CHAPTER 2 Hardware, Software, and the Roles of Support Personnel

Handbook of Informatics for Nurses & Healthcare Professionals, Fifth Edition by Toni Lee Hebda. Published by Prentice Hall. Copyright © 2013 by Pearson Education, Inc.

After completing this chapter, you should be able to:

* 1. Explain what computers are and how they work.
* 2. Describe the major hardware components of computers.
* 3. Understand what networks are and list the major types of network configurations.
* 4. Explain some considerations for choosing and using a computer system.
* 5. List the advantages and disadvantages of mainframe, client–server, and thin client technology.
* 6. Compare and contrast mobile and wireless devices, including personal digital assistants, cell phones, MP3 players, iPods, iPhones, and the BlackBerry in terms of basic technology and implications for use.
* 7. Understand the major types of software commonly used with computer systems.
* 8. Discuss the roles and responsibilities of various computer support personnel.

A [**computer**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29183) is an electronic device that collects, stores, processes, and retrieves data. Information output is provided under the direction of stored sequences of instructions known as computer programs. The physical parts of a computer are frequently referred to as [**hardware**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29708), and the instructions, or programs, are collectively known as [**software**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30833). A computer system consists of the following components:

* • Hardware
* • Software
* • Data that will be transformed into information
* • Procedures or rules for the use of the system
* • Users

Rapid advances in technology reshape computer capabilities and user expectations. Many changes have occurred since the introduction of the first computers in the 1940s. In general, computers have become smaller but more powerful and increasingly affordable. This is particularly evident with current notebook, tablet, personal digital assistant (PDA), and hybrid devices.

HARDWARE

Computer hardware is the physical part of the computer and its associated equipment. Computer hardware consists of many different parts, but the main elements are input devices, the central processing unit, primary and secondary storage devices, and output devices. These devices may be contained within one shell or may be separate but connected via cables or infrared technology. [**Figure 2–1**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid3519)describes the relationship among these components.

Input Devices

[**Input devices**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29884) allow the user to feed data into the computer. Common input devices include the keyboard, mouse and trackball, touch sensitive screen, stylus, microphone, bar code reader, fax modem card, joystick, image scanner, fingerprint scanner, digital camera, and Webcam.

Central Processing Unit

The [**central processing unit (CPU)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29059) is the “brain” of the computer. It has the electronic circuitry that actually executes computer instructions. The CPU can be divided into the following three components:

* • The [**arithmetic logic unit**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28884) executes instructions for the manipulation of numeric symbols.

FIGURE 2–1Basic components of a computer

* • [**Memory**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30161) is the temporary storage area in which programs and data reside during execution. Memory is subdivided into two categories: read-only memory and random access memory. [**Read-only memory (ROM)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30585) is permanent; it remains when the power is off. It typically cannot be changed by the user unless additional memory is installed. Read-only memory contains start-up instructions that are executed each time the computer is turned on. (i.e., booted). [**Random access memory (RAM)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30580) is a temporary storage area that is active only while the computer is turned on. It provides storage for the program that is running as well as for the data that are being processed. Since RAM may be segmented, more than one program may be resident in memory. As an example, a personal computer (PC) may have a word processing program, a spreadsheet program, and a database program all in memory at the same time. Note, however, that only one of these programs is actually running at any point in time. This capability is referred to as multiprogramming and is implemented within the operating system.
* • The [**control unit**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29281) provides instructions to other parts of the computer, including input and output devices. It executes stored programs one instruction at a time and directs other computer parts to perform required tasks.

The CPU is located inside the system cabinet, which is the box that many people think of as “the computer.” The CPU and memory are found on the main circuit board of the personal or desktop computer, which is known as the motherboard. The cabinet contains other components as well. [**Figure 2–4**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4121) will show some items that may be inside a computer cabinet.

Secondary Storage

[**Secondary storage**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30763) provides permanent space to retain data in an area separate from the computer’s memory after the computer is turned off. Common mechanisms for secondary storage include [**hard disk drives**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29703); [**USB flash drives**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31099); [**digital versatile or video disks (DVDs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29407); and [**high-density optical disc format (HD-DVD)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29773), which is the successor to DVD. Hard disk drives store digitally encoded data on rotating platters with magnetic surfaces. USB flash drives are portable, fairly inexpensive devices slightly smaller than a cigarette lighter that plug in to a USB port and can easily be transported from one computer to another. Digital video disks resemble the CDs and are used to record and play music but offer a larger amount of storage. [**Blu-ray**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29009) is a high-density optical format rival to HD-DVD. Some older machines may still have [**compact discs (CDs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29173), [**floppy drives**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29622) and [**diskettes**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29437), and [**zip drive disks**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31231), but these are not found on current computers. The CDs used for computers resemble those used for music. Floppy diskettes and zip diskettes come in square plastic cases. [**Magnetic tape drives**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30095) are still used for some large computers. Their primary purpose is for the backup of data stored on magnetic disk.

Output Devices

[**Output devices**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30397) allow the user to view and possibly hear processed data. Terminals or video monitor screens, projectors, printers, speakers, and fax modem boards are examples of output devices.

COMPUTER CATEGORIES

Computers vary in size, purpose, capacity, speed, and the number of users that can be accommodated simultaneously. The main categories of computers are:

* • Supercomputers
* • Mainframe computers
* • Minicomputers
* • Personal computers (also known as PCs or desktop computers)
* • Laptop or notebook computers
* • Tablet computers
* • PDAs and other handheld combination devices such as the iPhone, iPod, iPad, and BlackBerry
* • Embedded

The PDA has become a very popular device that is revolutionizing information access in healthcare. [**Table 2–1**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid3604) provides a brief description of the various types of computers and some advantages and disadvantages associated with each.

