Learning Objectives

1. Define computer, and distinguish between analog and digital computer designs
2. Identify the main types of single-user and multi-user computers
3. Discuss how computers have shaped our current world

What is a Computer?

A computer is a machine that accepts some kind of information, performs actions and calculations according to a set of instructions, and returns the results of its calculations.

Categories of computer design

- **Analog computers**
  - Usually mechanical
  - As they operate, their physical state changes from a fixed starting point
  - Solve only one specific kind of problem
- **Digital computers**—most computers today
  - Process sequences of numbers (to remember the term, think of digit-al)
  - Convert input into numeric codes used in calculations
  - Rely on electrical, not mechanical, components
  - Extremely fast and flexible
Single-user computers. Most computers, known as **personal computers** or **microcomputers**, are meant to be used by one person at a time. They can be used independently or connected via **networking**.

- **Desktop computers** are PCs designed to sit on or under a desk or table.
  - Most common type of personal computer
  - Powerful and versatile (e.g., accounting, communication, music production, and editing of text, music, videos, images)
  - Main component is the **system unit**, the case that houses the processing and storage devices
  - Not easily portable

- **Workstations** are specialized, single-user computers with more power and features than a standard desktop PC.
  - Popular among scientists, engineers, animators who need their greater speed and power
  - Often have large, high-resolution monitors and accelerated graphics-handling capabilities
Notebook Computers

- Also known as laptops
- Clamshell design
- Portable microcomputers
- Docking station for hook-ups
- Netbooks offer compact size and low price
- Category: Mobile computers

Notebook computers, also called laptops, are PCs that approximate the shape of a writing notebook and easily fit inside a briefcase.

- They have a clamshell design: the user raises the notebook’s lid to reveal a thin monitor and a keyboard, and when it is not in use, the computer can be closed for easy storage.
- Notebooks are fully functional microcomputers but more easily portable than desktops.
- Some notebook systems may be plugged into a docking station, which lets a notebook hook up to devices and services such as a full-sized keyboard, large monitor, and local network.
- Netbooks are a variation of notebooks that offer compact size and low price. These computers have less processing power and may not offer some devices such as DVD drives.
- Because of their portability, notebooks fall in a category called mobile computers.

Tablet Computers

- Portable, full-featured
- Input from stylus or fingers
- On-screen keyboard
- Voice input
- Recent popularity
  - iPad
  - Android tablets

Tablet computers are portable, full-featured computers that offer the functionality of a notebook computer and can accept input from a special pen, called a stylus or digital pen, or the user’s fingers.

- Some tablet computers can display an image of a keyboard on the screen, for the user to type on.
- Some have built-in microphones and accept voice input.
- A few have fold-out keyboards.
- Because of their portability and friendly interface, their popularity has recently exploded (e.g., iPads, Android tablets).

Handheld Personal Computers

- Small size
- Limited processing power
- Personal Digital Assistants (PDAs)
- Colorful displays
- Finger touches and swipes for input
- Smart phones = cell phones + PDA
- Vast selection of programs

Handheld personal computers are computing devices small enough to fit in your hand. Their small size and limited processing power put them in a separate category from notebook and tablet computers.

- The handheld PCs of the 1990s and early 2000s were commonly known as personal digital assistants (PDAs). Early PDAs could run a limited set of software programs, typically for note-taking, small spreadsheets, and appointment management. Input was entered with a stylus on a touch screen.
- Today’s handheld PCs often have user interfaces that feature colorful displays, shortcuts, and touch screens able to accept finger touches and swipes for input.
- Smart phones are cellular phones that include PDA features and programs.
  - These convenient multifunction devices are highly popular both for business users and consumers.
Rapid advances in smart phones include the availability of vast libraries of programs that may be downloaded to support business and entertainment interests.

Multi-User Computers

- The largest organizational computers support thousands of individual users at the same time, with some working from thousands of miles away. They may be devoted to a single purpose or a wide variety of tasks.
- Types:
  - Network servers
  - Mainframe computers
  - Minicomputers
  - Supercomputers

Network Servers

- Primary computer in a network
- Special software and equipment
- Can be linked to other servers
- Clusters / server farms: large groups of servers
  - Blade: thin unit housed in a rack

**Network servers** are central computers with special software and equipment enabling them to serve as the primary computer in a network of personal computers (e.g., running a large company’s email program or sending out Web pages on the Internet).

- When requests from the network are too large and complex for one server, a network may link together several, dozens, or even hundreds of servers.
- Large groups of servers may be called **clusters or server farms**.
- These clusters don’t need keyboards and screens, so they may not be contained in a big case like a typical PC. Instead, each server can be a thin unit, called a **blade**, which is housed in a rack with the other servers.
• **Mainframe computers** are large, powerful systems used in organizations where users frequently need to use the same data.
  - Users access the mainframe through a **terminal** or a standard personal computer.
    - A *dumb terminal* is simply an input/output device.
    - An *intelligent terminal* can perform some processing operations but usually does not have storage.
  - The largest mainframes can handle the processing needs of thousands of users at a time.
  - Most mainframes are limited to certain kinds of tasks, such as storing large amounts of data.

• **Minicomputers**, often called *midrange computers*, offer capabilities between those of a mainframe and a personal computer.
  - Some are designed for a single user; the most powerful serve hundreds of users at a time.
  - Users can access a central minicomputer through a terminal or standard PC.

• **Supercomputers** are the most powerful computers and physically some of the largest.
  - The fastest can perform nearly two quadrillion \(10^{15}\) calculations per second.
  - Some link together hundreds of thousands of processors.
  - Supercomputers are ideal for handling large and highly complex problems (e.g., forecasting the weather, mapping the human genome).
Why Computers Are Important

- Change how we work and live
- Provide ready access to information
- Create some kinds of new information

Some technological developments, such as railroads, the automobile, the telephone, and electricity, have changed how we work and live. Computers are bringing a similar degree of change.

Most or all of these changes share one element in common: information.

- Computers provide ready access to information.
- Computers make it easy to create some kinds of new information, such as the solution to an equation or a statistical analysis of data or even many types of creative products such as a musical composition or a new recipe.

Where Computers Are Used

- Homes
  - Communication
  - Work-related tasks
  - Schoolwork
  - Entertainment
  - Creativity
  - Finances
- Education/schools
  - Classes and degrees
  - Computer applications
  - Distance learning

- Communication—Family members stay in touch with services such as e-mail, social networking, and microblogging (Twitter).
- Work-related tasks—People can use computers to access work data and correspondence in their homes, and some people use computers to start home-based businesses.
- Schoolwork—Students use computers to conduct research and create reports and presentations.
- Entertainment—Computers and video game consoles offer a wide variety of popular games to play alone or with others.
- Creativity—Individuals use computer tools to create and share poetry, music, paintings, photographs, essays, stories, music, and videos.
- Finances—Many households keep track of spending, pay bills, and track investments online. People shop online, too.

- Education/schools

  - Schools are adding computer technology to their curricula.
  - Classes and degrees in computer science or computer skills (e.g., word processing, spreadsheets, computer-aided design)
  - Computer applications in non-computer classes (e.g., research using the Internet, presentations created with PowerPoint)
  - Computer technology, especially the Internet, provides access to education for people who can’t readily travel to a college or university because they live in remote areas or have limited time.
• **Businesses**
  - Many small businesses could not exist today without computer technology.
  - Inexpensive computers and software enable business owners to handle complex tasks such as accounting and inventory management that once required a staff of specialists.
  - Computers and networks allow individuals to work and stay in touch with customers from any almost location.
  - Larger industries use different kinds of computers in many combinations (e.g., a network of PCs at headquarters and computer-controlled robotics in a factory). Examples:
    - Computer-aided design and manufacturing
    - Computing to manage shipping routes and schedules, tracking of vehicles, scheduling of maintenance, invoicing and billing
    - Process-control systems to monitor production processes and flag problems for correction

• **Governments**
  - The U.S. Census Bureau has been using computer technology since the early 20th century, when it used mechanical computers to tally the population.
  - The Internal Revenue Service uses computers to process tax returns and encourages taxpayers to file online.
  - The military has commissioned some of the world’s most sophisticated computer technology for purposes as diverse as payroll management, calculation of the trajectory of missiles, and games and simulations used for training.
  - Many police forces equip cruisers with laptop computers and wireless Internet connections so officers can readily look up information about criminals, crime scenes, and procedures.

• **Health care providers**
  - Computers can make the delivery of health care more efficient and accurate.
  - Computers are used for procedures such as ultrasound, magnetic resonance imaging (MRI), and laser surgery. Robotic surgical devices can make it possible to perform delicate operations and even conduct surgery remotely.
  - Computers are used for managing medical records, including billing, patient histories, and prescriptions.
• Green computing: the efforts made toward reducing the environmental impact in the manufacture, use and disposal of computers
  • Making computers involves the use or production of hazardous materials. Green computing begins with handling these responsibly.
  • As computer components wear out, one way to minimize waste is to replace only those components, rather than entire computers.
  • Keeping computers cool requires a lot of power. Ways to minimize energy use are to create power-efficient hardware, use improved cooling techniques, and help cooling fans work efficiently by clearing dust from computers.
  • Computers can help people be “green” by providing information for making operations more efficient and by enabling people to work from home, rather than generating pollution by commuting.
• Social communication: Computers are changing the ways people communicate.
  • Mobile computers and smart phones give us instant access to other people.
  • Software programs let people share their physical location (e.g., Foursquare) or thoughts (e.g., Twitter, Facebook). The software makes it easier to do this with far more people.
Chapter 1B
Looking Inside the Computer

Learning Objectives

1.4 List the parts of a complete computer system, and discuss the phases of the information processing cycle.
1.5 Identify four basic categories of computer hardware.
1.6 Discuss the role of software as a part of the computer.
1.7 Explain the crucial link between data, users, and technology.

Computer System

A computer system is more than a box with components; it encompasses four elements that make the machine fully useful:
- Hardware
- Software
- Data
- Users
The Parts of a Computer

- **Hardware** consists of the physical (electronic and mechanical) devices that make up the computer, including input/output devices, the system case, cables, and networking devices.
- **Software** is a set of instructions that makes the computer perform tasks.
  - A program is any piece of software.
  - Programs may help the computer perform certain tasks or enable the user to perform certain tasks.
- **Data** consist of individual facts or pieces of information.
  - Choosing the right data is an essential part of making a computer system effective.
  - For programs to be useful, they require meaningful data.
  - Data are the raw materials for creating information—the concepts, facts, and ideas that people find useful.
- **Users** are the operators of a computer.
  - No computer is completely autonomous. Users are needed to provide data and put the results to use.
  - A direct user can also be other computers or computer components acting on behalf of people (e.g., a network server).

Information Processing Cycle

- The information processing cycle is a series of steps the computer follows to receive data:
  - **Input**: The computer accepts data from some source.
  - **Processing**: The computer's processing components perform actions on or with the data, based on instructions from the user or a program.
  - **Output**: The computer provides the results of its processing (e.g., text, numbers, a graph, sounds, or data held for storage).
  - **Storage**: The computer stores the results of its processing.
  - Storage to memory is usually temporary.
  - For permanent storage, the computer saves data to a hard drive or other storage medium.
  - Storage is an optional step.

Essential Computer Hardware

- Circuit board
- Processors
- Memory
- Input/output devices
  - Communication devices
- Storage
A computer's electronic parts and subsystems are generally installed on a **circuit board**, a piece of plastic or other material on which parts are mounted, organized, and connected.

- Circuit boards used to provide a specific ability are commonly called **cards** (e.g., sound or video cards).
- The largest circuit board in a computer is the **motherboard** (or mainboard), which contains components for connecting everything else together.
  - Connectors and ports for hooking up all the other parts, from the CPU to the webcam
  - Its own set of electronic components for regulating power to subsystems and managing the flow of data
  - Sometimes electronic subsystems for video and sound output and network communications
  - For the computer to be fully functional, the motherboard is connected to the following kinds of hardware devices.

**Processors** are the complex electronic circuits, etched onto silicon, that are responsible for transforming raw data into useful information (processing the data).

- The main processor for the computer is the **central processing unit (CPU)**, which organizes and carries out instructions from the user or software.
- In a personal computer, the CPU consists of a single specialized chip called a **microprocessor**.
  - The CPU is plugged into a special socket on the motherboard. Plugging a single unit into a motherboard gives computer makers flexibility in choosing CPUs for a computer.
  - Modern CPUs generate a lot of heat, so they are installed with cooling units (heat-conducting metal against the CPU, coupled with cooling fans). The cooling unit and circuit board make CPUs look large, but a microchip is actually a fraction of an inch across.

**NOTE:** for storage units, see slide #12

**Memory** is one or more sets of chips that store data and/or program instructions, either temporarily or permanently.

- **Random access memory (RAM)** is a set of small chips on a circuit board that allows the computer to store and retrieve data and instructions very quickly.
  - When a program is launched, it is loaded into and runs from RAM (often called memory for short).
  - As the program needs data, it is loaded into RAM for fast access.
  - RAM is **volatile**, mean it loses its contents when the computer shuts off or there is a power failure.
  - The more RAM a computer has, the more it can do and the faster it can perform certain tasks. If it doesn't have enough RAM, it will store some data on its hard drive, which slows the computer down.
Memory size is measured in terms of bytes, the amount of memory it takes to store a single character, such as a letter or numeral.

Modern computer memory is large, so the units are given as kilobytes, megabytes, gigabytes, and terabytes.

Adding RAM to a computer to improve its performance is one of the most common kinds of system upgrades.

Models of RAM differ in their speeds, methods for data storage and retrieval, and physical layouts. Each PC motherboard requires a specific type and speed range of RAM. A RAM card’s specifications must meet the requirements provided by the motherboard manufacturer and match any existing RAM modules.

Read-only memory (ROM) permanently stores data, even when the computer is shut off.

ROM is used to store computer instructions and hardware information that rarely changes.

ROM can be changed, but the process is much slower than for altering RAM.

ROM is called nonvolatile because the contents are never lost.

Input/Output Devices

- Input devices accept data and instructions from the user or another computer.
- Output devices return processed data to the user or another computer.
- Some types of hardware can act as both input and output devices (e.g., touch screens, communication devices).

Networking is the process of connecting one computer to another.

A modem converts digital (computer readable) data to analog signals (e.g., telephone, television) and analog to digital.

Network interface cards (NICs) are digital-to-digital hardware components that allow communication and can uniquely identify the computing device on the network.
• **Storage** devices hold data permanently, even when the computer is turned off. There are three main types:
  - Memory size is measured in terms of **bytes**, the amount of memory it takes to store a single character, such as a letter or numeral.
  - Modern computer memory is large, so the units are given as **kilobytes**, **megabytes**, **gigabytes**, and **terabytes**.

