80386 processor in the computer, a CD-ROM drive with an access time of less than 1 second, and a transfer rate of at least 150 kilobytes per second, while using no more than 40% of the computer's processing power. MPC Version 2 is more demanding, requiring at least an 80486 processor, and a transfer rate of at least 300 kilobytes per second. The advantage of MPC software is that it is able to run in the Windows environment, and can coordinate audio, video, text, and animation.

CD-ROM XA (extended architecture) is another specification that is being adopted by certain manufacturers of interactive games and educational products. Finally, the Photo CD specification enables users to have their photographs placed on a CD-ROM disk, where

they can be edited and manipulated as desired.² "Multi-session" capability is important since it enables users to have more than one roll of film placed on a single CD.

Recommendations for Buyers

The physician who is considering the purchase of a CD-ROM drive must make several decisions. For example, drives are available in external and internal versions. Internal drives are placed within the computer's case, are generally less expensive, and save space. However, if this drive needs service, it may be necessary to do without the use of the computer temporarily, whereas an external drive simply may be disconnected and serviced. External drives are also easier to install than internal drives; the latter require some degree of familiarity with the inside of a computer.

Some drives require that the disk be placed in a plastic caddie, then inserted in the drive. Others more closely resemble audio CD players, in which the disk is placed directly in a tray or drawer. The latter design is more convenient, but exposes the drive mechanism more to dust and oils.

A CD-ROM drive requires an interface, usually on a separate card, which allows it to communicate with the rest of the computer. If a separate interface card is required, be certain that your computer has an empty slot. In some cases, audio cards such as the Soundblaster Pro (Creative Labs Inc, Santa Clara, Calif) have an interface built in, obviating the need for an additional card. Drives using the standard Small Computer System Interface (SCSI) may be preferable to those using a proprietary interface, since they are faster and generally allow for more flexibility in configuring the computer. This consideration is particularly important for libraries and other institutional users who plan to attach several CD-ROM drives to a single computer or network. The disadvantage of CD-ROM drives with the SCSI is that they are usually more expensive than those with proprietary interfaces, although this price differential is expected to decline over the next 1 to 2 years.

Many CD-ROM software programs include audio output, such as spoken quotations or music, which is integrated with the rest of the computer program. Most CD-ROM drives have a headphone jack and volume control, and some also have RCA jacks, which facilitate the connection of an external CD-ROM drive to a computer's sound card or to an amplifier. In addition, some CD-ROM drive kits come with amplified speakers, which can be plugged into either the computer's audio card or the headphone jack of the CD-ROM drive.

Because of the growing number of useful medical and nonmedical applications that require the MPC specification, it is recommended that the CD-ROM drive be MPC compatible, and that the user's system meet or exceed the minimum requirements for the MPC specification. A reasonable IBM-PC compatible personal computer system for home or office use would include an 80486-33 processor, a 200-megabyte hard disk drive, a 1.44-megabyte floppy disk drive, 8 megabytes of random access memory (RAM), and a noninterlaced, super video graphics array (SVGA) screen with accelerated video. While specific recommendations quickly become outdated, a good rule of thumb is to buy the best system that you can get for \$2000 to \$2500. This will usually buy a solid entry-level computer, with adequate processor speed, memory, and storage capacity, a CD-ROM drive, and an audio card.

If possible, the drive should support the CD-ROM XA and Multisession Photo CD specifications. Finally, many CD-ROM drives come as a kit, often with a sound card and bundled software. Consider these carefully, as they may contain titles that are redundant or outdated, and may not provide additional value. MPC-compatible CD-ROM drives with interface are available for as little as \$175 to \$225; bundles that add an audio card and several CD-ROM titles can be obtained for approximately \$400. Double-speed drives with a transfer rate of 300 kilobytes per second are available for \$300 to \$500. A checklist for prospective buyers is shown in Table 2.

Software

Once you have purchased and installed a CD-ROM drive, what can you do with it? To date, thousands of software titles have been released on CD-ROM, in both medical and nonmedical categories. They are characterized by large amounts of information, and generally contain text, graphics, audio, and sometimes animation or video. For example, an article about compact disks might contain text, a picture of a CD-ROM drive, and a narrated animated demonstration of the technology.

Many titles use a simple but powerful technique

Table 2. Checklist for Buyers of CD-ROM Drives

The computer system

- A free slot for the controller card (most internal and some external CD-ROM drives)
- A free drive bay for the CD-ROM drive (internal drives only)
- 200MB hard drive or more (20MB necessary for MPC standard)
- An audio card (optional), and a free slot for it
- Central processing unit: 80486 recommended (80386 necessary for MPC standard)
- Display with minimum 800 × 600 resolution, and an accelerated video card
- Random access memory (RAM): 4MB–8MB recommended (2MB necessary for MPC standard)

The CD-ROM drive

- External vs internal (see text)
- Access time (500 ms or better)
- Transfer rate (150K/sec or better)
- Meets MPC specification
- Meets XA or Photo CD standard (optional)
- Has a headphone jack with volume control
- Has RCA jacks for external audio (optional)
- Bundled software: caveat emptor

CD-ROM software

- Is the disk for IBM-compatible or Macintosh computers?
- If it is MPC-compatible, does your equipment support this specification?
- If a reference, is it the current year's version?

CD-ROM denotes compact disk-read-only memory; MB, megabytes; MPC, Multimedia Personal Computer; K, kilobyte; ms, millisecond; XA, extended architecture.

known as "hypertext," which enables users to explore related words or topics. For example, in an article about computers, clicking with the mouse on the word *semiconductors* displays an article about semiconductors (a mouse is a device used to point to and select objects on the computer screen). Within the semiconductor article, clicking on the term *transistors* may lead to a dictionary definition of transistors, and so forth. This kind of knowledge exploration can be absorbing and informative.

General Interest Applications

Among the most popular applications are general reference encyclopedias and atlases. A CD-ROM title that nicely demonstrates the vast storage capabilities of this medium is *Global Explorer* (\$149, DeLorme Mapping Co, Freeport, Me). This single disk contains a detailed color atlas of the entire world, as well as brief descriptions of 20,000 points of interest. Users can zoom in on any spot on the map, with a maximum resolution that puts an approximately 250 square mile area on the screen. The atlas includes major roads, bodies of water, elevations, and other topographic features. In addition, more detailed street level maps are available for 100 major cities.