TABLE 2–1 Types of Computers

| **Type** | **Description** | **Advantages** | **Disadvantages** |
| --- | --- | --- | --- |
| Supercomputer | Designed and used for complex scientific calculations | Performs complex calculations very quickly | Expensive  Limited functionality |
| Mainframe | Used to support organizational information systems  Multiple processors  Varies in size | High-speed transactions  Supports many terminals and users simultaneously  Large storage capacity | Expensive  Software expensive and inflexible |
| Minicomputer | Smaller version of a mainframe  Designed for multiple users  Supports corporate computing for smaller organizations | Less expensive than a mainframe  Supports many terminals and users simultaneously | Relatively expensive |
| Personal computer (PC) or desktop computer | A single- or dual-processor machine intended for one user | Inexpensive processing  Can connect to other systems through a network, dial-up, cable, or wireless connection | High support costs  Somewhat slower response with fewer capabilities than larger systems |
| Laptop or notebook computer | Streamlined, portable version of a PC or desktop system | Provides portable computer capability | Limited battery life  More expensive than a comparably equipped PC  Generally has a smaller keyboard than a PC |
| Tablet computer | Smaller than a notebook computer  Weighs 2–3 pounds or less | Small size makes it easy to carry  Generally accepts handwriting or keyboard input  May receive and transmit data from and to other systems | Limited battery life  Slightly more expensive than a desktop system  Cannot receive transmissions in some areas known as deadzones |
| Handheld/personal digital assistant | Small special-use device | Small, lightweight  Inexpensive  Quick learning curve  Easily taken to the point of care  Increases access to information  Can improve productivity  May accept handwriting, voice, or keyed input  May download data from information systems and transmit data to other service  May incorporate the functionality of more than one device (i.e., PDA, e-mail terminal, cell phone) | Small screen size  Offers less functionality than desktop and notebook computers  Limited battery life  Limited speed and processing ability  May not hold up to rough use  Synchrony with other computers may require special equipment  E-mail connectivity/telephone service requires wireless systems  Small size makes it easy to steal  Information security concerns related to theft  May not be able to receive transmissions in some areas known as deadzones |
| Hybrid Embedded | Small, multipurpose device  Small, special purpose | Often combines telephone, text and/or e-mail messages, other Internet services, address book, and calendar functions  Easily transportable  Integral part of many appliances, automobiles, and other devices such as intravenous infusion pumps | Small screen and keys can be difficult to use  Limited functionality |

[**Supercomputers**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30893) are the largest, most expensive type of computers. They are complex systems that can perform billions of instructions every second. Prohibitive cost limits their use primarily to government and academic settings.

[**Mainframes**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30100), which are large computers capable of processing several million instructions per second, are used for quickly processing large amounts of data and supporting large user communities. Mainframe computers support organizational functions and therefore were the traditional equipment in hospital environments until recently. Software for mainframes supports many customized functions, and this level of specialization results in its high cost.

A [**minicomputer**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30191) is a scaled-down version of a mainframe computer. Minicomputers are slightly less costly than mainframes but are still capable of supporting multiple users as well as the computing needs of small businesses. Because they have become more powerful, minicomputers may be used in hospitals. Typically, minicomputers are used as servers in client–server systems.

[**Personal computers (PCs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30437) are also known as desktop computers and were previously referred to as [**microcomputers**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30181). This computer category provides inexpensive processing power for an individual user. A PC may stand alone or be connected to other computer systems through a network, dial-up or wireless connection, or cable service. Personal computers connected via a network are sometimes referred to as clients, in client–server systems. Improved reliability, availability, manageability, and processing capabilities allow PCs to assume responsibilities once associated with mainframe computers. Some variations of the microcomputer are the notebook or laptop, tablet PC, and handheld computers. All these devices offer portable computer capability away from the office or desktop. The [**notebook**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30286) or [**laptop**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30024)computer is a streamlined version of the PC, using batteries or regular electric current. These devices are more expensive than comparable desktop computers. The [**tablet PC**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30929) can be carried in one hand like a clipboard and is smaller and lighter than a notebook computer but rivals notebook capability. It not only accepts handwritten input via a stylus but also incorporates a keyboard and supports Windows-based applications. The stylus can be used like a mouse. Devices may also be configured to accept dictation. Handheld computers are special-use devices that offer portability and many of the features found in laptop and tablet PCs. Advances in technology add to the functionality of these devices. Some can accept handwriting and voice input, as well as send and receive data.

Personal digital assistants are a well-known type of handheld computer. These small devices were once used to keep appointment calendars, addresses, and telephone numbers. Advances in processing capability, memory, and design make PDAs attractive for a wide variety of functions, including many common software applications and data collection. Personal digital assistants can store extensive reference materials and can access patient information and transmit and receive information such as electronic prescriptions. These devices may be used for decision making at the point of care.

Hybrid or combination devices comprise another category of handheld devices. Hybrids may combine PDA capability with cell phones, MP3 players, or other functions. The BlackBerry, iPhone, and iPod are hybrid devices. An MP3 player is a small handheld digital music player. It received its name from the audio file extension that it supports. MP3, also known as MPEG audio layer 3, compresses audio signals without sacrificing sound quality, resulting in small, easily transferred files. MP3 players often support other file types as well. The iPod is a portable music player that supports MP3 and other file types. Its large capacity allows it to download, store, and play songs, movies, games, and photo slideshows from a computer or wireless connection. The iPod supports games, functions as a portable hard drive, and offers contact and calendar functions that can synchronize with PCs.

The iPhone is a multimedia, Internet-enabled mobile phone with touch screen and virtual keyboard and buttons. Functions include a camera, text messaging, visual voice mail, and a portable media player. The iPhone also supports the following Internet services: e-mail, Web browsing, and local Wi-Fi connectivity. The BlackBerry is a handheld device that supports wireless services that include a mobile telephone, push-mail, text messaging, Internet faxing, and Web browsing. It also supports address books and calendars.

Work is under way at several universities on a quantum computer, which will break away from the binary mold used for current digital computers. Quantum computers will harness the power of quantum states and encode information as qubits. A [**qubit**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30565) is a measurement similar to the bit but allows for a superposition of both 1 and 0.

Another relatively new computing technology is called grid computing. Grid computing exploits the concept of distributed processing to solve certain classes of computing problems that cannot be solved within reasonable periods of time, even with the use of supercomputers. In healthcare research, one such class of problems is the identification of potentially effective drug treatments for certain diseases. Since the potentially effective drugs can number in the hundreds of millions, researches cannot look at each treatment individually. Grid computing allows for thousands of individual computers to be assigned this evaluation task, thereby reducing the elapsed time. Harnessing the computing power of these thousands of computers results in the creation of a computing grid. Today, the premier grid computing facility in the world is the World Community Grid. This grid is comprised of thousands of individual computers connected via the Internet. You personally can participate in the World Community Grid by making your own computer available as one of the problem-solving nodes. See [**Figure 2–2**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid3771) for an example of grid computing toplogy. Visit [**www.worldcommunitygrid.org**](http://www.worldcommunitygrid.org/) for more details on grid computing.