• **Magnetic Disks** - round, flat objects that spin around their center, almost always housed inside a case of some kind:
  - **Read/write heads** read data from the disk or write data onto the disk.
  - The complete device that holds the disk is a **disk drive**.

• **Optical Storage** uses lasers to read data from or write data to the reflective surface of an optical disc such as a CD or DVD:
  - **CD-R** disks allow you to create your own disks but cannot be erased and reused.
  - **CD-RW** disks allow you to write and erase data multiple times on the same disk.
  - **DVDs** are popular for permanent, removable storage because they hold a great deal of data (more than 4 gigabytes). With a DVD drive, a computer user can read from and write to DVDs and CDs, listen to music, and watch movies.
  - **Blu-ray discs**, the most recent form of optical storage, use a blue-spectrum laser. That type of laser and advances in disc design greatly increase the disc’s storage capacity, so Blu-ray drives are becoming the new standard for home entertainment and permanent data storage. The drives often can read CDs and DVDs as well as Blu-ray discs.
• **A solid state drive (SSD)** is a memory subsystem that relies on special kinds of ROM to permanently store data. SSDs use memory chips and have no moving parts, so they have no risk of losing data due to mechanical failures, and they generally use less power, so they are ideal for mobile computing devices and may represent the future of data storage.
  
  - **Flash drives** are a type of SSD that connects to the computer with a USB plug, which is inserted in a USB port. These easily portable storage devices can hold as much data as some hard drives.
  
  - The small, thin memory cards used to store data in phones and computers also are types of SSD. There are two major formats: **CompactFlash (CF)** and **Secure Digital (SD)**.
  
  - These come in a range of styles and storage capacities, typically providing 2 to 32 GB of storage but some storing terabytes of data.
  
  - They require little power to run (making them ideal for devices with limited battery capacity) and can be easily removed and transferred to a reader on a PC, allowing quick transfer of images or video to the PC.
  
  - These advantages plus falling costs may make SSDs a new standard, replacing hard drives.

• Software programs tell the computer's hardware components what to do. A computer using a program is said to be **running** or **executing** the program.

  - To be available on a program, the software must be **installed**, which means that the program is written into the computer's permanent storage.

    - Installation usually includes adding references to the new program into the computer's operating system, so the operating system will know where to find the program and how to start it.

    - Other installation tasks are creating and placing data files for the program to use, establishing connections to devices such as printers, and updating software modules in other programs the new software will use.

    - On most consumer devices, software installation runs automatically after the user gives permission.

  - **Application software** tells the computer how to accomplish specific tasks (e.g., word processing, drawing).

    - Thousands of applications are available.

    - Some popular types are document publishing software, spreadsheets, database management, presentations, graphics, multimedia authoring, business software, education software, Internet applications, and games.

    - The software must be adapted to its intended use, such as the operating system that will run it and the kinds of tasks the user will perform.

    - Changes in hardware, such as the design of new processors, typically require changes in the application software.

    - Application software need not reside entirely on the user’s machine; computers can connect to and use software stored on the Internet and local computer networks (e.g., sharing reports and spreadsheets online with Google Docs).
**System Software**
- System software is any program that controls the computer’s hardware or can be used to maintain the computer.
  - **Firmware** is used to directly control hardware devices (e.g., keyboards, hard drives, cell phones, television). It is embedded on microchips and installed in the device it controls.
  - **Operating systems** (e.g., Windows, Mac OS X, and Linux) tell the computer how to use its own components.
  - A **network operating system** allows computers to communicate and share files and device resources across a network, controls network operations, and oversees the network’s security.
  - **Utilities** are programs that make the computer system easier to use or perform a highly specialized function such as troubleshooting hardware problems.

**Computer Data**
- Data refers to raw materials used to create information.
- Computer data are organized into files, which are sets of data grouped together and given a name.
- A file of data that a user can open and use is often called a document.
- Computer programs are also organized into files; these contain the instructions and data needed to run the program.

- Computer data: Data serves as the computer’s raw material for performing every task.
  - The term *data* refers to raw materials used to create information (concepts, ideas, and facts people find useful).
  - Computers aid in converting data into information.
  - Digital computers convert all data—letters, numbers, sounds, pictures, and software directions—into strings of digits (hence the terms digitize and digital). They process the instructions in a strict sequence and convert the digital result into information displayed in a way meaningful to a user.
  - Computer data are organized into files, sets of data grouped together and given a name.
  - A file of data that a user can open and use is often called a document.
• The user's role: The following roles are common for the user of a personal computer.
  • Setting up the system: Unpacking and connecting hardware and customizing how it works
  • Installing software: Some software is preinstalled on a computer; other hardware is selected and installed by the user (e.g., by inserting a disk or downloading it from a Web site).
  • Running programs
    • Some programs start up with the computer is turned on and may even run without the user's knowledge.
    • For most application software, the user needs to launch and run the program. (Chapter 1 described how to do this with a mouse.)
  • Managing files: Setting up a logical system for storing files on the computer, knowing when to delete files, moving them, and copying them to a storage device for safekeeping
  • Maintaining the system
    • Running utilities to keep disks free of clutter and ensuring that the computer is working efficiently
    • May occasionally involve fixing parts inside the computer (often the responsibility of a qualified technician)

• "Userless" computers
  • Many kinds of computers require no human interaction once they have been programmed, installed, and started up (e.g., a car's onboard computer or computers in home appliances, security systems, or navigation systems).
  • These computers are typically controlled by their operating systems, often installed on special memory chips.
  • Nevertheless, these systems do have users, just not users who directly interact with the computer. Users depend on the systems to provide the desired outputs.
Learning Objectives

2.1 Compare how to interact with an operating system using a graphical user interface and a command-line interface
2.2 Summarize how to input information into a computer with a computer’s keyboard, mouse, and touch screen
2.3 Describe other ways to input information into a computer
2.4 Explain why and how computer users need to address the ergonomics of using a computer

User Interfaces

- Operating system basics
- Graphical user interfaces
- Command-line interfaces

- Input (and output) devices interact with two software subsystems that sit between these devices and the user: the operating system and the user interface.
• An operating system is a kind of software known as system software—software that controls the system’s hardware and interacts with the user and application software. It is the computer’s master control program and performs the following functions: (PPT 1.20)
  - Displays the on-screen elements with which you interact—the user interface
  - Loads programs into the computer’s memory so that you can use them
  - Coordinates how programs work with the computer’s hardware and other software
  - Manages the way information is stored on and retrieved from disks

• Graphical user interface (GUI): Users launch programs and make choices with graphical objects such as windows, menus, icons, buttons, and other tools.
  - In Windows and other GUIs, the metaphor for the graphics is a desktop; the background of the GUI is a desktop on which graphical tools are presented and within which work is stored. (PPT 1.22)
    - Small pictures on the desktop, called shortcuts, represent links to resources on the PC or network. (They are often mistakenly called icons, which are simply pictures used to represent an object.)
    - Using your mouse or other pointing device, you can move the pointer and choose (activate) a shortcut, telling the OS you want to use the resource represented by the shortcut.
  - Elements on the Windows desktop
    - **Taskbar**—at bottom of desktop; used to launch and manage programs
    - **Start button**—opens Start menu
    - **Start menu**—contains shortcuts for launching programs and opening folders (When you start a program, a button representing it appears on the taskbar; click on these to switch quickly between programs.) (PPT 1.23)
• When you right-click an object in Windows, a small menu usually appears. (PPT 1.24)
  • This menu may be called a **shortcut menu** or a **context menu**.
  • It provides quick access to the most common commands associated with the object.
• When you launch a program, it is loaded into memory and begins to run.
  • It may take up the whole screen; or
  • It may appear in a rectangular frame called a **window**; or
  • It may appear only as a shortcut on the taskbar.
• **Windows** (PPT 1.25)
  • In a GUI such as Windows, you access all the computer’s resources through windows.
    • Viewing the contents of a disk
    • Running a program
    • Editing a document
    • Viewing a Web page
    • Changing system settings
  • A different window appears for each resource you use.
• Common GUI features of a window
  • **Title bar**— Identifies the window’s contents and contains Minimize, Restore, and Close buttons
  • **Menu bar**— Provides lists of commands and options for the program
  • **Toolbars**— Contain buttons that let you issue commands quickly
  • **Scroll bars**— Let you scroll to view parts of the program or file that do not fit in the window
• Although the graphic OS lets you run multiple programs and resources at the same time, you can work in only one window at a time.
  • The window currently in use is the **active window**; its title bar appears in a deeper color, and its taskbar button appears highlighted. The window appears on top of any overlapping windows.
  • To access the contents of a window, select it by clicking on the open window or the taskbar button.
• Besides clicking icons and toolbar buttons to initiate tasks, you can perform tasks by choosing commands from lists called menus.
  • In most program windows, you open menus from a horizontal list called the **menu bar**.
  • To execute or run a menu command, you click it.
  • For some commands, you can use keyboard shortcuts instead of the mouse.
  • The traditional menu style is a list of vertical choices, but some newer programs favor a **ribbon** style.
    • Choices and options in a ribbon menu are displayed horizontally across the top of the work area.
    • Traditional menus are displayed only when the user wants to make a selection from them; ribbons are typically always visible.
• **Dialog boxes** are special-purpose windows that appear when the OS or application needs to give you status information and possibly a choice of actions or when you need to tell a program (or the OS) what to do next. (PPT 1.26)
**Command-line Interface**

- The user enters typewritten commands rather than interacting with graphical objects to execute tasks.
- Users enter commands at a prompt on the screen.
  - For example, in DOS, the prompt usually includes the identification for the active disk drive (a letter followed by a colon), a backslash (\), and a greater-than symbol (>), as in C:\.
- A command-line interface is not as intuitive as a GUI, but entering commands can be quick.
- Windows offers an optional command-line interface, called Command Prompt.
  - This is most often used by administrators to run non-GUI programs for managing and troubleshooting Windows.
  - Any program that can be run in Windows can be launched from the Command Prompt.

**Common Input Devices**

- Input devices enable users to enter information and commands.
- Ports connect input and output devices to the computer. On a personal computer, look for them on the front, back, and sides of the processing unit.
  - Ports come in a variety of shapes for connecting to particular pieces of hardware. (PPT 1.9).
  - Many devices (e.g., cameras, printers, some models of keyboards and mice) connect via USB ports (USB = Universal Serial Bus).
**Keyboard**—The primary input device for entering text and numbers; includes about 100 keys: (PPT 1.10)

- **Alphanumeric keys**—Letters, numbers, the space bar, and the Tab, CapsLock, Backspace, and Enter keys
- **Modifier keys**, which modify the input of other keys—Shift, Alt (Alternate), and Ctrl (Control). Holding down a modifier key while pressing another key changes the second key’s input in some way.
- **Numeric keypad**—A set of numbers, operation signs, and cursor movement keys that resembles a calculator’s keypad.
  - Usually located on the right side of a keyboard. On smaller notebook models, these functions may be assigned to alternate values on the alphanumeric keys.
  - Pressing the Num Lock key switches the meaning of the keys between digits and cursor control.
- **Function keys**—Keys (usually a total of 12) labeled F1, F2, etc.
  - Usually arranged across the top of the keyboard.
  - Input commands with one keystroke.
  - The command associated with a key depends on the program.
- **Cursor-movement keys**—Navigate the cursor around the screen. The *cursor*, or *insertion point*, is a vertical line or other symbol displayed on the screen to show your place in a document or command line.
- **Special-purpose keys**—Exact function of each depends on the program in use.
  - Del (Delete)—Typically used to remove objects in the currently running program
  - Esc (Escape)—Often used to cancel the appearance of a dialog box or move back one level in a multilevel environment
  - Ins (Insert)—Switches some programs between “insert mode” (when text is inserted, the existing text is pushed forward) and “overtype mode” (when text is inserted, it replaces the text that was there before)
  - PrtScn (Print Screen)—Allows the user to capture whatever is sown on the screen into an image file
  - ScrLk (Scroll Lock)—Typically causes the cursor to remain stationary on the screen; the document’s contents move around it
  - Pause—In some programs, stops or pauses execution of a command
  - Start—In the Windows operating system, opens the Windows Start menu
  - Shortcut key (a key with an image of a menu)—In Windows-based application programs, opens an on-screen shortcut menu
- **Keyboards may also offer Internet and multimedia controls that perform functions such as opening e-mail, launching a Web browser, or controlling the volume of the speakers.**
Mouse and Trackball

- **Mouse**—a pointing device that is widely used for entering data on a full-sized PC.
- The pointer allows users to select the specific graphical objects they wish to activate or change.
- A mouse may be:
  - mechanical—sensors read information from a rolling ball
  - optical—a sensor and image processor reads and interprets information from a beam of light
- **Trackball**—a pointing device in which you move the pointer by rolling a ball.

Using the Mouse

- **Pointing** is using the pointer to a location on the screen by pushing the mouse around on the desk.
  - Moving the mouse left (right) moves the pointer left (right).
  - Moving the mouse away from you moves the pointer up.
  - Pulling the mouse closer to you moves the pointer down.
  - When you have moved the pointer to an object or location on the screen, you can click, drag, or scroll.
- **Click** means pressing the primary (usually left) button on the mouse. This typically selects an object on the screen.
- **Double-clicking** means pressing the primary mouse button twice in rapid succession. This typically requests an action, such as opening a program or file.
- **Right-clicking** means pressing and releasing the non-primary (usually right) button. This usually opens a shortcut menu of commands and options related to the object you have pointed to.
- **Dragging** means pressing and holding the mouse button and continuing to hold it as you move the mouse. As the pointer on the screen moves, so does the object you have pointed to.
  - When you have dragged an item to a new position, release the mouse button to release the item in that location.
  - Moving items around this way is known as **drag and drop**.
• **Scrolling** is moving a list of information up or down on the screen. If you have a mouse with a wheel between the right and left buttons, many programs allow you to scroll by turning this wheel.

• **Touchpad** (or **trackpad**)—A stationary pointing device operated by moving a finger across a small touch-sensitive surface; the movement of the pointer on the screen follows the path of the finger
  - Many people find a touchpad less tiring to use than a mouse or trackball.
  - The small size (typically 1.5 to 2 inches square) makes it ideal for notebook computers.
  - Most touchpads include two or three buttons that perform the same functions as mouse buttons.
  - Besides using the primary button, you can tap the pad with a fingertip to “click” or “double-click.”

• **Pointers in the keyboard**
  - A small pointing stick may be positioned near the middle of a portable computer’s keyboard.
  - The user controls it with his or her index finger to move the pointer on the screen, which can save time and effort compared with other pointing devices.
  - Two buttons beneath the spacebar perform the same functions as the buttons on a mouse.
  - Generic terms for this device include *integrated pointing device* and *3-D point stick*. A popular brand is **TrackPoint**.

• **Touch screens**
  - Accept input from a user’s fingertips directly on the computer screen.
  - Computers and terminals with a single purpose, such as menus in restaurants or ticketing booths for airlines, use touch screens offering a menu of choices.
  - Smart phones and tablet PCs have more sophisticated touch screens that allow users to drag and drop items, double-tap to open programs, and make windows larger or smaller.
  - Touch screens are most useful when a simple, intuitive interface is important and where dirt or weather would interfere with keyboards and pointing devices.
• Other input devices meet special needs of users, such as speed or entertainment in particular applications.

• Pens (also called styluses)
  • Used for tablet PCs, PDAs, and other handheld computers.
  • The user writes information on the screen or points to objects on the screen.
  • Handwriting recognition is complex, and writing tends to be slower than typing, so this method is not idea for entering large amounts of text.
  • Artists who create images on a computer often use graphics tablets that combine extra-sensitive touch screens and pens.
  • Pen-based computers are commonly used for data collection, such as checking a box, and creating a record of a signature.
  • Sometimes the input pen is also the computer. The Livescribe Echo Pen writes with real ink on special dotted paper. As the user writes, a computer in the pen stores both the writing motions and nearby sounds, saving a spoken lecture along with the written notes.
    • The notes and audio can be reviewed together.
    • They also can be transferred from the pen to a PC, searched for keywords, and shared with others.

• Game controllers are specialized input devices designed to take advantages of the features of a particular set of games.
  • Game pads are small, flat devices designed to be held with both hands. Newer game pads provide an array of buttons, triggers and thumb-driven joysticks that let the user send complex commands to the game system.
  • Game systems such as the Nintendo Wii support wireless controllers that transmit input based on their location as well as through buttons on the controller. As the controller moves through the air, the motion is translated into actions in the game.
- **Bar code readers** are flatbed scanners or handheld scanners that read bar codes, or patterns of printed bars that identify items
  - The reader emits a beam of light (such as a laser beam) that is reflected by the image and read by a detector.
  - The detector converts the bar patterns into numeric data the computer can understand.
  - **QR (quick response) Codes** are a new format for storing data visually.
    - The code appears as a square filled with dots and lines.
    - Optical scanners, including smart phones with a camera and the right software, read and interpret these codes.
    - Uses include tracking items in a business or directing a cell phone to open a specific Web address in a browser.
- **Image scanners** convert any printed image into electronic form by shining light onto the image and sensing the intensity of the light’s reflection at every point. (A bar code reader is a specialized image scanner.)
  - Color scanners use filters to separate the components of color into the primary additive colors (red, green, blue) at each point.
  - Image scanners translate printed images into an electronic format that can be stored in a computer’s memory. Users can use software (e.g., Photoshop) to manipulate the image.
  - Text documents can be scanned with **optical character recognition (OCR) software** to translate the image into text that can be edited (e.g., converting a fax into text that can be edited with a word processor).
  - Scanners may be handheld or desktop models.
    - Handheld scanners require multiple passes to scan a single page.
    - Flatbed scanners offer higher-quality reproduction.
- **Biometric scanners** analyze physical patterns in humans.
  - Fingerprint scanners detect the print pattern of a finger pressed against the scanner and send a digital version of that image to a computer. These provide secure access to bank accounts, buildings, and other secure destinations.
  - Scans of human faces are used for research by behavioral scientists.
  - Eye-tracking scanners are used by marketers, the military, and medical researchers to obtain data about where people are looking.
• **Audio input devices** (PPT 1.15)
  
  - Microphones are used to record speech (e.g., to create a multimedia presentation) or participate in audio and video chat (e.g., Skype).
  - These applications require a microphone and speakers or a headset with an attached microphone.
  - With audio recording software, you can save audio files to embed in documents, post on Web pages, or attach to e-mails.
  
  - **Speech recognition** or **voice recognition** software translates spoken words into text and sends controls such as Open or Cancel to the computer.
    - For users with disabilities, computers combine speech recognition hardware and software, such as Dragon's NaturallySpeaking, to control their computer's activity.
    - The computer also may link to hardware that controls lights, heating and other environmental systems, so disabled users can operate those systems simply by speaking.
  
  - **Microphone quality** varies greatly.
    - Higher-quality microphones often incorporate a digital converter, reducing the chances for sound data to be adversely affected as it travels to the computer.
    - Lower-grade microphones may simply transmit analog electrical information to the computer's sound subsystem for conversion into digital data, risking a loss in sound quality before the analog signal is converted.
    - Chatting with friends can be done with practically any microphone, while speech recognition or broadcasting may require a better model.
  
  • **Video input devices**
  
  - **PC video cameras** capture full-motion video images, which can be transmitted to a few recipients in a videoconference or broadcast on the World Wide Web (e.g., on YouTube).
    - **Webcams** are popular and inexpensive PC video cameras that can sit on top of a PC’s monitor or placed on a stand.
    - Often users record themselves with a webcam, which allows participants in a videoconference to view real-time images of one another during the session.
    - Notebook computers often contain built-in video cameras, typically inside the case just above the top of the screen.
  
  - **A video capture card** lets the user connect other video devices, such as DVD players and camcorders, to the PC.
    - Images may be transferred between the video device and the PC.
    - Video files transferred to the PC may be edited.
Inputting Music

- Import files from CDs, MP3 players, or tape players.
- A built-in musical instrument digital interface (MIDI) port or MIDI adapter allows the connection of electronic instruments to your computer.

If you want to import audio files from CDs, MP3 players, or even tape players, audio input devices exist for these.

A built-in musical instrument digital interface (MIDI) port or a dedicated MIDI adapter will let you connect many kinds of electronic instruments to your computer.

- MIDI-based instruments can communicate with and control one another.
- Any PC can be used to control MIDI instruments and record their output.
- Musicians use MIDI to write, record, and edit music and to control instruments during performances.

Digital Cameras

- Digital cameras are portable, handheld devices that electronically capture still images.

- The electronic files of the images may be copied to a PC, where they may be edited, copied, printed, embedded in documents, or transmitted to others.
- Most digital cameras can store dozens to hundreds of high-resolution images.
- Web designers and graphic designers can copy and edit digital photographs in numerous ways to create artwork, marketing materials, and other kinds of presentations. For example, with landscape design software, a landscape designer can take an image of a house and show what it would look like with various kinds of shrubbery and trees.

Ergonomics and Input Devices

- Ergonomics is the study of the physical relationship between people and their tools, including computers. (PPT 1.16)

- Computer users often spend hours at a time in front of their computers. Lack of moving around and looking around can lead to aching muscles and strained eyes.

- Repetitive stress injuries (RSIs) occur when repetitive, improper use of a muscle group leads to strain injuries.

- Such injuries have been observed in individuals who spend most of their time entering data with computer keyboards.

- One type of RSI that is especially well documented among computer users is carpal tunnel syndrome, a wrist or hand injury caused by using a keyboard for long stretches.

- Avoiding keyboard-related injuries: RSIs can be avoided by practicing good work habits and setting up hardware and the workspace in a way that is ergonomically friendly. (PPT 1.17)

- Chair—Choose a comfortable, ergonomically designed chair with adjustable armrests and good lower-back support. Set it to the proper height for you to maintain good posture.

- Desk—The desk should hold your keyboard and mouse at the proper height, so that your hands are at the same height as your elbows or a few inches lower when you hold them over the keyboard.
• Keyboard—Consider buying an ergonomic keyboard, which is curved to allow you to hold your hands in a more natural position.

• Wrist support—If you type a lot, a wrist support allows you to rest your hands comfortably when you pause. However, do not rest your wrists while typing.

• Posture (PPT 1.18)
  • While typing, keep your wrists straight so your hands are in a straight line with your forearms, viewed from above and from the side.
  • Sit up straight, with your feet flat on the floor in front of you.

• Learn to type. The “hunt and peck” method encourages slouching.

• Take frequent breaks. Get up and move around for a few minutes each hour. Stretch occasionally throughout the day.
Monitors

- A monitor displays images on a screen that is divided into tiny dots, called **pixels**. Each pixel has a unique address, which the computer uses to locate the pixel and control its appearance.
  - Monochrome and color: Whatever their type of display, monitors can be categorized by the way they display colors:
    - **Monochrome monitors** display only one color, such as green, amber, or white, against a contrasting background (usually black). These monitors are used for text-only displays. PCs today rarely use these monitors.
    - **Grayscale monitors** display varying intensities of gray against a white or off-white background. When these displays are used—for example, in low-end portable computers such as handhelds—they are chosen as a way to lower costs.
    - **Color monitors** can display between 16 and 16 million colors. If needed, many can be set to
display in monochrome or grayscale mode. Most PCs today have color monitors.

• **Cathode ray tube (CRT)** monitors are powered by a large vacuum tube
  - The CRT monitor shoots beams of electrons onto a glass screen coated with phosphors, chemicals that glow when struck by the electrons. Switching the beams on and off as they scan across the surface of the monitor illuminates patterns of phosphor dots.
  - They are heavy and bulky because of their thick glass display, magnets for controlling the electron beam, and required distance to produce and aim the beam.
  - CRT monitors are relatively low cost and display bright, sharp images.
  - Because of their size, weight, and relatively great power consumption, they have fallen out of favor.

• **Flat-panel displays** are much lighter-weight, thinner alternatives to a CRT. They are common with desktops and an essential part of notebook computers.
  - Most flat-panel monitors have a **liquid crystal display (LCD)**. An LCD monitor contains a light source and a screen of special crystals in the monitor between the user and the light source. By default, the crystals do not allow light to shine through them. But when electricity is applied to them, the crystals shift, allowing light to pass through. Switching on specific pixels of crystals creates patterns on the monitor.
    - A **passive matrix LCD** relies on transistors for each row and each column of
The color displayed by a pixel depends on the electricity coming from the transistors at the end of the row and top of the column.

- An active matrix LCD assigns at last one transistor to each pixel, and each pixel is turned on or off individually. Active matrix displays use thin-film transistor (TFT) technology, which employs as many as four transistors per pixel.

- A disadvantage of LCD monitors is that their images can be difficult to see in bright light. They also have a limited viewing angle, but technological improvements have been extending the viewing angles of LCD monitors.

- Because LCD monitors employ a constant source of light behind the crystals (usually a fluorescent light bulb), brightness may vary across the monitor’s surface—brightest near the bulb and darker away from it.

- LED monitors are an alternative aimed at correcting variable brightness. They use the liquid crystal design found in LCD monitors, but the light source is a grid of tiny electronic lights called light-emitting diodes (LEDs). Spreading the LED grid across the entire back surface of the monitor makes brightness more consistent.

- Specialized monitors
  - Paper-white displays produce a very high contrast between the
monitor’s white background and displayed text and graphics. These displays are used by document designers such as desktop publishing specialists and magazine compositors.

- **Electroluminescent displays (ELDs)** are similar to LCD monitors but use a phosphorescent film held between two sheets of glass. A grid of wires sends current through the film to create an image.

- **Plasma displays** are created by sandwiching a gas such as neon or xenon between two sheets of glass. When the gas is electrified via a grid of small electrodes, it glows. Controlling the amount of voltage applied at various points causes each point to act as a pixel.

• Comparing monitors: The best choice of monitor for a user is the one that looks best to that person’s eyes. Some factors are worth considering:

  • **Size**: For ease of viewing, buy the largest monitor that fits your budget and workspace.

  • **Text display**: In a sample document, letters should be crisp and clear, without distortion.

  • **Image display**: In a photograph or Web site, the colors should meet your expectations.

  • **Resolution** refers to the number of pixels displayed on the screen. A particular computer will support a range of resolutions; the monitor purchased for the computer should be compatible with the resolution you want to use.

  • **Response rate** is the amount of time in milliseconds that it takes for a pixel to change from black to white. A fast rate is more important for playing graphically intense games or watching movies than for surfing the Web or chatting with friends.

  • **Contrast ratio** measures how close the monitor can get to perfect black and white. The bigger the ratio, the better.
Comparing Monitors, cont’d.

- **Viewing angle** measures how far to the side a user can be before the picture fades or blurs. LCD monitors produce the best picture when viewed from straight ahead.
- **Refresh rate** identifies the number of times per second that the monitor draws its visible image. Most monitors can support at least 60 Hz (refreshing the display 60 times each second), which is a common rate produced by video cards.
- **Dot pitch** is the distance between the like-colored phosphor dots of adjacent pixels, measured as a fraction of a millimeter. The smaller the dot pitch, the finer and more detailed the images.

Video Card

- A **video card**, also called a video controller or video adapter, is an intermediary device between the CPU and monitor that contains the video-dedicated memory and other circuitry necessary to send information to the monitor for display.
- The quality of images displayed by a monitor depends as much on the video card as on the monitor itself.
- In many newer computers, the video circuitry is built directly into the motherboard, eliminating the need for a separate card.
- Users who want high-end video capability may add a higher-powered graphics card, which plugs into the motherboard.
- Given the high-resolution, high-quality color images, animations, and video demanded by today’s users, a video controller provides its own dedicated microprocessors and memory to free the CPU and system RAM from having to manage the millions of calculation and storage required to produce video output.
- Video cards now commonly support at least two displays, allowing the computer to combine the display area and treat two physical monitors as if they were a single device.
- Digital output is standard.
  - Many video cards also include a digital-to-analog converter to drive older, analog displays.
  - Many cards support the high-definition HDMI output standard.
• For very intense graphics (e.g., video games with a complex, fast-moving picture), some video cards can be linked together so multiple cards share the processing load.

• **Eyestrain** is fatigue of the eyes, caused by focusing on the same point for too long.
  - It is one of the most frequently reported health problems associated with computer use.
  - Eyestrain does not pose long-term risks to eyesight but can lead to headaches and reduce productivity.