FIGURE 2–2 Example grid computing topology

PERIPHERAL HARDWARE ITEMS

Peripheral hardware or, more simply, a [**peripheral**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30422), is any piece of hardware connected to a computer. Examples of peripheral devices include:

* • Monitors
* • Keyboards
* • Terminals
* • Mouse and other pointing devices such as trackballs and touchpads
* • Secondary storage devices such as external CD and DVD drives and memory sticks
* • Backup systems
* • External modems
* • Printers
* • Scanners
* • Digital and Web cameras (Webcams)
* • Multifunction devices that combine functions such as printers that also scan, copy, and fax

The [**monitor**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30216) is the screen that displays text and graphic images generated by the computer. Personal computer monitors use LCD or cathode ray tube (CRT) technology. [**Liquid crystal display (LCD)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30060) technology uses two sheets of polarizing material with a liquid crystal solution between them. An electric current sent through the liquid causes the crystals to align so that light cannot pass through them. Each crystal acts like a shutter, either allowing light to pass through or blocking the light. Liquid crystal displays may be monochrome or color. Monitors that accept handwriting via a stylus use an electromagnetic field under or over an LCD to capture the movement on the screen. The monitor may be housed separately from the CPU or contained within the same box. Touch screens offer another variation in monitor technology. Touch screens are sensitive to contact; this allows users to enter data and make selections by touching the screen. Laptops and flat monitors use LCD technology. Liquid electromagnetic display–backlit LCD panels are available but are a more expensive variant of the technology. Liquid crystal display monitors require less desktop real estate; weigh less than CRT devices; are more energy efficient; and provide a brighter picture with crisper text, less glare, and no flicker, thereby reducing eye strain. Cathode ray tube monitors use old television technology to generate colors by combining amounts of red, green, and blue. [**Refresh rate**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30625) and [**resolution**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30683) are terms that refer to monitor characteristics. The refresh rate is the speed with which the screen is repainted from top to bottom. Early monitors had a slow refresh rate that caused the screen to flicker. Higher refresh rates eliminate flicker. [**Resolution**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30683) is the number of pixels, or dots, that appear horizontally and vertically on the screen, making up the image. Resolution is expressed as the number of horizontal pixels by vertical pixels. Higher resolution numbers provide a better screen image. Cathode ray tube monitors are bulky but can display a greater number of colors and may be preferred by graphic artists for that reason.

[**Keyboards**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29994) are input devices with keys that resemble those of a typewriter. Keyboards allow the user to type information and instructions into a computer.

A [**terminal**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30974) consists of a monitor screen and a keyboard. It is used to input data and receive output from a mainframe computer. Unlike a PC, the terminal itself does not process information, thus giving rise to the expression “dumb terminal.” Very few terminals remain in operation due to the fact that it is expensive to find and replace parts for outdated technology.

The [**mouse**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30231) is a device that fits in the user’s hand and can be moved around on the desktop to direct a pointer on the screen. It is often used to select and move items by pressing and releasing a button. A mouse pad optimizes function by providing a surface area with the proper amount of friction while minimizing the amount of dirt that enters the mouse.

Some other examples of pointing devices include joysticks, touchpads, and trackballs. A [**joystick**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29989) allows the user to control the movement of objects on the screen and is primarily used with games. A [**touchpad**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31009) is a pressure- and motion-sensitive surface. When a user moves a finger across the touchpad, the on-screen pointer moves in the same direction. A [**trackball**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31014) contains a ball that the user rolls to move the on-screen pointer. Touchpads and trackballs work well when available space is limited, as with laptop computers.

Secondary storage devices are generally provided via the hard disk drive, flash drive, or DVD or Blu-ray drives. Older computers and large mainframe computers may make use of technology that is not found on new PCs. The hard disk drive allows the user to retrieve and read data as well as save, or write, new data. Data are stored in the hard drive magnetically on a stack of rotating disks known as *platters*. The amount of information that can be stored on a disk is known as its *capacity*. Capacity is measured in bytes. Hard disk drives generally offer a larger capacity than do secondary storage devices. Home and office PCs offer hard disk drives with a capacity that is measured in gigabytes. One gigabyte is equivalent to 1,073,741,824 characters.

Unlike the CD drives that they replaced, DVD drives can read or play CDs as well as DVDs and access data more quickly. Most DVD drives now read and write data, storing up to seven times more data than a CD. A DVD is similar to a CD used to record music and is commonly used to store multimedia or full-length movies. A few older computers may still have floppy disk drives. A floppy disk is a thin plastic platter within a plastic cover. The amount of storage provided was small compared to a DVD. Digital versatile or video disk drives are generally located within the system cabinet but may also be external and connected using cables. Other options for secondary storage particularly on larger computers include optical disk drives, magnetic disk or tape drives, and RAID. [**Optical disk drives**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30382) rely on laser technology to write data to a recording surface media and read it later. The advantage of this technology is its large storage capacity. A [**tape drive**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30934) copies files from the computer to magnetic tape for storage or transfer to another machine. A file is a collection of related data stored and handled as a single entity by the computer. The concept of a file is more of a logical concept rather than a hardware concept. In a virtual tape system data is saved as if it were stored on tape, but it is actually stored on a hard drive or another storage medium. Virtual tape systems offer better backup and retrieval times at a lower operating cost. The tape drive uses tiny electromagnets to write data to a magnetic media by altering the surface. A [**redundant array of independent disks (RAID)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30615) is precisely what the name indicates: duplicate disks with mirror copies of data. Using RAID may be less costly than using one large disk drive. In the event that an individual disk fails, the remaining RAID would permit the computer to continue working uninterrupted.

[**Backup systems**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28939) are devices that create copies of system and data files. These systems use secondary storage device technology or take advantage of online backup options. The copies are generally kept at a location separate from the computer. A backup system is an important measure for protection against computer failure or data loss.