• **Measures to reduce eyestrain**
  - If you use a CRT monitor, choose a monitor that holds a steady image without flickering.
  - Position your monitor so it is 2 to 2-1/2 feet away from your eyes, with the screen’s center a little below your eye level. Then tilt the screen’s face upward about 10 degrees. (You may need to adjust these guidelines if you wear glasses or contact lenses; check with your eye doctor.)
  - Place your monitor where no light reflects off the screen, or else use an anti-glare screen to reduce the reflections.
  - Keep your screen clean.
  - Avoid looking at the monitor for more than 30 minutes without a break. When you take a break, focus on objects at several different distances, and close your eyes for a few minutes.
  - Do not let your eyes become dry. An eye doctor can suggest remedies for dry eyes.
Sound Systems

• Sound system devices include:
  – Microphones
  – Speakers
  – Headphones and headsets
  – Sound cards / circuit boards
    that convert sound from analog
to digital form, and vice versa
  – Sound editing programs

• Sound cards are circuit boards that convert
  sound from analog to digital form, and vice versa, for recording or playback. They may
  also accept digital input.
  – Analog signals from microphones,
    MP3 players, etc. are converted into
digital data for the computer to
  process.
  – Digital data representing music
    stored in the computer can be sent
to the sound card and converted to
electrical current that speakers can
  play.
  – Many new computers provide a
    sound subsystem directly on the
    motherboard and do not require a
    separate sound card.
  – In newer computers, the primary
    use for a separate sound card is for
    specialized or premium output.
  – Some sound cards can also process
digital signals to and from other
digital devices such as DVD
    players and game consoles. This
    preserves sound quality because
digital transmission is commonly
done via fiber optic wire, and the
digital sound data does not degrade
as it travels. Unless the wire or
transmitter is broken, the sound
data at the receiving end is just as
complete as what was sent.

• Sound editing programs provide a miniature
  sound studio, allowing the user to create,
mix, and edit sound files from single sound
  waves to complex multichannel
  orchestrations.

Printers

• Basic categories:
  – Impact printers create an image by striking an inked
    ribbon against paper
  – Nonimpact printers use other means to create an image

• Impact printers create an image by striking an inked ribbon against
  paper with some physical instrument such as metal pins or
  hammers.

• Nonimpact printers use other means to create an image, applying
  ink to the page without physically striking a ribbon on the page.
• Types of printers: Hundreds of options are available within a few basic groups.
  - **Dot matrix printers** are impact printers commonly used in workplaces where physical impact with the paper is important (for example, with carbon-copy or pressure-sensitive forms).
    - The printer creates an image by using mechanism called a **print head**, which contains a cluster (matrix) of short pins arranged in rows and columns.
    - The print head pushes out the pins in various combinations to create shapes, letters, and numbers.
  - **Inkjet printers** are nonimpact printers that create an image directly on the paper by spraying ink through tiny nozzles. The nozzles are mounted on a carriage that slides back and forth across the page as the page is fed through the printer.
    - Color inkjet printers have four ink nozzles, each spraying a different color: cyan, magenta, yellow, and black. These are combined to create any color.
    - Inkjet printers typically use one cartridge for each color, which saves money by reserving colored ink for color printing and allowing the user to change only the colors of ink that have been used up.
  - **Laser printers** are nonimpact printers that rely on a laser to accomplish the printing. The printer has a CPU and memory to interpret the data it receives from the computer and to control the laser.
    - The laser in a laser printer can aim at any point on the drum, creating an electrical charge. **Toner** (a powder composed of tiny particles of ink) sticks to the drum in the places the laser has charged and then is transferred to the paper by the drum. A hot roller
bonds the toner to the paper.

- A color laser printer works in the same way except that the process is repeated four times, with a different color of toner used for each pass. (The colors are the same as for inkjet printers.)

- All-in-one or **multifunction peripherals** combine a laser or inkjet printer with scanning, photocopying, and faxing capabilities.

- **Special-purpose printers**
  - **Dye-sublimation (dye-sub) printers** produce realistic quality and color for photo images. A ribbon containing panels of color is moved across a focused heat source capable of subtle temperature variations. The heated dyes evaporate from the ribbon and diffuse on specially coated paper or other material. Variations in color are related to the intensity of the heat. These printers produce superior quality but are slow and costly.
  - **Photo printers** use inkjet or dye-sub technology to create high-quality images. They are slow but convenient to use with digital cameras. Some accept input directly from a camera through a cable or wireless connection or a slot for the camera’s memory card.
  - **Thermal-wax printers** operate with a ribbon coated with panels of colored wax that melts and adheres to plain paper as colored dots when passed over a focused heat source. They create low-cost output with bold colors, so they are used primarily for presentation graphics and handouts.
  - **Plotters** are used to print large-format images, such as construction drawings created by an architect.
    - Table plotters use robotic arms, each of which holds a set of colored pens or pencils for drawing on a stationary sheet of paper.
• Roller plotters use only one drawing arm but move the paper. The drawing arm moves side to side as the paper is rolled back and forth.

• **Line printers** are a type of impact printer that works like a dot matrix printer but uses a wide print head that can print an entire line of text with a single strike. They do not offer high resolution but are extremely fast (and noisy).

• **Band printers** are impact printers with a rotating band embossed with alphanumeric characters. To print a character, the machine rotates the band to the desired character. A hammer taps the band, pressing the character against a ribbon. These printers are very fast and robust.

• Comparing printers: The selection of a printer should be based on the kinds of output needed, as well as the following considerations:
  
  • **Image quality (print resolution):** The more **dots per inch (dpi)** a printer can produce, the higher its image quality. For example, 600 dpi means the printer can print 600 columns of dots and 600 rows of dots in each square inch of the page.
  
  • **Speed:** Printer speed is measured in **pages per minute (ppm)**.
    
    • In general, printers have separate ppm ratings for text and graphics, because printing graphics takes longer.
    
    • As print speed rises, so does cost.
    
    • Manufacturers often quote both the speed for draft printing (a lower quality, lower-resolution way of printing text) and full-quality output—e.g., 40 pages per minute in draft mode but only 6 per minute at full quality.
  
  • **Cost**
    
    • Initial cost: It is possible to buy a decent, basic inkjet or laser printer for as little as $100, but the initial cost
is only a part of the total cost of owning and using a printer.

- **Maintenance cost:** Prices of ink or toner vary widely, so compare these prices, and investigate how often you will have to replace parts and ink/toner. Also, in general, supplies for a color printer will cost more than supplies for a black-and-white printer.

- **Paper:** Some printers require special paper. Before buying, learn the paper requirements, and if special paper is required, check its price.

- **For a projector to work with a computer, it must be able to convert digital data to an analog image our eyes can see.**

- **An early method was to place an LCD monitor minus its light on an overhead projector, which served as the light source and displayed the image as if an ordinary slide transparency had been used. This technology still exists as a do-it-yourself option.**

- **Digital light processing (DLP) projectors use a special chip on which are mounted a grid of thousands or millions of microscopic mirrors. The mirrors can be individually shifted back and forth to reflect the source light through a lens for projection or away from the projection lens.**

  - The mirrors correspond to the pixels of a monitor. As an LCD monitor can activate crystal dots on the screen to display a pattern, a DLP projector can flip specific mirrors toward the lens and project a pattern.

  - The mirrors can be switched on and off several thousand times each second, so the brightness of each pixel can be adjusted by changing the amount of time the mirror is switched on. The human eye cannot detect such rapid changes.

  - **Ways to add color**

    - By passing light through a filter to create red, green and blue light, and then timing each color with the mirror switching, the
A projector can blend bursts of colored light together at each pixel to create different color shades.

- Some projectors simply use three DLP chips dedicated to red, green and blue light, and combine the output to create the image.
- Digital projectors can be placed on a table or mounted on a wall.
- Methods of accepting output
  - Hooked up to the computer as a monitor
  - Via a local network of computers
  - From a USB flash drive
- Some have a limited user interface for configuring options and issuing display commands.
- Some have a digital wand for highlighting and annotating displayed images.

**SMART Boards** (brand name of SMART Technologies) are digital versions of the whiteboards used in classrooms and meeting rooms

- A board attached to the wall is a touch-sensitive input device.
- A short-throw projector (a projector designed to be used very close to the display area) is installed at the top of the board.
- Special pens and an eraser are used for input. The user can also draw on the board with a finger.
- The SMART Board connects to a computer that collects input from the board and provides output to be displayed.
- The writing and drawing is digitally stored, so the SMART Board and its software can do more than an ordinary whiteboard can.
  - After presenting concepts on the board, users can send these images to others directly from the computer via email or a local network.
  - The computer can provide background images and shapes, which the user can drag and place by fingertip on the whiteboard.
  - The computer can provide command icons at the edge
Haptic Feedback

- Haptic feedback - the communication of vibration, motion, or physical resistance
  - This feedback can make output more relevant or noticeable.
  - Handheld devices (e.g., cell phones) contain a vibrator that buzzes with alerts for incoming messages or to enhance the experience of playing a game.
  - Game controllers often include mechanical motion generators.
    - The haptic feedback increases the user's sense of immersion in the game.
  - Force feedback is the application of motion to a controller in conjunction with a visual event.
    - In modern aircraft and flight simulators, haptics are sometimes used in digital control systems like joysticks to provide feedback that pilots felt in the analog controls of older airplanes.

Hardware systems that remotely control robots and robotic arms, may contain haptic technology so operators feel resistance as they move controls to twist, squeeze and lift.
Computer-aided manufacturing: Computer output is used to drive industrial machinery and robot production in many different manufacturing industries.

- Computer instructions coordinate and control several different motors in a robotic arm to position it in exactly the right place at exactly the right time to perform its operation. So long as no malfunctions occur, the robot arm will perform its task exactly the same way every time, ensuring consistent quality.
- Applications include welding automobiles, drilling holes precisely and efficiently in ready-to-assemble furniture, and fabricating tiny computer chips.
Chapter 3A
Operating System Basics

Learning Objectives

3.1 Summarize the ways in which an operating system works with the computer and user.
3.2 Describe the way data are moved around the computer and the basic concept of the machine cycle.
3.3 List and describe the major PC operating systems.
3.4 Explain how the Windows file system organizes its files.

Types of Operating Systems

- **Real-time operating system**: A very fast, relatively small OS designed to respond to hardware and program requests almost instantly.
- **Not designed to handle a wide variety of tasks, but simply to guarantee the OS will respond right away to a request from the user or hardware.**
- **These are often embedded OSs, i.e., built into the circuitry of a device.**
- **Real-time applications** are needed to run medical diagnostics equipment, life-support systems, machinery, scientific instruments, and industrial systems.

- **Single-user/single-tasking operating systems**: Allow a single user to perform just one task (process) at a time.
- **Examples**: MS-DOS (a precursor of Windows), Palm OS (used on Palm handheld computers).
- **Few desktops and notebooks run this type of system anymore. Users can be more productive with systems that can run several tasks at a time.**

- **Single-user/multitasking operating systems**: Allow a single user to perform two or more functions at once.
- **Include the most commonly used personal computer OSs, such as Microsoft Windows and the Macintosh Operating System.**
• Allow multitasking, which greatly increases users’ productivity. Users can have more than one program open and share data between programs.

• **Multi-user/multitasking operating systems**: Allow multiple users to use programs that are simultaneously running on a single network server (a **terminal server**).
  
  • Each user has a complete environment, called a **user session**, on the server. Each user session runs separately from the others on the server.
  
  • All or most of the computing in this type of environment occurs at the server.
  
  • Examples: UNIX, VMS, and mainframe operating systems such as MVS.

### Supporting Programs

- The operating system manages all the other programs that run on the computer, and it provides services to these programs when they use **system calls** to request the services (e.g., to list the files in a folder or print a document).
**Windows: Sharing Data**

- **Clipboard** - a temporary holding place in the computer’s memory
  - **Cut command** - moves the data out of the application and onto the Clipboard
  - **Copy command** - leaves the data in place and a copy of it is saved on the Clipboard
  - **Paste command** - moves the data from the Clipboard into the document

- The Clipboard can be used for moving data between different programs, a feature enhanced by **OLE** (Object Linking and Embedding).

**Managing Computer Hardware**

- The operating system is the intermediary between the programs and the hardware devices.
- Processing interrupts so programs and hardware subsystems work in harmony
  - An **interrupt** is a request for attention by some part of a computer system.

**When programs run, they need to use the computer’s memory, monitor, disk drives, printer, and other devices.**

- The operating system is the intermediary between the programs and these hardware devices.
- In a network, the OS also mediates between each computer and the other devices on the network.

- Processing interrupts so programs and hardware subsystems work in a harmonious way with each other
  - An **interrupt** is a request for attention by some part of a computer system.

- While a computer is processing tasks, it watches for interrupts that are a higher priority than what it is doing. When an interrupt request has a higher priority, the system saves what it is working on, handles the new request, and then continues with its previous task.

- The OS processes interrupt requests (IRQs):
  - Responding to interrupt requests to use memory and other devices
  - Keeping track of which programs have access to which devices
  - Coordinating everything the hardware does, so activities do not overlap and cause a breakdown

- The OS may also generate its own interrupts to ensure the computer can process important system functions at appropriate times.

**Many applications let you move chunks of data (e.g., put data from a spreadsheet into a word-processing document or insert a photo into a presentation). In some OSs, you do this with a feature called the Clipboard, a temporary holding place in the computer’s memory.**

- Select the material to be moved (say, by highlighting it by clicking and holding your mouse’s primary button).
- Choose the **Cut command**, which moves the data out of the application document and onto the Clipboard. Or choose the **Copy command**, which leaves the data in place when a copy of it is saved on the Clipboard.
- Select the point in the document where you want the material to be inserted.
- Choose the **Paste command**, which moves the data from the Clipboard into the document.
- Because the Clipboard is part of the operating system, rather than an application program, it can be used for moving data between different programs, a feature enhanced by **OLE** (Object Linking and Embedding).

- **Object embedding**: A simple cut and paste from one application to another. Embedded data retains original format and cannot necessarily be modified by the application in which it is embedded.
- **Object linking**: Embedded data retains a link to the original document. E.g., spreadsheet data copied and pasted in a memo but later updated would be updated in the memo, too. (This linking is not automatic—must be created with commands in the applications.)
**Working with Device Drivers**

- Device drivers are programs that allow the OS and other programs to use a hardware device.
- The operating system provides some of the device drivers.
- Others may come with purchase of the device.

**Binary and Text Code**

- Binary: the computer’s number system
- Text code - list of which combinations of bits represent which characters
  - ASCII: Eight-bit code that specifies characters for values from 0 to 127.
  - Extended ASCII: specifies characters for codes from 128 to 255.
  - Unicode Worldwide Character Standard: Represents each letter, number, or symbol with up to four bytes.

- Computer output is so sophisticated that computers seem to understand users, but actually they just turn switches off and on in very complex patterns at very high speeds, following directions precisely. The CPU consists of millions of tiny transistors (electronic switches), each of which is either off or on.

- Binary: the computer’s number system
  - Most humans use a decimal number system, written with numerals 0 through 9
    - Called “base 10” because it uses 10 numerals.
    - When the value exceeds 9, we add another digit (10), then a third digit after 99 (to make 100), and so on.
  - The number system for computers is called binary or base 2, because it uses two numerals, 0 and 1.
    - In binary, $1 + 1 = 10$, and $11 + 1 = 100$.
    - Binary is used for computers because its two numerals correspond to the two possible states for electricity, off and on.
    - Example: 35 in the decimal system is 100011 in binary. The binary expression 100011 can be represented with six electronic switches in a pattern on-off-off-off-off-on.
    - In a computer, each binary digit is called a bit.
    - A group of eight bits is called a byte, which represents a single character such as a letter of the alphabet.
Early programmers realized they needed to agree on a single **text code**, or list of which combinations of bits represent which characters. Today three text codes are broadly accepted for personal computers.