A [**modem**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30211) is a communication device that allows computers to transmit information over telephone or cable lines. Faster modems transfer information more quickly. This, in turn, saves time and telephone charges. Modem speed is measured by the number of bits that can be transferred in 1 second of time, or [**bits per second (bps)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28994). A [**bit**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28989) is the smallest unit of data that can be handled by the computer. In actuality, transfer occurs in thousands of bits per second, or [**kilobits (kbps)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29999). Many PCs include modem and fax capabilities via a fax modem board. A [**fax modem**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29592) board allows computers to transmit images of letters and drawings over telephone lines. [**Wireless modems**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31206) allow users to send and receive information via access points provided with a subscription to wireless service. The [**digital subscriber line (DSL)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29397)[**modem**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30211)allows users who have this service available to them both by virtue of location and subscription to access highspeed service via telephone lines.

A [**printer**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30500) produces a paper copy of computer-generated documents. Several types of printers are available. Laser printers offer the highest quality print by transferring toner, a powdered ink, onto paper like a photocopier does. Ink-jet printers heat ink and spray it onto paper to provide a high-quality output. Dot matrix printers create letters and graphics through the use of a series of metal pins that strike a ribbon against paper. Color is an option with all three printer types. Prices vary according to quality and capability, with prices starting under $100 and ranging upward. Overall operating costs are based on purchase, supplies, and power consumption. Ink-jet printers were once considered cost effective, but ink costs over time make laser printers a viable option. Printers that also scan, copy, and fax are available. Users should base their selection on need. Laser printers are the office standard because they are quiet and provide a high-quality print. Inkjet printers are suitable for some settings but can be slow, and ink may smear when exposed to moisture. Dot matrix printers are noisy, provide a poor-quality print, and are rarely found now.

The [**scanner**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30728) is an input device that converts printed pages or graphic images into a file. The file can then be stored and revised using the computer. For example, a printed report can be scanned, stored in the computer, and sent electronically to another output device. [**Digital cameras**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29382) offer a means to capture and input still images without film. Digital images may be downloaded to a computer, manipulated, and printed. A [**Webcam**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31175) is a small camera used by a computer to send images over the Internet. [**Multiple function devices**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30241) combine functions such as printers that also scan, copy, and fax.

NETWORKS

A [**network**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30271) is a combination of hardware and software that allows communication and electronic transfer of information between computers. Hardware may be connected permanently by wire or cable, or temporarily through modems, telephone lines, or infrared signals. This arrangement allows sharing of resources, data, and software. For example, it may not be practical to have a printer for every PC in the house or office. Instead, several PCs are connected to one printer through a network. Common use of hardware requires consideration of overall needs, convenience of location, priority by user and job, and amount of use. [**Figure 2–3**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid3891) depicts a network.

FIGURE 2–3 Schematic representation of a network

Networks range in size from [**local area networks (LANs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30075), with a handful of computers, printers, and other devices, to systems that link many small and large computers over a large geographic area. For example, some LANs provide support for [**client/server**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29090) technology. In client–server technology, files are stored on a central computer known as the [**server**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30783). Any type of computer may act as a server, including mainframes, minicomputers, and PCs. One current trend is to combine servers by partitioning the hard drive to act as more than one server. This is known as a virtual server. [**Client**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29090) computers can access information stored on the server. One major advantage of a LAN is that only one copy of a software program is needed for all users since it can be stored on the server. The client computers then access the server to use the software. This contrasts with the need to supply a separate copy of a software program for each PC user. The primary disadvantage to client–server technology is vulnerability. If the server fails, the network fails. Multiple servers circumvent this problem. Larger, more expansive systems are known as [**wide area networks (WANs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31190).

[**Thin client technology**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30989), also known as [**server-based computing**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30793), represents another networking model that relies on highly efficient servers. All system processing occurs on the server, rather than on the client or local PC, as seen in traditional client–server technology. The thin client is primarily a display, keyboard, and mouse or other pointing device. It sends keystrokes and mouse movements to the server over the network, and the server sends back changes in the display. Any PC can serve as a thin client. The minimal hardware requirements for this model give rise to the name “thin client” as opposed to “fat client,” as seen in traditional client–server technology. This model helps to reduce hardware costs; older equipment can be used longer, and new thin clients cost less than traditional PCs because no local drives or storage devices are required. The absence of local drives and storage also reduces maintenance and administrative costs and facilitates software upgrades. Software resides on the server requiring one upgrade at the server rather than a physical visit to each PC or client. Security is enhanced because users cannot run foreign disks locally that may contain a virus.

The largest and best known network in the world is the [**Internet**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29944), also known as the [**Net**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30261). The Internet actually consists of thousands of interconnected networks. The Internet was once limited to individuals affiliated with educational institutions and government agencies. Variations of Internet technology are available via intranets and extranets. Both intranets and extranets use software and programming languages designed for the Internet. [**Intranets**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29964) are private company networks that are protected from outside access. [**Extranets**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29582), on the other hand, apply Internet technology to create a network outside the company system for use by customers or suppliers.

Like all computer technology, the Internet is evolving into what is being called Internet 2.0. This evolution will dramatically change the manner in which users will interact with each other. This next generation Internet will immerse users into a three-dimensional virtual world. Avatars will represent individual users, who will be able to meet, conduct business, and collaborate on ideas, all in virtual space. One of the more widely known implementations of the next generation Internet is Linden Lab’s Second Life. Visit [**www.secondlife.com**](http://www.secondlife.com/) for details on how to participate in this new, evolving technology.

HOW COMPUTERS WORK

Computers receive, process, and store data. They use binary code to represent [**alphanumeric**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28834) characters, which are numbers and alphabetic characters. [**Binary code**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28969) is a series of 1s and 0s. All 1s are stored on the disk as magnetized areas, and 0s are stored as areas that have not been magnetized. Each 1 or 0 is called a [**bit**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28989). Eight bits make up one [**byte**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29044). The unique code for each character is eight bits long. In the code for numeric characters, each position corresponds to a specific power of 2. [**Box 2–1**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid3936) provides a binary representation of the number 13.