- **ASCII** (American Standard Code for Information Interchange): Eight-bit code that specifies characters for values from 0 to 127. The most commonly used text code.
- **Extended ASCII** specifies characters for codes from 128 to 255, including pronunciation, special punctuation, and graphic symbols.
- **Unicode Worldwide Character Standard**: Represents each letter, number, or symbol with up to four bytes (32 bits).
  - The four-byte system allows for up to 4 billion characters, including Chinese, Korean, and Japanese character sets, as well as mathematical and scientific symbols.
  - The first 256 codes correspond to ASCII and Extended ASCII codes.
  - Many software developers are modifying older ASCII code to support Unicode and the global community.

**Moving Data**

- **Bus**: The electronic path that is used to transfer data between hardware components.
  - **Parallel bus**: A bus sending information in parallel across multiple wires.
  - **Serial bus**: A bus sending information one bit at a time in series.
- **Internal bus**: Connects the CPU to memory modules and subsystems on the motherboard.
- **External bus**: Connects external devices to the CPU. Plugging the devices into a port connects them to the external bus.

Hardware and procedures for moving data: Processing the encoded binary data requires specific hardware and procedures at each step of the information-processing cycle.

- **Bus**: The electronic path that is used to transfer data between hardware components.
  - **Parallel bus**: A bus sending information in parallel across multiple wires.
  - **Serial bus**: A bus sending information one bit at a time in series.
- Computers have two main buses, internal and external.
  - **Internal bus** (or system bus): Connects the CPU to memory modules and subsystems on the motherboard.
  - **External bus** (or expansion bus): Connects external devices to the CPU. Plugging the devices into a port connects them to the external bus.
• External bus standards ensure that hardware manufacturers and software developers can transfer data to and from the CPU. Standards change, but the following are in widespread use today.

• **IEEE 1394** (commonly known as **FireWire**): A serial bus typically used to transfer video and audio data.
  - One of the oldest bus standards still in use (developed in the late 1980s).
  - Originally supported a transfer rate of up to 400 megabits per second.
  - The latest standard, FireWire 800 (IEEE 1394b), supports 800 megabits per second.

• **Peripheral Component Interconnect (PCI) bus**: Bus designed by Intel to integrate various hardware devices into a computer.
  - Still used for sound cards and network interface cards.
  - Demands of video output have outstripped its capabilities.
  - Parallel PCI bus has a 32-bit interface and a peak transfer rate of just over 1 gigabit per second.

• **PCI Express (PCIe)**: Bus created as a replacement technology for the PCI bus.
  - More efficient data transfer design.
  - Allows for the addition of lanes (data pathways) to support increasing demands.
  - Used for newer video cards.

• **Serial ATA (SATA)**: Current standard for connecting hard drives to the computer.
  - Uses a small, 7-pin connector.
  - Supports features such as hot swapping (ability to plug and unplug a hard drive without switching it off)
  - Transfer rates up to 6 gigabits per second.

• **Universal serial bus (USB)**: Common popular bus that is found on all modern personal computers and supports a host of hardware devices.
  - 4-pin connector houses a single pair of data transmission wires.
  - Supports transmission rates up to 480 megabits per second.
  - Supports up to 127 devices connected to one computer.
  - Allows convenient hot swapping of devices.
  - USB 3.0—new transmission standard appearing in newer computers—uses eight data wires to achieve a transfer rate of 5 gigabits per second.
Cache Memory and CPU

- Cache: a smaller, faster memory subsystem than the computer’s main RAM
- The CPU has two basic parts for processing data:
  - Control unit: directs the flow of data through the CPU (contains the CPU’s instruction set and is expressed in microcode)
  - Arithmetic logic unit (ALU): Carries out the processing that involves comparing numbers (logical operations) or carrying out arithmetic operations

- Cache memory
  - To process data quickly, CPU must be able to efficiently store and retrieve data. RAM is faster to use than a hard drive, but not fast enough.
  - A cache is a smaller, faster memory subsystem than the computer’s main RAM.
    - Generally physically closer to the CPU to speed data transfer.
    - Modern CPUs have more than one cache, with the most immediate ones located in the microprocessor unit that plugs into the motherboard.
    - Computer loads data into the cache in chunks from a slower source (e.g., RAM, hard drive, or a cache farther away). Loading data in chunks increases the likelihood that the loaded data will be needed again, reducing the number of retrievals.
    - When the CPU needs data, it requests it from the nearest, fastest cache. If that cache doesn’t have it, it requests the data from a supporting cache.

- Processing data with the CPU
  - Every software program is in effect a set of instructions for the CPU and other hardware subsystems.
  - The CPU follows consistent, specific steps to carry out the instructions.
  - For doing this, the CPU has two basic parts.
    - Control unit: The part that manages all the computer’s resources, directing the flow of data through the CPU.
      - Contains the CPU’s instruction set (instructions for carrying out commands).
      - Each instruction is expressed in microcode.
    - Arithmetic logic unit (ALU): Carries out the processing that involves comparing numbers (logical operations) or carrying out arithmetic operations (adding, subtracting, multiplying, dividing).

- Machine cycle: Complete set of steps in executing an instruction.
  - Instruction cycle
    - Fetching: Retrieve a command or data from memory.
    - Decoding: Break down the command into instructions that correspond to those in the CPU’s instruction set.
  - Execution cycle
    - Executing: Carry out the instructions in order.
    - Storing: Store results of the instruction in memory (not always necessary).
  - Computers can carry out millions of instructions per second.
  - To carry out instructions even faster, computers use pipelining (beginning a new machine cycle before one is completed).
• Concepts affecting all operating systems:
  • Bit size: Number of bits the OS uses to represent values.
    • When the computer needs to store and retrieve data from RAM, it must be able to say exactly where the data should be stored, and be able to retrieve exactly the data it requires. Therefore, every byte of a computer's RAM has its own unique numeric identifier, called an address.
  • The larger the bit size, the more addresses the computer can create from the numbers available. E.g., a 32-bit operating system can store numbers up to 4,294,967,295, so it can manage data storage and retrieval for up to 4 gigabytes of RAM, an amount common in today's PCs. Even if the computer has more RAM, it cannot create more addresses for more data.
  • A 64-bit operating system removes this restriction. It can make addresses well over 18 quintillion in value, which in theory could support computers with many exabytes (billions of gigabytes) of RAM.
  • CPU subsystems may use different bit sizes.
  • A 64-bit CPU can run a 32-bit operating system by changing to a 32-bit mode, but a 32-bit operating system cannot make use of 64-bit CPU functions.

• Backward compatibility
  • The OS works so closely with hardware and software that many software applications are written to work with specific parameters and behaviors in the OS. Fundamental changes in the way the OS handles hardware and software requests may cause some or all of the applications to stop working properly.
  • Rather than trying to make all application developers change their software, OS developers make new operating systems backward compatible (designed to work with most or all of the programs that were created for the old version).

• Ways to achieve backward compatibility
  • Translation functions that allow the new OS to convert input and output to an old format when communicating with older software.
  • An emulator, or software program designed to re-create the exact environment of the older program.
Common Operating Systems

- Windows
  - Largest market share.
  - The latest version, Windows 7, provides improved support for multicore processors, a user interface designed to be simpler and more intuitive, and improved security tools.
- Mac OS X
  - Used for computers sold by Apple (“Mac” refers to the Macintosh personal computer).
  - Graphical OS based on Unix
  - Latest version (Snow Leopard) includes improved desktop support, better voice and video handling, and smaller required disk space for handling file storage.
  - Graphics style and program options differ from Windows.
  - Used on about 5 percent of computers (because limited to Apple).
- Linux for Desktop PCs
  - “Freeware” based on Unix with strong power and capabilities
  - Multi-user, multitasking OS
  - Can run on nearly any computer and support any application
  - Command-line interface but “shells” available for a graphical user interface (GUI)
  - Commercial versions available at low cost with utilities, GUI shells, and documentation
  - Attracts users who enjoy being part of a global community of developers
  - Usually a server platform, but desktop applications have been developed
- Other operating systems: Older OSs continue to exist in specialized and older environments, and new OSs are being developed to make the most of handheld devices.
  - DOS
    - Acronym for disk operating system
    - Came into widespread use in the 1980s on the IBM PC and similar computers
    - Command-line interface with limited support for hardware and networking
    - Can support only small amounts of memory
    - Sometimes still embedded in devices that perform simple, single tasks or running specialized applications written for DOS where no modern alternatives are available
  - Unix
    - Command-line interface
    - Predates DOS (created in 1969)
    - Multi-user, multitasking OS
    - Used in mainframes and supercomputers
    - In limited use in academic and scientific environments
  - iOS
    - Apple’s OS for its mobile devices (e.g., iPhone, iPad)
    - Released in 2007 with the iPhone
    - Not licensed for other manufacturers’ devices
    - Multitasking OS
    - User interface based on fingertip taps, swipes, and pinches; also responds to shaking and rotating the device
• **Android**
  - Mobile OS based on Linux
  - Made available to the public in 2008
  - Supports a multi-touch interface and a host of mobile and smart phone features from calling and messaging to allowing the device to act as a wireless Internet connector for a PC
  - Most widely used smart phone operating system among its competitors

• **Chrome OS**
  - Linux-based OS that boots the computer straight to a Web browser interface
  - Relies on the browser interface and computing done largely by servers on the Internet to provide user services
  - Useful for netbooks, which lack the computing power to run a full OS and complex software
  - Sold on machines manufactured by Google partners
  - A version called Chromium OS is available to the public

• **Organizing disk storage: tracks and sectors**
  - The OS is responsible for determining the exact layout of data on a storage disk. The drive has a surface that can store data; the OS decides how to use it.
  - **Formatting** or **initializing**: Magnetically mapping the disks’ surface so the computer can go directly to a specific point on it.
  - Used drives can be reformatted.
  - Reformatting erases any data on the disk.
  - **Stages of formatting**
    - Forming **tracks**—concentric rings on each side of the disk
    - Dividing tracks into **sectors**—locations where binary data is physically stored
      - Numbered in sequence so the computer can locate a sector using a unique number
      - Smallest units within which any magnetic disk can work
      - Hold the same number of bytes, regardless of physical size
    - Optical disks use a different physical method but the same basic concept of tracks and sectors.
Finding Data on a Disk

- **File system**: logical method for managing the storage.
- When a disk is formatted, four areas are created:
  - Boot sector: A program that runs when the computer starts up, in a process called **booting**.
  - File allocation table (FAT): Keeps track of file locations.
  - Root folder: A folder that holds information about all the other files on the disk.
  - Data area: The remaining area of the disk.

How the OS finds data on a disk

- Process varies somewhat from one OS to another, with each method resulting in a different **file system** (logical method for managing the storage).

**FAT file system**

- Used by older versions of Windows and in digital camera memory cards.
- When a disk is formatted, four areas are created.
  - **Boot sector**: A program that runs when the computer starts up, in a process called **booting**.
  - Determines whether the disk has the basic components needed to run the OS and, if so, begins loading the OS.
  - Contains information the OS needs to access data on the disk (e.g., number of bytes per sector, number of sectors per track).
  - **File allocation table (FAT)**: Keeps track of file locations. If a disk sector is damaged, it is marked as unusable on the FAT.
  - **Root folder**: A folder (directory) that holds information about all the other files on the disk.
  - **Data area**: The remaining area of the disk, where files and program folders are stored.

**New Technology File System (NTFS)**: A newer file system that offers better security and performance (including the use of file names greater than 8 characters).

- New Technology File System (NTFS): A newer file system that offers better security and performance (including the use of file names greater than 8 characters).
- When the OS receives a request to read from the hard drives, it follows this process:
  - Checks the FAT to identify the physical location of the data.
  - Directs the disk controller to retrieve the contents of the required sectors.
  - Sends the retrieved data to the subsystem (usually RAM) that made the request.
- When the OS writes data to a hard drive, it follows this process:
  - Checks the FAT to find an open area.
  - Stores the data in open sectors.
  - Logs the file’s identity and location in the FAT.
- Other OSs use similar processes, although file system designs are unique. Example:
  - **HFS+**: the file system for Mac OS X, supports the same file structure but has a different method of finding data in directories.
  - **HFS+** supports the Macintosh file design of separating program data and visual element data.
- **Web-Based Distributed Authoring and Versioning (WebDAV)** file system describes a structure for managing access and changes to files that are stored on the World Wide Web and are created and modified by multiple users in different locations.
  - OSs that support WebDAV include Windows, Mac OS X, and Linux.
• Gives users access to shared files on the Web as if they were using files and folders on their own system.

• Windows uses the same file system structure as the user sees in the user interface.
  • A disk drive’s root folder is represented as the drive itself (e.g., \ for the main hard drive).
    • All files and folders directly in the root directory are shown in the top level of the drive.
    • Folders within folders and files within files are shown graphically.
  • Other user conveniences are not reflected in the disk’s actual file structure.
    • **Shortcut**: An object that points to another file (e.g., a shortcut can locate a start a program). Shortcuts are maintained by the OS and not stored as files on the hard disk.
    • The desktop, or display of files and icons, is maintained as part of the file system (because files can be stored on the desktop).

• Periodic maintenance: When data are stored efficiently instead of files being spread about in small fragments, the OS will work much faster. The OS makes a limited effort to clean up temporary data, but some maintenance tasks performed by the user can optimize disk performance.
  • Remove unnecessary files.
  • Compress the data.
  • Defragment the drive.