BOX 2–1 Binary Representation of an Arabic Number

The Arabic number 13 is represented using the binary system as 00001101. Each bit (0 or 1) represents a particular power of 2, depending on its position. If the position is taken by a 0, then it has no value. If the position is taken by a 1, it has the value of the associated power of 2. The Arabic number represented is the total of the powers of 2 represented by the 0s and 1s.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Binary representation of 13 | 0 |  | 0 |  | 0 |  | 0 |  | 1 |  | 1a |  | 0 |  | 1 |  |  |
| Powers of 2 by bit location | 27 |  | 26 |  | 25 |  | 24 |  | 23 |  | 22 |  | 21 |  | 20 |  |  |
| Arabic value of position | 128 |  | 64 |  | 32 |  | 16 |  | 8 |  | 4 |  | 2 |  | 1 |  |  |
| Actual value of bit | 0 | + | 0 | + | 0 | + | 0 | + | 8 | + | 4 | + | 0 | + | 1 | = | 13 |

FIGURE 2–4 Internal view of a PC

Computer programs, or software, use binary code to provide the instructions that direct the work computers do. Personal computers, notebooks, and PDAs differ slightly from supercomputers, mainframe computers, and minicomputers in the structure of their CPU. The CPU in larger computers is generally composed of one or more circuit boards, whereas smaller computers rely on a [**microprocessor chip**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30186), which contains the electronic circuits of the CPU etched on a silicon chip, mounted on a board, otherwise known as the [**motherboard**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30226). All electrical components, including the main memory, connect to this board. [**Figure 2–4**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4121) depicts the internal components of a PC. The motherboard also provides slots for network interface cards and peripheral device interface cards. The [**network interface card**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30276) physically connects a computer to a network, controlling the flow of information between the two. Likewise, [**peripheral device interface cards**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30432) connect equipment such as printers to the computer and control the exchange of information. The slot arrangement on motherboard allows users to change or add computer system components easily. Portable or laptop computers can be connected to networks or peripheral devices through the use of a [**Personal Computer Memory Card International Association (PCMCIA) card**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30443). These cards can be inserted into a slot, in the case of the laptop computer, to add increased functionality such as additional memory or network connections. The Personal Computer Memory Card International Association was founded to establish standards for integrated circuit cards and promote interchangeability among mobile computers (PCMIA [**2007**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4643)). The organization also promotes interchangeability in other devices that include cameras, cable television, and automobiles.

The processor speed on PCs is measured in [**gigahertz**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29668). A gigahertz (GHz) represents 1 billion cycles per second. The processor speed determines how rapidly instructions are handled. In general, each new PC model offers a faster CPU speed.

Whenever the power to a PC is turned on, the computer performs a start-up process. The program code for this test is stored in permanent memory and is known as [**basic input/output system (BIOS)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28984). The BIOS confirms that information about component parts is present and that this information coincides with existing hardware.

SELECTION CRITERIA

Equipment selection should be based on needs and expectations. When selecting a computer system and related hardware, it is important to consider the following:

* • *The types of applications required. For example, some people use primarily word processing programs, whereas others need applications to perform numeric calculations*.
* • *The program execution time and computer capacity needed to process jobs*. Complex jobs require higher processor speed and more memory for timely execution.
* • *The number of workers who need computer access at any one time*. Single-user access demands can be met by a PC. Multiple demands for access may be better served by a network.
* • *Storage capacity*. Storage needs are determined by the amount of information that must be kept and the length of time it must be retained.
* • *Backup options*. When information stored and processed on computers is critical to conduct daily business, another copy should be available to restore normal services after a crash.
* • *Budget considerations*. The cost of hardware and software for various options should be considered in relation to the benefits and limitations associated with each.
* • *Maintenance considerations*. There are several issues related to maintenance. These include durability, battery life and time required for recharging batteries, and the ability to easily disinfect or clean equipment to minimize the chances of spreading infection (Neely & Sittig [**2002**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4640)). Infection control may be accomplished via placement of computer equipment in areas away from splatter, the use of hand washing and antimicrobial hand cleaners, keyboard skins, and designated cleaning procedures with periodic cultures of equipment.
* • *Portability*. Not all users require portability but when it is called for, size, weight, and equivalent functions must be evaluated.

These factors will help determine which type of computer or network is the best option, as well as the required hardware features. Advance planning ensures that current and future computer needs are well served.

User Needs and Ergonomic Considerations

Human factors should be considered in every work environment. Human factors, otherwise known as [**ergonomics**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29557), involve the study and design of a work environment that maximizes productivity by reducing operator fatigue and discomfort. Ergonomics considers physical stresses placed on joints, muscles, nerves, and tendons as well as environmental factors that can affect hearing and vision. Poor setup of computer equipment leads to somatic complaints that include headaches, eye strain, irritation, stress, fatigue, and neck and back pain. Even though the number of reported occupational injury claims has declined, failure to consider ergonomics is costly in terms of lost productivity (Bernhart [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4578); “Body Knowledge” [**2007**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4581); Brewer et al. [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4584); “Eye Strain” [**2010**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4587); Imrhan [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4613)). Ergonomics should receive the same attention given to other workplace education particularly since workplace injuries do not always start in the workplace. Additional research is also needed on the efficacy of interventions performed given that few quality studies have been done in this area. Ergonomics is especially important for users of laptop computers because these devices are designed for portability rather than good ergonomics. The keyboard and screen are too close together causing eyestrain and poor hand position, and perching the computer on one’s lap leads to poor posture (Gorman [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4591); Holzer [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4610); Tessler [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4650)). Whenever possible, plug-in keyboards and laptop stands should be used to foster good ergonomics. Two health problems associated with poor ergonomics include computer vision syndrome and repetitive motion disorders.

[**Computer vision syndrome (CVS)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29229) is a term the American Optometric Association uses to describe eye and vision problems that result from work done in proximity, such as when using a computer for long periods of time (Krader & Anshel [**2010**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4626); Rosenfield, Gurevich, Wickware, & Lay [**2010**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4647)). Eye and vision problems comprise the most frequently reported health problems and do impact productivity but receive less attention than do the musculoskeletal disorders primarily because vision problems are largely symptomatic and fleeting. Special consideration must also be given to the needs of the aging employee in designing work spaces. Computer vision syndrome symptoms include eyestrain, headaches, blurred distance or near vision, dry or red eyes, neck and/or backache, double vision, and light sensitivity. Poor lighting conditions, poor posture, and existing refractive errors contribute to the development of CVS in up to 90% of all computer workers.