• **Utilities**: Software programs that offer new features for the OS or enhance or extend the operating system’s capabilities (e.g., with programs to compress data and defragment the hard drive). (PPT 1.30)
  • **Backup utilities** can help you copy large groups of files from your computer to another storage medium for safekeeping.
  • **Anti-malware** is software that examines files, memory and parts of the operating system to detect and remove malware (any software designed to harm a computer’s data or operating system or to compromise security).
    • Protection against malware, including viruses, is discussed in Chapter 6.
    • Anti-malware may also monitor computer activity in real time to detect risks in new files or Web sites.
  • **Firewall** utilities examine traffic coming from your computer to the Internet, and from the Internet to your computer, and block traffic that may introduce problems. These utilities are a simpler version of specialized computers that serve as firewalls for Internet service providers and large corporations.
  • **Screen savers** display a moving image or sequence of pictures on the computer screen whenever the computer has not been in use for a set period of time.
    • Remain active until the keyboard or pointer is used again.
    • No longer needed for their original purpose (to prevent a static image from “burning” into the
monitors), but are a popular way to customize a computer.
### Learning Objectives

3.5 Identify four ways to acquire software

3.6 Describe three kinds of formatting you can perform with word-processing software, and define types of data that can be used by spreadsheet software

3.7 Identify four ways to load graphic files into a computer, and compare the types of graphics software and their uses

### Acquiring Software

- Commercial software
- Freeware and public domain software
- Open-source software
- Web-based applications

- Occasionally individuals write their own software, but usually they acquire existing programs in one of several ways.
• **Commercial software**: Software the owner sells or requests payment for.
  - The vast majority of software used
  - **Stand-alone programs**: An application that performs only one kind of task (e.g., an e-mail program)
  - **Software suites**: A set of carefully integrated tools designed to work together seamlessly (e.g., Microsoft Office)
  - **Shareware programs**: Software that developers encourage users to share and try out before purchasing.
    - Unpaid versions may include advertising.
    - Not the same as free trials or demo copies, which have limited function or are provided for a limited time and then expire.

• Freeware and public domain software
  - **Freeware**: Any software made available to the public for free.
    - The author maintains an ownership interest.
    - Users must abide by the terms of a license agreement.
  - **Public domain software**: Software that is available at no charge to the public and includes the source code as well, so the user can use the program however he or she wishes.
  - **Open-source software**: Software whose source code is available to users (e.g., OpenOffice business software)
    - Developers can modify and customize the code within guidelines.
    - May be sold by the owner or offered at no charge.

• Software and document storage may be hosted on the Web.
  - A user can access the same document from any computer.
  - More than one person can access a document.
  - Multiple users and computers do not need multiple copies of the software.
  - Accessing the software usually requires registering and paying a fee.
  - This method of acquiring software is part of **cloud computing** (discussed in Chapter 6).
Installing Software

- **Script**: A program that runs during installation
  - Registers files in various folders on the hard drive
  - Adds entries to a file called the **registry**, which tells the OS the locations and purposes of files, programs, and utilities.

- Some programs may be designed to be portable
- **Installation program and data files**
  - Usually contained on an installation disk
  - Can be downloaded from the Internet
  - Can be installed and have a gradual installation of remaining components.

- Most programs are designed to work closely with the OS and hardware subsystems, so the OS must be able to use information from the software. Therefore, the program must be installed on a PC.

- **Script**: A program that runs during installation
  - Places files in various folders on the hard drive.
  - Adds entries to a file called the **registry**, which tells the OS the locations and purposes of files, programs, and utilities.

- Some programs, especially freeware or shareware, may be designed to be portable. This software may be installed on a USB flash drive instead of on a hard drive.

- When you want to remove programs from a PC, you need to run an uninstall script that was included when the program was installed.
  - Properly deletes all related files and folders.
  - Removes file and program information from the registry.

- **Installation program and data files**
  - For most commercial software, these are contained on an installation DVD.
  - Some companies allow these to be downloaded from the Internet.
  - For software requiring many gigabytes of data (e.g., World of Warcraft game), the seller can initially provide enough of the software to install and start using the program, then gradually download and install more components while the program is being used online.

Productivity Software

- **Word processing programs**
- **Spreadsheet programs**
- **Presentation programs**
- **Database management software**
- **Personal Information managers**
**Word processing programs** (or **word processors**): A set of tools for creating all kinds of text-based documents.

- **Capabilities**
  - Can insert images, sounds, videos, animations.
  - Can create long documents with a table of contents, chapter titles, index, etc.
  - Can link to other documents such as spreadsheets.
  - Can create documents with hyperlinks for use on the Web.

- **Main editing window**: shows document and several tools
  - **Document area** (or **document window**): A view of the document being created.
  - **Menu bar** (or **ribbon**): Display of titles of menus (lists of commands and options).
  - **Toolbars**: Display of buttons that represent frequently used commands.
  - **Rulers**: Display of positions of text, tabs, margins, indents, etc.
  - **Scroll bars**: Tools for scrolling through text when there is too much to display in the document area.
  - **Status bar**: Display of information related to position in the document, page count, and status of keyboard keys.

- **Enter text by typing on the keyboard**
  - A flashing cursor indicates where text will be entered.
  - To add text somewhere else in the document, move the cursor with the mouse or cursor control keys.

- **Editing**: Changing text in the document.
  - **Block**: A continuous group of characters (including words, lines, spaces, and paragraphs) marked for editing or formatting.
  - To **select** a block, use some combination of clicking and dragging across it or using keyboard combinations. The selected text is highlighted (which replaces the blinking cursor).
  - Blocked text can be deleted (with the Del or backspace key), replaced (by typing something new), moved (by dragging it with the mouse), or changed in appearance (by using formatting commands).
  - To **deselect** a highlighted block, simply click anywhere in the document but on the block. The highlighting will disappear, and the cursor will return.

- **Formatting**: Controlling the appearance of text, the layout of text on the page, and the use of pictures and other graphics.
  - **Character formatting**: Formatting that controls the attributes of individual text characters.
    - **Font**: Named set of characters with the same characteristics (e.g., Times New Roman, Arial).
    - **Font size**: Height is measured in **points** (1/72 inch).
    - **Type styles**: Effects applied to characters (e.g., italics, boldface, underlining).
  - **Paragraph formatting**: Settings applied to entire paragraphs.
• **Includes line spacing, paragraph spacing, indents, alignment, tabs, borders, shading.**

• **Paragraph:** In a word processor, any text that ends with a paragraph mark (created by pressing the Enter key).

• **Document formatting:** Settings applied to the entire document.
  
  • Includes page size, page orientation, headers and footers, and special formatting such as columns.
  
  • Documents can be divided into sections, each with its own format.
  
  • These methods of entering, editing, and formatting text are used in many other kinds of software as well.

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**Spreadsheet programs:** Software for entering, calculating, manipulating, and analyzing sets of numbers.

**Capabilities**

• Applications include tracking family finances, preparing corporate financial statements, and analyzing statistics.

• Can show information in traditional row-and-column format or in a slick report format with headings and charts.

• Can answer “what if?” questions by showing how results are altered when one number (such as the interest rate on a loan) is changed.

• **Main editing window shows document and several tools.**

  • **Document area is a worksheet,** and several worksheets can be collected into one workbook (or notebook).

    • Each worksheet can be named.
    
    • An empty worksheet looks like a grid of rows and columns.
    
    • The intersection of any row and column is called a cell. A cell holds data in the form of text, numbers, formulas, or images.

    • Like a word processor, a spreadsheet window typically includes a menu bar or ribbon, toolbars, scroll bars, and a status bar.

• **Formula bar:** Location to create and edit formulas and data used in the worksheet.
Spreadsheet Programs

- The active cell is indicated by a cell pointer.
- Cell address: the name of the column followed by the number of the row.
- Types of data that can be entered:
  - Labels: Names for data values, usually expressed with text.
  - Values: Any number or text considered to be data.
  - Dates: May be read as information or used in calculations.
  - Formulas: Special cell contents that perform calculations.
  - Graphics, audio files, video and animation files.

- Entering data
  - Using the mouse or arrow keys, select a cell to make it active.
  - The active cell is indicated by a cell pointer, a rectangle that makes the cells borders look bold.
  - The active cell can be named by its cell address, the name of the column followed by the number of the row.
  - Type data to be entered in the selected cell or in the formula bar.
  - Data already in the formula bar can be edited as well.

- Types of data that can be entered
  - Labels: Names for data values, usually expressed with text. Used for row and column headings and to describe data in a cell.
  - Values: Any number or text considered to be spreadsheet data, rather than a label.
    - Can be entered directly by the user or a result of a calculation.
    - Can include whole numbers, decimals, negative numbers, currency, scientific notation, and more.
    - Can be text that will be analyzed, e.g., to be searched for strings of characters.
  - Dates: May be added to be read as information or to be used in calculations (e.g., number of days a loan is past due).
  - Formulas: Special cell contents that perform calculations or logical tests, using the values of other cells as inputs for the formula. Values produced by a formula may be used in other formulas.
  - Graphics, audio files, video and animation files.

Presentation Programs

- Presentation programs: Software for creating and editing colorful, compelling presentations that can be displayed in various ways.

- Capabilities
  - The user creates slides, single-screen images that contain some combination of text, numbers, and graphics, often on a colorful background.
  - A presentation is a series of slides displayed in order to an audience.
  - Slides can be simple, or the presentation can be a multimedia event.
  - A group of slides may be saved in one file so you can open and work with related slides together.

- Main editing window shows a document and several tools.
  - Typically, one slide is shown in the document window.
  - Tools include a menu bar or ribbon, one or more toolbars, rulers, buttons for slide viewing and navigating, and a status bar.
  - As with word processing and spreadsheets, the user adds elements through a combination of typing and using commands from the menus.
and toolbars and by using the mouse to drag elements.

- Slides can be simple, or the presentation can be a multimedia event.
- Slides can be inserted anywhere in the presentation, copied from other presentations, and reordered.

- Creating a basic presentation
  - Slides can be created from scratch, but the simplest approach is to select a template (a predesigned document with coordinated fonts and colors, a layout, and a background) from a set of these included in the software.
  - When the blank slide appears in the document window, add text, charts, and/or graphics.
    - Add text in resizable text boxes.
    - Add graphics in resizable frames.
    - To create a chart, select the format, and enter data into the chart’s datasheet. The program uses the data to create the chart.
    - To enter a graphic other than a chart, draw it with built-in paint tools, or select an image file. Possible images include images provided with the presentation software and drawings or photos stored on the PC.
    - Tools may used to select elements to animate and choose the type of animation.

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- Hardware options
  - PC screen: Informal presentation to a small audience
  - Large-format monitor: Can display slides at the proper resolution and large enough for a sizable audience to view comfortably. However, the devices are expensive and difficult to transport.
  - Television screen: Older computers/televisions need a PC-to-TV converter. Newer televisions can work in high-definition video mode, connecting to the PC with a DVI or HDMI cable.
  - Data projector: Portable high-resolution data projectors can display slides to a large audience. They plug into a PC port and accept video output.

- Presentation method
  - Manual methods: Move from one slide to the next by clicking the mouse button or pressing Enter on the keyboard.
  - Automatic method: Preset a display time for each slide.
  - You can rearrange the order of slides shown during the presentation.
  - Drawing tools let you draw on a slide being displayed.
• A **database** is an organized method for storing information
  - A simple database does not require specialized software; spreadsheet software, for example, can do a satisfactory job.
  - When a database tracks more than a few rows and columns of data, it is harder to create tables and relationships, fill them with data, and answer complex questions by using a general tool such as a spreadsheet.

• **Database management system (DBMS):** Software used for creating and populating a database and using it to retrieve and analyze the data. An example is Microsoft Access.
  - **Building an Access database**
    - **Tables:** Two-dimensional row and column sheets created to hold data for a single concept (e.g., one customer or employee).
    - Table columns define types of data (e.g., name, address).
    - All of the values in each row are associated with each other and are called a **record**.
    - One column in every table is the table’s **key**, whose values uniquely identify each record in the table. When the contents of one table (e.g., customer) are related to a second table (e.g., purchases), the key column forms that relationship in the database.
  - **Formulating queries in Access**
    - A **query** is a user’s request for information, specifying the data to be retrieved.
    - Can be as simple as a request for a list of data.
    - Can be complex and involve multiple tables.

• **Personal information managers (PIMs); also known as contact managers or contact management software:** Software designed to keep track of many kinds of personal contact information for many different people. Example: Microsoft Outlook
  - Today it is difficult to keep track of people’s contact information.
    - Many people have multiple phone numbers and e-mail addresses, as well as other forms of contact such as Twitter IDs and Facebook pages.
    - A PIM makes the task easy by providing special placeholders for the information.
  - **Capabilities**
    - Storing contact information for each name added to your contact list or **address book**
    - Managing your schedule, creating reminders, setting up to-do lists
    - E-mail program for contacting people on your contact list
    - Associating specific names with specific customer contacts (e.g., a list of meeting attendance can be linked to names in the address book)
    - Maintaining a permanent record of business activities
  - **Customer relationship management (CRM) software:** Extends the features of a PIM with other features for managing ongoing client relationships:
• Tracking customer purchases
• Forwarding customer inquiries to agents who can follow up
• Logging complaints and requests for support
• Analyzing company performance in terms of customer satisfaction and customer behavior
• Social media: Tools such as TweetDeck allow you to collect and distribute social media updates from a central location. Tweet
• Organize and display the ongoing status updates from different social media networks on a single screen
• Make a single update and broadcast it to multiple social services at once

Graphics programs and their users have become so polished that it can be impossible to distinguish a photograph or hand-drawn illustration from a graphic that is generated or edited with a computer

Structure of graphics files: Computer graphics fall into one of two categories.

• **Bitmaps:** Grids that make up a computer image; each cell of the grid is filled with one or more colors.
  - Principle similar to the pixels of a computer monitor
  - Best type of graphics for retouching a photo, creating seamless tile textures, or creating a 3D image.

• **Vector files:** Graphics files created using a set of vectors, or mathematical equations describing lines and closed graphic shapes.
  - Best method for being able to resize an image without degrading its sharpness, to reposition elements in an image, or to achieve the look of an illustration
  - Can use mathematical equations to define line thickness and color, the pattern or fill of a shape, and other attributes

File formats and compatibility issues

• **File format:** Standardized method of encoding data for storage; tells the program the type of data and its organization.
  - Proprietary format: Under the sole control of the developer
  - Universal format: Based on openly published specifications

Most bitmap images can use any of the standard file formats; they are thus **compatible** with these programs.

Most vector-based graphics programs use a proprietary file format. They either are **incompatible** with other programs or not totally supported by them. A handful of common file formats (DXF, IGES) have been created in an effort to provide a universal file format.

Getting images into the computer: Artists and designers often begin with an existing image and edit or enhance it. These images must be loaded into the computer in some way.
• Scanners: Similar to a photocopy machine, but instead of printing out an image, the scanner creates an image file to store on the computer (usually a bitmap file).
• Digital cameras: Store a digital image (usually a bitmap) that can be transferred to the computer.
• Digital video cameras: Capture and store full-motion video on small tapes or optical disks.
• Clip art: Collections of graphics that may be copied and pasted into documents.
  • Available with word-processing programs, on DVDs, and over the Internet
  • The term clip art refers to the older practice of preparing books full of drawings that the buyer could literally clip out and paste into a paper document.