BOX 2–2 Measures to Ensure Good Ergonomics When Using a Computer Work Station

**Determine how a workstation will be used**. Choose optimal settings for the chair, desk, keyboard, and monitor for the person who will use the area or that can easily be adjusted for each user. Adjustments are appropriate when wrists are flat and elbow angle is 90 degrees or more to prevent nerve compression.

**Determine the length of time the user will be at the workstation.** Individual adjustments are less critical if use is occasional or for very brief periods.

**Configure work areas for specific types of equipment.** Most workstation desks are designed for PCs rather than notebooks. Use a docking station or plug-in keyboard and stand if needed to ensure proper monitor and keyboard height.

**Select sturdy surfaces or furniture with sufficient workspace.** Desks should have room to write and use a mouse.

**Provide chairs with good lumbar support.** Relaxed sitting requires chairs that allow a reclined posture of 100 to 110 degrees.

**Educate all workers on the need for good body mechanics when working with computers.** Good posture is essential to reduce physical strain whether the individual works from a standing or sitting position.

**Position monitors just below eye level approximately one arm’s length away.** The monitor should be about 30 inches from eye to screen and 20–40 degrees below the line of sight. This will help to prevent neck strain, especially for bifocal wearers.

**Adjust screen resolution, font size, and brightness as needed.** Sharp screen images help to reduce eye strain.

**Periodically look away from the monitor to distant objects.** This helps to avoid eye-focusing problems.

**Minimize screen glare.** Purchase nonglare monitors or place monitors at right angles to windows. Provide blinds or draperies, or adjust area lighting as needed.

**Take frequent breaks.** Intersperse computer work with other activities to avoid RSIs.

**Avoid noisy locations.** Noise is distracting and stressful.

**Place the workstation in a well-ventilated area.** Fresh air and a comfortable temperature enhance working conditions.

**Use ergonomic devices with caution.** Select items that have been researched. Do not continue use if it remains uncomfortable after a trial period. Just because an item carries the label *ergonomic* does not mean that it is beneficial.

**Use optical prescriptions designed for computer work.** Everyday visual correction does not always work well for extended periods of computer work.

**Provide lighting that can be adjusted to the needs of the individual.** Older individuals need more light than younger persons to clearly view a task. Too little light contributes to eye fatigue and decreased productivity.

[**Repetitive motion disorders**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30655)**or**[**repetitive stress injuries (RSIs)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30663) result from using the same muscle groups over and over again without rest (National Institute of Neurological Disorders and Stroke [**2007**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4636)). One well-known example of a repetitive motion injury is [**carpal tunnel syndrome**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29049). Carpal tunnel syndrome occurs when the median nerve is compressed as it passes through the wrist along the pathway to the hand. This compression results in sensory and motor changes to the thumb, index finger, third finger, and radial aspect of the ring finger. Other repetitive motion injuries may involve the neck and shoulders. Good ergonomics helps to avoid occupational injuries and keeps employees productive. [**Box 2–2**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4203) provides a checklist to ensure good ergonomic design when designing and working at computer workstations. Another aspect of ergonomics addresses worker concerns about alleged health risks associated with computer use. The list of alleged health risks includes, but is not limited to, the following: cataracts, conception problems, miscarriage, and/or birth defects. Research has not established any clear links between computer use and these risks. [**Table 2–2**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4252) lists several examples of commercially available ergonomic devices. Some controversy exists regarding the degree to which these devices benefit the user and prevent injury. Young ([**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4656)) suggested that organizations provide an area where employees can test ergonomic devices before bulk purchases are made. This would also be helpful for employees who need assistance to adapt to new types of devices (Armbrüster, Sutter, & Ziefle [**2007**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4575)).

TABLE 2–2 Examples of Ergonomic Devices

| **Device** | **Purpose** |
| --- | --- |
| Glare filter | Reduces eyestrain related to glare or light reflected from a monitor and may help make images appear sharper and text easier to read |
| Negative tilt keyboard | Tilts away from the user with the keyboard below elbow height to allow the user to rest arms, shoulders, neck, and back during pauses in typing |
| Document holder | Keeps documents at the same height and distance from the user as the monitor, limiting head and neck movement and tension |
| Ergonomic mouse | Various designs that aim to reduce wrist and hand pain  No consistent research findings to support its use |
| Lumbar support | Maintains the natural curves of the back, minimizing back pain |
| Wrist rests | May actually increase carpal tunnel pressure unless a broad, flat, firm surface provides a place to rest the palm, not the wrist |
| Support braces/gloves | May relieve carpal tunnel symptoms when worn at night  There are no consistent research findings to support use while typing |
| Ergonomic keyboards | Split keyboard designed to improve posture  Research fails to support the benefit of this device |
| Foot rest | Encourages proper posture and supports the lower back to keep the pelvis properly tilted |

Physical Constraints

Space is a chronic problem in healthcare settings. For this reason, workstation planning is less a function of good ergonomics and more a function of finding a place to put the equipment. Ergonomics rarely receives high priority in planning. Provisions should be made for adequate numbers of computers in the clinical setting, located in quiet areas such as conference rooms.

Another major constraint to the installation of computers and networks in any institution centers on wiring and cabling. Adding power lines and cables for network connections to a current work space may prove to be more expensive than building a new work area. This is one reason for the growing popularity of wireless systems.

MOBILE AND WIRELESS COMPUTING

The terms mobile and wireless are often used interchangeably but are not the same. A device can be mobile without being wireless. [**Mobile computing**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30206) uses devices that can be carried or wheeled from place to place. These devices may or may not have the capability to transmit and receive information while they are mobile. When mobile devices do not have a wireless connection the user must re-establish a connection periodically to receive updated information or to send collected information to a large computer on the network. This connection may be achieved by plugging into a network port; docking port; or, in the case of some handheld devices, the use of a special cable to communicate with a computer that is connected to the network. Mobile devices may include desktop, specialized workstations or notebook computers on carts as well as some PDAs. [**Wireless devices**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31200) are equipped with a special card enabling the broadcast and reception of signals that reach the network via access points. That network may be wireless or ultimately a traditional network connected by cable. Wireless devices are not tethered by a physical connection such as a cable or telephone line. Wireless devices can continually receive and transmit up-to-date information. Increasingly the term *mobile* is used to refer to wireless devices. Mobile and wireless computing offer the following advantages:

* • *Both technologies bring computing to the bedside*. Point-of-care access allows healthcare providers and clients to view relevant information at the location where it is needed and eliminates the need to return to a workstation at the nurses’ station, which might be in use.
* • *Cost*. Mobile and wireless technology reduce the number of computers needed because the healthcare worker takes the device with him or her to where it will be used rather than require a device at a fixed location. Mobile and wireless systems also reduce the costs associated with connecting a traditional network with cables. Installing cable is labor intensive, disrupts care, and can be difficult to accomplish, particularly in older buildings.
* • *Improved data collection*. Computers at the point of care facilitate data collection. Care providers collect and input data once rather than taking handwritten notes for later entry into a computer.
* • *More efficient work processes*. Wireless technology and redesign of work processes enable healthcare professionals to work more efficiently. A graphic example is seen with online prescription of drugs where the physician or nurse practitioner quickly accesses allergy and drug interaction information and instantly sends prescriptions to the hospital or patient’s pharmacy without problems with interpretation of handwriting.
* • *Error reduction*. Wireless technology is hailed as a means to prevent errors because it can deliver up-to-date information, provide decision support, access reference materials, and even provide electronic prescription application access at the point of care.

Until recently, wireless technology was plagued by a lack of interoperability. This obstacle was removed by the adoption of a standard for wireless data transmission, making it possible for all wireless devices manufactured after the adoption of the standard to communicate. Recent advances in processing capability make the PDA particularly attractive because it is small, lightweight, and easy to use.

The advantages associated with mobile and wireless technology also raise concerns that include:

* • *Theft and loss*. These devices are more subject to theft and easy to lose because they are mobile and small enough to carry away. This requires the implementation of safeguards to protect information contained on stolen devices.
* • *Threats to data security*. The security of data may be compromised when devices are stolen. The technology used to protect data on wireless networks has been less secure than technology used to encrypt information on traditional, hardwired networks. Vendors have been working on this issue.
* • *Battery life*. Battery life varies according to use patterns and processing demands. Around-the-clock use requires close attention to the use of charge units and/or spare batteries.
* • *Data loss*. Mobile devices are used to collect and send information to another computer system. Damage to devices, theft, loss, or downtime related to dead batteries may lead to loss of data before it can be shared.
* • *Memory limitations*. While advances continue to add to the capability of handheld devices, memory limitations remain an issue, particularly when users expect additional features and capabilities.
* • *Limited ability to display and see information*. Small screen size limits the amount of information that can be viewed at one time.
* • *Deadzones*. Wireless devices may not be able to transmit and receive information in certain locations.
* • *Lack of a means to readily exchange data between hospital information systems and handheld devices*. Physicians typically want clinical information systems available to them on their PDAs. The ability to provide clinical data to handheld devices can be arduous and expensive to develop.

Another concern related to the use of PDAs is that organizations need to develop a comprehensive strategy for their use and support if they do not already have one in place. Many physicians and other healthcare providers are purchasing their own PDAs but cannot fully realize benefits associated with their use without organizational plans for PDA use and support. Purchase recommendations from Information Services staff can help to avert disappointment. Useful information related to PDA use and available applications and databases can be found through the publications and Web sites of professional organizations. *PDA Cortex was* an early online journal for mobile computing for healthcare professionals. The *PDA Cortex* web site remains available but has not been updated since 2005. There are now several journals that focus upon mobile computing and mobile computing in healthcare. Mobile computing now incorporates a wider variety of devices beyond PDAs.

SOFTWARE

[**Software**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30833) is a set of instructions that tells the computer what to do. [**Programs**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30520) and applications are forms of software. All software is written in [**programming languages**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30535). Each programming language provides a detailed set of rules for how to write instructions for the computer. Numerous programming languages exist. A few examples are listed here. Common Business Oriented Language (COBOL) remains popular for business applications. Massachusetts General Hospital Utility Multi-Programming System (MUMPS) has been used for healthcare applications. Ada is a high-level, general-purpose programming language originally developed for the defense department. Ada supports real-time applications. C is a flexible language that is particularly popular for PCs because it is compact. C++ is a descendent of C. Unlike its predecessor it supports object-oriented programming, which allows reuse of some instructions. C++ is favored for graphical applications in the Windows and Macintosh environments. Beginners All-Purpose Symbolic Instruction Code (BASIC) is widely found in home computing. Java is a popular language for the development of programs for use on the Internet. Visual Basic is a programming language used for the development of graphical user interfaces. Structured Query Language (SQL) is an example of a programming language that allows the user to query or search a database for specific information.

Several categories of software exist; each has a different purpose. Some major software categories include operating systems, application software, database management systems (DBMSs), and utility programs.

Operating Systems

The most essential type of software is the [**operating system**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30377). The operating system is a collection of programs that manage all of the computer’s activities, including the control of hardware, execution of software, and management of information. Control of hardware refers to the ability of different parts of the computer to work together. Operating systems allow users to manage information through the retrieval, copying, movement, storage, and deletion of files.

The operating system also provides a user interface. The [**user interface**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31119) is the means by which the individual interacts with the computer. For many years PC users had to enter specific text commands. Microsoft Windows provided a [**graphical user interface (GUI)**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29688). A GUI provides menus, windows, and other standard screen features intended to make using a computer as intuitive as possible. Graphical user interfaces decrease the amount of time required to learn new programs and eliminate the need to memorize commands. Work is under way on natural interfaces. The most natural user interface is the voice. Natural user interfaces are expected to free the user from conventional constraints such as mechanical keyboards, pointing devices, and GUIs, thereby making computers easier to use. Significant progress has occurred in recent years. An example of this progress may be seen in Apple’s iPhone 4 with its integration of Siri, a voice-enabled personal assistant feature that allows users to converse with their phone (Ionescu [**2011**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4616)). Siri uses Apple applications on the iPhone 4 to find the information requested. Wireless technology, a highly mobile lifestyle, and advances in interactive voice recognition also contribute to the increased use of voice recognition in call centers and for dictation. Voice recognition will not replace keyed data for some time yet in general use. There are still limits to the number of words that are recognized, and it is necessary to create a model of the user’s voice before use. There is also an issue with accuracy, which is less than 100%.