• Types of graphics software: Even the most sophisticated graphics software often cannot deliver all the capabilities required, so designers typically use more than one of the major types:
  • Paint programs: Bitmap-based graphics programs
    • Tools can include paintbrush, pen, chalk, watercolors, airbrush, crayon eraser.
    • Because the images are created with pixels, artists can perform functions such as changing the color of every pixel.
    • Sophisticated programs can produce many effects, such as making paintbrush strokes look drippy or neat, thick or transparent or giving an apparent texture to the background.
  • Photo-editing programs: Bitmap-based software that edits photos at the level of pixels.
    • Can control precisely how a photo will look.
    • Can be used to edit non-photographic images and create images.
    • Enable editing beyond the bounds of traditional photography (e.g., adding or deleting elements or combining two photos into one graphic).
  • Draw programs: Vector-based graphics programs
    • Well suited for work when accuracy and flexibility are as important as coloring and special effects.
    • By simply clicking and dragging, the artist can move, modify, or copy shapes.
    • Sometimes called object-oriented programs because each item drawn is treated as a separate and distinct object.
    • Each item consists of an outline and a fill. The fill can be nothing or a solid color, vector pattern, or photo.
Types of Graphics Software

- **Computer-aided design** (or computer-aided drafting or computer-aided drawing): Vector-based software that creates technical drawings.

- 3D modeling/animation programs:
  - **3D modeling software**: Software used to draw 3D images used in movies, television, and print.
    - Runs on fast PCs and computer workstations.
    - Images can be modified with electronic tools—for example, adding holes or textures.
  - **Computer-generated imaging (CGI)**: Software that applies the principles of traditional animation but offers tools to take the drudgery out of hand-drawing each frame of an animated scene.
    - Animation files can be displayed on the computer screen or output to CD-ROM, videotape, or film.
    - The software can animate three-dimensional characters and create photorealistic scenes.

Multimedia Software

- Today, information more often is presented in a multimedia format.
- A computer can accept and respond to input from its user, allowing these multimedia experiences to be interactive.
- Some multimedia software includes:
  - Audio editing and production
  - Video editing and production
  - Multimedia authoring

- **Multimedia software**: For much of history, information was presented in one medium at a time, say, written in a book or spoken by a lecturer. Today, information more often is presented in a multimedia format.
  - Computers make it possible to present more media.
    - Example: A computerized encyclopedia can offer sound and video clips, as well as the ability to navigate via hyperlinks.
  - Because a computer can accept and respond to input from its user, computers also allow these multimedia experiences to be interactive.
  - With the greater complexity of multimedia come more software tools for using and creating it. Multimedia software can be purchased as a suite of tools, but some applications are sold separately.
    - Audio editing and production: Tools for recording and digitizing sound, mixing tracks, editing individual sound tracks, applying effects and filters, creating master recordings, matching sound to digital video.
    - Video editing and production: Tools for editing footage, building scenes, adding soundtracks, and using templates for graphics and visual themes.
    - Multimedia authoring: Tools for creating and publishing interactive games, simulations, and online instruction.
      - Adobe Director allows users to integrate and customize audio and video, including the creating of 3-D graphics.
Learning Objectives

4.1 Briefly explain the process of choosing a computer configuration to purchase
4.2 Describe the three basic categories for data storage devices, and explain the relevance of each category for a new computer configuration
4.3 Identify three ways that you can acquire a new computer, and briefly discuss pros and cons of each method

Determining Computing Needs

• Yourself as a computer user:
  – Casual or heavy user
  – One task or a variety of tasks
  – Power user
  – Business user
• Technology already used in your environment (e.g., existing wireless network, DVDs for input and/or output, data sharing/transport with a USB flash drive)

• Determining Your Computing Needs
  With a vast array of hardware and software choices, users often achieve their ideal computing experience by customizing the computer environment.

• Understanding your current technology setup
• Yourself as a computer user
  • Casual or heavy user
  • One task or a variety of tasks
  • Power user (e.g., gamer, composer, movie editor)
  • Business user
• Technology already used in your environment (e.g., existing wireless network, DVDs for input and/or output, data sharing/transport with a USB flash drive)
Determining Computing Needs

- Existing devices/programs that must be compatible
  - Printers
  - Video camera
  - Hard drives
  - USB devices
  - Wired vs. wireless network
  - Software

Reviewing Requirements

- Optimal device type
  - Game consoles: most economical when only use is games
  - Mobile devices
    - Most useful for staying in touch anywhere, anytime
    - Limited options for hardware configuration
  - Tablet computers
    - Convenient for mobility plus some processing power for work
    - Limited options for hardware configuration
  - Conventional PCs—desktops and notebooks
    - Generally needed to meet a larger set of required applications plus processing power
    - Many configuration options, especially for desktops
    - More graphics power, storage, RAM

- Operating system
  - May be determined by software’s required OS.
  - Some operating systems (e.g., Apple’s) run only on certain hardware (Apple’s).
  - Most software choices with Windows-based PCs.
  - If software is not a limiting factor, try out OSs to find the preferred interface.
  - Windows 7 and some other OSs are available in 32-bit and 64-bit versions (see Chapter 3). A 32-bit version won’t save much money but will limit capacity and performance.

- CPU
  - High priority for heavy processing (e.g., intense games, detailed work with art or sound, or complex statistical or database calculations)
  - Medium priority for business applications
  - Low priority for casual use (checking e-mail, posting Facebook updates)

- RAM
  - Can make a vast difference in computer’s performance
  - Always a high priority

- Storage (typically a hard disk, though this may change)
  - High priority for libraries of TV shows, movies, music or photos, or for complex games
• Medium priority for most other users
• Low priority for casual users

Graphics
• High priority for gamers, photo/video editors, and users with more than one monitor
• Medium priority for watching videos
• Low priority for creating text documents and surfing the Web

CPU
• Fine-tuning your purchase: Be sure the computer has the performance and capacity you require while keeping expenses under control.

• For higher performance, multiple microprocessor cores are combined into one unit, so processing tasks are distributed among the cores.
  • If the CPU is a high priority: at least four cores (a **quad-core processor**), or six to eight cores for extreme processing needs
  • If the CPU is a medium priority: dual-core processors
  • If the CPU is a low priority: single-core processors, to save money

• Electric frequency, measured in gigahertz (GHz), represents relative speed.
  • High and medium priority: fastest processor you can afford
  • Low priority: speed is less important

• Major manufacturers: AMD and Intel.
  • Many online reviews of each model’s performance.
  • Differences are not large for most uses.
**RAM**

- Even casual users should look for at least 2 gigabytes of RAM. (Windows alone needs 1 gigabyte.) If RAM is a medium or high priority,
- 4 gigabytes will meet most users’ needs, because consumer software is generally not designed to use more.
- Users who need to actively run many programs at the same time or do video and movie editing may need 10 to 16 gigabytes—and a 64-bit operating system.
- Considerable variation in how fast RAM modules read, write and transfer information.
  - **Latency**: Delay between request and completed task.
  - If RAM or CPU is a high priority, invest in faster RAM.
  - RAM frequency needs to match value specified by motherboard manufacturer.

**Monitor**

- Video and photo editors should place a high priority on both image quality and size.
- Gamers should focus on response rate, to make sure the display keeps up with fast-changing video.
- To watch full-screen movies, consider a wide-screen monitor.
- If video is not a priority, the monitor is a good place to economize.
- Visit a store to identify acceptable display quality.

**Graphics**

- Most motherboards contain a basic video processor and an expansion slot that can accept a video card.
  - If graphic performance is a low priority, use the video output from the on-board processor.
  - Medium priority: Consider upgrading to a card that has more memory and a faster graphics processor.
  - High priority: Add at least one video card to handle the processing load.
  - Notebooks often share the computer system RAM with the video processor. For fast graphics, look for a model that does not borrow RAM for video memory.
• Networks and peripherals
  • Networking hardware
    • Standard hardware: Built-in Ethernet port and controller, allowing a wired connection to a location network and the Internet
    • Standard in mobile devices: wireless networking hardware
    • Desktops usually need to have wireless capability added (if desired) with an internal card or an external USB antenna.
  • USB ports
  • Other types of peripherals
  • If you frequently plug in and remove USB devices, look for conveniently located USB ports (on the front of a desktop case), or buy a USB hub device that can be plugged into the computer.
  • If you require other types of peripheral interfaces (e.g., eSATA for external hard drives, FireWire for video devices), be sure these are included and supported.

• Case
  • Always a low priority relative to price and performance
  • You have the most choices if you build your own computer or order parts to have one built.
  • If you have money to spare, you can buy a stylish case.
• Power supply
  • Generally a standard feature (no options), unless you build your own computer.
  • A critical part for reliable performance.
    • Converts AC power into precise amounts of direct current for the computer to use.
    • Monitors and regulates the power it provides, to avoid damage to electronics and performance problems.
    • A burning out power supply can deliver a burst of electricity that ruins the motherboard, CPU and other subsystems.
  • Check online reviews to make sure the power supply can adequately power the system and is highly rated for reliability.
Storage Devices and Options

- Hard disk drives
- Optical drives
- Removable media

Hard Disk Drives

- Used for permanent storage
- Generally the computer’s primary storage device
- If storage is a:
  - High priority: biggest drive affordable (e.g., 1 to 3 terabytes)
  - Less critical: 500 gigabytes to 1 terabyte
  - Casual users: can go under 500 gigabytes if this offers more than negligible savings
- Solid state drives: Use less power than a hard drive and operate silently

- Generally the computer’s primary storage device
- Most common consideration is the amount of data they can hold
  - If storage is a high priority: biggest drive affordable (e.g., 1 to 3 terabytes)
  - If storage is less critical: 500 gigabytes to 1 terabyte
  - Casual users: can go under 500 gigabytes if this offers more than negligible savings
- Rotation speed: faster rotation reduces time for sectors to arrive at the read/write head.
  - Consumer hard drives typically have a rotation rate of either 5400 or 7200 rpm, and the difference is hard to detect.
  - For applications that rely heavily on the hard drive (e.g., large database programs), the faster speed improves performance.
  - For less energy consumption, “green” hard drives (e.g., Western Digital’s Caviar GP) vary their spin rate, slowing down when not in demand. May slow down a high-performance application.
- For large storage capacity or an easy backup, the system can include two hard drives.
  - One drive can hold the OS and the program software.
  - The other drive can store data.
  - Each drive can hold backups of files on the other.
- Solid state drives (SSDs): Use less power than a hard drive and operate silently because they have no mechanical parts.
  - For some operations, store and retrieve data faster than a hard disk drive.
  - Cost much more than a hard disk drive.
Optical Drive
- For multimedia, software installation, and backup
- An optical drive that uses a laser to write to and read from a plastic disk—a type of removable media
- Types of disks:
  - CD
  - DVD
  - Blu-ray
- Choosing an optical drive
  - If you can afford it, include a Blu-ray writer
  - If not, choose a DVD read/write drive

Removable Media
- For portability and backup
- Includes:
  - External hard disk drives
  - USB flash drives
  - Readers for solid state memory cards
- Risks of portable media devices:
  - Extremely easy to drop or forget
  - Easy to steal

- Optical drives for multimedia, software installation, and backup
- Most computers include an optical drive that uses a laser to write to and read from a plastic disk—a type of removable media.
- If properly cared for, optical disks do not lose the data they store, so they are useful for permanent archives.
- The disks are simple playback devices for movies and music.
- For reading and writing data, they are far slower than hard disks and SSDs, so not suitable as the primary storage device.
- Types of disks
  - Originally, the drives supported compact disk (CD) formats. As technology matured, formats were created for reading and writing and allowing data to be erased.
  - DVD drives largely replaced CD-only drives. They allowed reading, writing, and rewriting data, but more data could be stored on a disk. Most also support the reading and writing of CD formats.
  - Blu-ray technology is challenging the dominance of DVDs. They provide a faster response and greater data density. They are backward compatible with DVD and CD formats.
- Choosing an optical drive
  - If you can afford it, include a Blu-ray writer capable of reading and writing the older formats.
  - If Blu-ray is too expensive, choose a DVD read/write drive that supports reading and writing DVDs and CDs.

- Removable media for portability and backup
- External hard disk drives: Hard disk drives contained in a case designed to sit on a desk rather than in a computer case.
  - Has a plug for standard AC power, rather than drawing from the computer’s power supply.
  - Has a port to access the computer via an eSATA, FireWire, or USB connection.
  - Can be removed and carried, so large amounts of data are portable.
  - A simple way to add permanent storage capacity without installing disks inside the computer.
- USB flash drives
  - Originally a convenient way to transfer a few files from place to place.
  - Increasing capacity (64 to 256 gigabytes) and transfer rates make them popular for transporting entire programs and large amounts of data.
- Readers for solid state memory cards (e.g., CompactFlash, SDHC cards)
  - Uncommon for data storage but needed by some users.
  - Some computers have built-in readers for these cards.
  - Unless you use the cards frequently, consider buying an external reader that connects to the computer via USB adapter.
- Risks of portable media devices
  - Extremely easy to drop or forget
  - Easy to steal
- Some portable media products include built-in data encryption to prevent the use of stolen data.
- Security is covered in Chapter 6.

- Building a computer yourself
  - Among the least expensive ways to acquire a computer
  - Greatest control over which components are used
  - Uncommon method
  - An interesting project
  - Main tool required is a screwdriver
  - Hardest part is learning what to do
    - Ensure that motherboard, CPU, and memory are compatible.
    - Ensure that power supply is sufficient.
    - Ensure you have all the needed components and accessories.
    - Trouble-shoot any problems.
    - Online resources are available for help (e.g., Tom’s Hardware for reviews and problem-solving tips, YouTube for installation videos).
  - Online and local stores sell components and kits, and a local store may be willing to order parts and build a computer to your specifications.

- Buying a ready-made computer
  - Brand-name computers (e.g., Hewlett-Packard, Sony)
  - **White box computers**: computers constructed by the store instead of a by a major manufacturer
  - Advantages
    - You immediately get a working, tested computer.
    - Often you get a list of exact components, so you can review their suitability.
  - The main risk is that it may not perfectly match your needs. Check to see if it can be upgraded in the future (e.g., adding RAM, hard drives).
Customizing a Purchase

- Buyer chooses from a basic range of capabilities—adding, eliminating, upgrading, or downgrading features and components.
- Price of the system changes with each selection.
- System closely or exactly matches the buyer’s preferences.
- Buyer doesn’t have to be as technologically knowledgeable as when building a computer.
- Buyer can choose the computer and peripheral devices and have the complete system delivered.
- Financing may be available.