Operating systems exist for all categories of computers. Windows and Linux are operating systems for PCs. Windows has been through several versions. Current versions include XP, VISTA, and, most recently, Windows 7. [**Macintosh computers**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30085), or [**Macs**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30085), have their own operating systems. Macs are commercial computers that offer a graphical interface and are available for home and office use. Macs are produced by Apple Computer Incorporated. Fewer software programs are available for Macs, but adaptations are available that permit Macs to run PC software. UNIX is an operating environment developed in the 1970s that can run on virtually any hardware platform, from PCs to mainframe systems.

Application Software

[**Application software**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid28864) is a set of programs designed to accomplish a particular task such as word processing, financial management, or drawing. Application software builds on the foundation provided by the operating system. [**Box 2–3**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4428) lists some common types of software applications.

Another factor that facilitates computer use is the development of software tutorials and online help. Most software packages now offer tutorials for review before application use, making software much more accessible to first-time users. Help screens are available while the program is running.

BOX 2–3 Common Types of Software Applications

* • **Word processing**. Allows the creation of documents, utilizing features such as spelling and grammar correction, thesaurus, and graphics or pictures.
* • **Presentation graphics**. Supports the preparation of slides and handout materials.
* • **Spreadsheet**. Performs calculations, analyzes data, and presents information in tabular format and graphical displays.
* • [**Database**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid29306). Helps to manage large collections of information, such as payroll information, phone directories, and product listing. Performs calculations and produces reports from the stored information. Allows the user to find specific information.
* • **Desktop publishing**. Offers expanded features that may not be commonly found in word processing programs. Useful for the creation of newsletters and other publications.
* • **Web design**. Allows the user to create or revise Web pages and content that can then be posted to a Web site.
* • **Specialized software**

[**Project management**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30540). Supports the management of projects with identification of tasks and time frames for completion, including program evaluation review technique (PERT) charts.

**Personal information managers**. Enhance personal productivity with time management tools, including an appointment calendar, telephone directories, and reminder lists.

**Personnel scheduling**. Automates the process of scheduling staff.

**Report software**. Allows database use for queries and to discern trends without the need to write code in computer programming languages.

Examples of application software, which perform healthcare-specific functions, include the following:

* • Patient Registration (ADT)
* • Electronic Patient Record
* • Patient Accounting
* • Physician Order Entry/Results Reporting
* • Quality Management

Software to perform these functions may either be purchased from one or more software vendors or be developed in-house by the healthcare organization. The decision to build or buy software is discussed in later chapters of this textbook.

Database Management Systems

A DBMS is a software application responsible for the creation, maintenance, and use of a database. A database is an integrated collection of data structured for multiple uses. Today, the most common database type is the relational database. A majority of the previously mentioned applications have, as their foundation, a relational database. [**Figure 2–5**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4501) is a partial example of a relational database design for an electronic health record application.

Utility Programs

[**Utility programs**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid31124) help to manage the computer and its data. Early operating systems offered few utility options such as optimization of the hard disk, system backup, or virus checks. To fill this need, a separate category of software evolved. Many utility programs are now included as part of the operating system. However, users may still choose to install and use utility programs that are independent of their operating systems.

FIGURE 2–5 High-level data structure diagram

FUTURE DIRECTIONS

Technology is a pervasive part of everyday life. It is an integral part of home appliances and found throughout the healthcare delivery system. It is frequently invisible to the user but does require a bevy of behind-the-scenes people to ensure both its ongoing and optimal use. Technology will continue to develop and evolve in ways that are difficult for us to imagine today. Devices will become smaller and easier to use. This process will extend the capabilities of providers and create new disciplines. One area that is expected to have a large impact in the near future is nanotechnology. [**Nanotechnology**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_040.xhtml#eid30251) is the science and technology of engineering devices at the molecular level (Gulson & Wong [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4598); “Health and Medicine” [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4607); Knowles [**2006**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4623); McCauley [**2005**](https://jigsaw.vitalsource.com/books/9781323102497/epub/OPS/loc_011.xhtml#eid4632)). Nanotechnology is already used in cosmetics and sunscreens and other industries. Work is under way to create electrical circuits that would allow the development of smaller computers, design new monitoring technologies, and develop smart drug delivery systems. At this time the effects of nanotechnology on human health are not known and will need to be monitored over time.

CASE STUDY EXERCISE

You are appointed to the hospital’s information technology committee as the representative for your nursing unit. The charges of the committee include the following:

* • Identify PC software that is needed to accomplish unit work, such as word processing, spreadsheets, and databases.
* • Determine criteria for the selection and placement of hardware on the units.

Discuss these issues and how they affect patient care and workflow.

 Visit [**nursing.pearsonhighered.com**](http://nursing.pearsonhighered.com/) for additional cases, information, and weblinks.

SUMMARY

* • Computers are machines that process data under the direction of a program, or stored sequence of instructions.
* • The major hardware components of computers are input devices, the CPU, secondary storage, and output devices.
* • The major categories of computers are supercomputers; mainframes; minicomputers; PCs or desktop systems; laptop or notebook computers; tablet computers; and handheld devices such as PDAs, the BlackBerry, iPod, and iPhone.
* • Peripheral hardware items, such as the keyboard, mouse, monitor, modem, and printer, help the user put data into the computer, read output, and communicate with other users.
* • Networks are linked systems of computers. Local area networks, WANs, and the Internet are all types of computer networks.
* • Networks may use various technologies including cabling, radio signals, client–server, and thin client.
* • In choosing a computer system, one must consider current and future information processing needs, budget, and human factors.
* • Good ergonomics reduces physical discomforts and injury associated with computer use.
* • Mobile and handheld computer technology provide the promise of efficiency, improvements in the safety of care delivery, cost savings, and work redesign.
* • Software is the set of instructions that make a computer run and control its resources. Operating systems, applications, utility programs, and programming languages are all types of software.
* • Support personnel are essential to help people use PCs and information systems effectively and to maintain and upgrade hardware and software.

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