Support and Maintenance

- The best time to investigate policies for technical support and warranties is before making a purchase.
- Building your own computer
  - The maker of each part typically provides a limited manufacturer’s warranty that covers manufacturing defects.
  - The duration of warranties is typically short (e.g., 1 to 3 months).
  - Check store policies on returns and exchanges in case you order the wrong components.
- Local computer stores
  - Warranties may be more generous on computers built by the store than on individual components.
  - Local stores may offer relatively fast repair services.
- Major retailers and online configuration companies (e.g., Dell)
  - Typically sell warranty packages in addition to the computers. Investigate how warranty repairs are handled (e.g., calling for phone support, mailing in the computer), and whether data will be protected during repairs.
  - More expensive warranty programs may provide for on-site repair of the system and may not require you to use telephone support beforehand. These benefits may be worth the extra cost.
  - Some stores offer long extended warranties.
    - Typically, if electronic parts do not fail within a few months, they will continue working for at least a couple of years.
    - However, an extended warranty for labor may be beneficial.
    - Compare the cost of an extended warranty with the expected cost of replacing the computer after a shorter warranty expires.
• Ensuring that the computer’s environment is ready
  • Set up a workspace that meets the conditions for ergonomics (see Chapter 2).
  • Minimize power fluctuations in the power supply.
    • At a minimum, plug all components into surge-protecting power strips. (Note: Not all power strips offer surge protection.)
    • If possible, purchase an **uninterruptible power supply**, a unit that contains a battery backup system along with power delivery that is more consistent than a surge-protecting power strip.
• Setting up the computer.
  • Be patient when plugging in devices and components, especially the monitor cable (connecting pins can bend if not properly lined up).
  • If a connector is not plugging in easily, double-check the positioning.
• Using the computer: The first time you start up a brand-name computer, you will find that it starts up a variety of smaller programs that offer subscriptions, free trials, etc. Switch off or uninstall any you do not want.
• Keeping the computer clean
  • Cleaning the system unit
    • Dust in the computer can interfere with the air flow needed to keep the computer cool, which reduces its operating life and increases its power consumption.
    • Periodically unplug the system unit, remove the side panel, and use a can of compressed air to clear dust from the CPU fan, front and rear air ports, the power supply, and anywhere else dust has accumulated.
    • Do not use a vacuum cleaner.
    • If there is too much dust for the compressed air to remove it, call a local computer store to see if they have a higher-pressure air system.
• Cleaning the monitor
  • A flat panel monitor has a delicate surface, so don’t use window cleaner on a paper towel.
  • Gently wipe the dust from it with a microfiber cloth.
  • Don’t scrub at little spots and dots. If they remain, dab at them with a moist corner of the microfiber cloth.
• Removing unwanted software
  • Chapter 6 will describe how to protect yourself against malware.
  • Utilities you install can affect system performance. If your system slows down right after you install a program, consider whether you should uninstall it.
Chapter 4B

Mobile Gear

Learning Objectives

4.4 Explain the basic configuration of a notebook computer

4.5 Contrast tablets and smartphones, and explain the primary advantages of each type of computer

4.6 Describe the way that a Wi-Fi device connects to the Internet

4.7 Explain how shared storage and cloud services can help minimize the amount of data you need to carry with you in your computer
Mobile Devices

- Portable computers: self-contained units with keyboard, monitor, and system combined
- Convergence: process where devices or applications with different initial purposes become more alike
- Mobile devices include:
  - Notebooks (laptops)
  - Netbooks

Notebooks

- Attempt to provide all the programs and functions of a desktop environment
- Advantages over desktops:
  - Portability
  - Battery doubles as an uninterruptible power supply
- Network connection ports
  - Wired
  - Modem
  - Wireless
- HDMI port: sends a signal to digital television

- Early digital computers required an entire room, but design innovations led to the creation of portable computers—self-contained units with keyboard, monitor and system combined. These were initially “luggable,” but computer designers have found ways to integrate more applications into devices even as they have shrunk dramatically.
- Advances in mobile computing are now arriving so fast that we are seeing the beginning of significant convergence, the process where devices or applications with very different initial purposes become more and more alike as they share features.

- Notebooks (or laptops): full computers for almost everywhere
- Attempt to provide all the programs and functions of a desktop environment in a package the user can comfortably carry and open almost anywhere.
  - Full-size keyboard, monitor, external mouse
  - Can run any software that a desktop can run
    - Same operating system as a desktop
    - Same basic hardware technology as a desktop
  - Can be expanded with external devices (e.g., printer, digital camera)
  - Can access external networks as effectively as a desktop
- Advantages over desktops
  - Portability
  - Battery doubles as an uninterruptible power supply
- Network connection ports
  - Wired: Ethernet port for use where a wired connection is provided.
  - Modem: Telephone modem for situations where broadband is unavailable but a phone connection is available.
  - Wireless: A common form of notebook connection to the Internet. Older computers may require additional hardware, plugged into a USB port or PCMCIA slot.
  - Laptop operating systems commonly support convenient ways to connect to various networks, including the ability to save connection information and log on automatically.
- Extra ports to make input/output more flexible
  - Specialty connections for video or digital memory cards
  - HDMI port for sending a signal to digital television (HDMI = high-definition multimedia interface)
  - Port for an analog monitor
  - Audio port for a headset
  - USB ports for various other devices, including mice, printers, cell phones
• Notebooks generally designed to run from one battery

• Notebook batteries
  • Size/capacity measured in cells, the sections of the battery that hold power to be distributed
  • Batteries with more cells last longer
  • Batteries with more cells cost more, take up more room, and weigh more

• If the laptop is plugged into a wall outlet, the computer will charge the battery until it is full.

• **Hot swapping:** Removing a battery and replacing it with another one while the computer is running and plugged into the wall.
  • Allows a user with more than one battery to charge the second battery when the first one is fully charged
  • Check to be sure the system is designed to allow hot swapping
  • Do not hot swap batteries if the computer is running on battery power. Shut down the computer completely before changing batteries, or you will lose your work session.

• **Battery life determinants:**
  • Number of cells (more = longer life)
  • Hardware configuration (big monitors, high-performance CPUs draw more power)
  • Power management settings
  • What the computer is doing (e.g., word processing vs. high-performance games)

• Because most laptop buyers are more concerned with weight than battery life, most laptops have relatively small batteries. For those who need longer life for some uses, a solution is to buy a long-life battery to insert for long plane trips or other times when battery life is important.

• **Managing power settings**
  • Battery icon (right end of Windows tool bar)
    • Shows how much power remains
    • Right-click on icon to bring up a power management screen
  • **Power plan:** Lists various setting for the computer to use on battery or wall power. User can create a power plan by selection from the options given.
    • How long to allow a fully lit display
    • When to put the screen and computer to sleep
    • How bright to make the screen
  • Users generally choose more conservative power settings for battery use.
Netbooks

• Nearly notebooks:
  – Screen size: 9 to 10 inches, versus 13 to 22 for a notebook screen
  – CPU typically less powerful
  – Memory and hard drive capacity tend to be less than in notebooks
  – Usually lack DVD drive and have fewer input/output ports

• Operating system
  – Windows 7 Starter: a reduced-feature version of Windows 7 that lacks many personalization features

For users who want the traditional structure of a notebook computer but don’t need the full power or size

• Screen size (measured diagonally) of 9 to 10 inches, versus 13 to 22 for a notebook screen
• CPU typically less powerful and designed to consume less electricity
• Memory and hard drive capacity tend to be less than in notebooks
• Usually lack DVD drive and have fewer input/output ports than a notebook

• Operating system for Windows-based notebooks: Windows 7 Starter, a reduced-feature version of Windows 7 that lacks many personalization features and support for higher-end multimedia.

Advantages

• Price about half the price of a basic notebook
• Consume less power, so batteries last longer before they need charging
• Sufficient OS and hardware to enable Internet browsing, e-mail, and office applications
• Practical for computing where work space is limited (e.g., on an airplane)
• Full functionality of wireless connectivity: Most have a wired Ethernet port and support the latest wireless transmission standards.

Google Chromebook

• Relies heavily on cloud services for applications and underlying operation.
• Limited OS boots in seconds and places user directly into a Web browser, from which users can navigate to websites or launch applications.
• Programs and data files reside on Google’s cloud servers, rather than on the Chromebook’s hard drive.
• The network provides powerful service without needing powerful hardware for the Chromebook.
• Ideal only for users who can access the Internet whenever they want to use the computer.
• May be impractical for users who travel where Internet service is spotty or inexpensive, or who need programs not available from Google and its partners.
Handheld Devices

- Tablet computers
- Smart phones

Tablet Computers

- Input
  - Touch-sensitive screen
    - Responds to contact with fingers or a stylus
    - Instead of using a mouse to click and drag, the user taps icons and moves objects by sliding a fingertip.
    - Some models support more complex touch-based operations.
      - Expanding and shrinking windows by moving the thumb and forefinger apart and together
      - Scrolling rapidly along a list of menu options or icons by swiping at it with a finger
      - Drawing the shapes of numbers and letters, which the computer interprets as its best guess of which numbers and letters were drawn (slower than entering data with a keyboard)
  - Virtual keyboard: display of keyboard keys on a touch screen
    - Users tap on the pictures as if they were actual keys
    - Some find this natural; others prefer the mechanical response of a real keyboard.
  - Port for keyboard

- Convertible tablets: Tablet computers that contain a keyboard attached by a special hinge.
  - The tablet screen can be rotated and flipped up, yielding the arrangement of a notebook.
  - Allow people to use the computer either as a more traditional notebook or as a hands-on tablet.

- Processor, drives, monitor similar to notebooks
  - Main hardware difference is the touch screen and video output.
  - OS must be extended to handle touch input.
    - Windows-based tablets typically have a version of Windows 7.
    - Apple’s iPad runs a version of iOS, the company’s operating system for mobile devices.
  - Include hardware and software to support wired and wireless communication.

- Comparing models
• Competing versions include Apple’s iPad, Motorola’s Xoom and Hewlett-Packard’s TouchPad.
• Features and prices tend to be similar across models, although specifics vary.
• What differentiates the models the most is the user experience.
  • Operating systems may display options in different ways (e.g., a list of names vs. a set of icons).
  • Different software may be supported.
• Shopping for a tablet
  • Visit stores and test models, especially the experience of using the touch screen.
  • Learn what applications are available for each model you are considering. Consider which applications you want, not just how many are available.
  • Compare the total cost, including any subscriptions and applications you intend to use.

• Predecessors
  • While computer designers looking for ways to make desktop computers more portable developed laptops and tablets, handheld computers were created from the start to provide mobile computing. Instead of shrinking the computer, handheld designers were squeezing more applications into a small device.
  • They created personal digital assistants (PDAs), and PDA technology later merged with cell phones to become today’s smart phones.
  • Psion Organiser: Released in 1984 and marketed as “the world’s first practical pocket computer.”
    • The first model displayed one line of text; the second model provided up to four lines.
    • Alphabetic keyboard
    • Basic clock and simple database for entering and retrieving information
  • Apple Newton MessagePad: Released in 1993.
    • Much larger than today’s PDAs
    • Large screen and no keyboard; input with a stylus
    • Later Newton models added keyboard support and the ability to reorient the display in landscape mode (horizontally across the longest dimension).

• Convergence with cell phone technology
  • PDAs and cell phones both have small screens and miniature or alternative input methods.
  • Both devices needed a way to be linked to other computers and networks.
  • Combining cell and PDA technology creates the smart phone, a single device that can serve as a phone and deliver Internet access and an array of software.
  • Today the market for older-style PDAs is dwarfed by that for smart phones.
• BlackBerry and iPhone: Two common models with distinctive features
  • BlackBerry
    • Input with a small, curved QWERTY keyboard, a tiny trackball, and selector buttons
• Wide array of software applications
• Primary function is efficient delivery of e-mail directly to the unit, so the user doesn’t need to look up e-mail via the Internet.

• iPhone
  • Designed with the multimedia user in mind
  • Input with a touch screen (including a virtual keyboard) that requires finger touch
  • Provides Internet software that received e-mail and allows Web browsing
  • Offers audio and video media support
  • Vast library of downloadable applications

• Modern smart phone hardware
  • Dual-core processors
  • Active-matrix organic LED (AMOLED) screens for reduced power usage even as screen resolution improves
  • Motion and proximity sensors, gyroscopes and compasses
  • Accessories for Bluetooth wireless protocol, which provides short-distance radio communication between devices (e.g., hands-free cell phone use)

• Operating systems
  • Android: Available on many makers’ devices, some of which have customized the OS to distinguish their devices.
  • Symbian
  • Apple iOS: Proprietary, runs only on Apple hardware (e.g., iPhone)
  • Windows

• Features of mobile products overlap somewhat.
  • Calendar and appointment systems on notebooks and smart phones
  • Phone calls on smart phones and on notebook computers via Voice over Internet Protocol (VoIP) programs (e.g., Skype)

• Choose a type of device based on how you will use it
  • Light-duty mobile computing tasks suitable for a handheld
  • Managing a schedule daily and hourly
  • Managing a list of contacts
  • Taking notes
  • Receiving and sending e-mail
  • Responding to text messages and online status updates
  • Spending time online

• Services requiring features of a notebook
  • Carrying desktop data, programs, and work environment when you travel
  • Producing presentations with the computer that holds data and programs
  • Running complex and processor-intensive software
  • Connecting to a monitor
• If your mobile needs are limited to phone calls, you can enjoy the power of a full-featured computer by purchasing a desktop computer and carrying just a cell phone.

Network providers: Make network access available free or for a fee

• Cellular service providers
  • Use their own network of cell sites (collections of antennas and transmission and reception equipment)
  • Commonly offer deals to lure subscribers and impose restrictions that make it more difficult to switch to another company
    • Often lock phones so the phone can connect only to the provider’s network.
    • Early termination fees plus the cost of a new phone often make it uneconomical to switch carriers.
    • Some phones can be unlocked after an initial subscription period; others are not locked.
  • Most do not provide direct Internet access.
    • They make a connection between the Internet and cell phone network at a central location.
    • They communicate Internet data to the user via the cell network hardware.

• Internet service providers (ISPs)
  • Some ISPs provide area-wide wireless plans
  • WiMAX (Worldwide Interoperability for Microwave Access): Telecommunications protocol with a data transfer rate competitive with other broadband methods and the ability to cover a much wider area than a Wi-Fi antenna.
    • WiMAX signals can be received at least a few miles away.
    • WiMAX subscribers need a special antenna to connect to the service.
  • Besides companies in business specifically to provide connections to the Internet, ISPs include establishments that buy an Internet connection and elect to share it with others, such as a coffee shop’s customers.
  • The hardware for sharing an Internet connection is a router, a traffic-directing device
    • Creates and manages connections with the local wireless users.
    • Communicates data between the users and the Internet.
    • Some smart phones can use their cellular Internet connection to perform a router’s function if they are connected to a computer.
Network Providers

• Router installation
  – Router’s IP address: numbers that identify the router on the network
  – SSID: name that identifies the wireless router
  – Unsecured connection: anyone within range can simply connect and gain access
  – WEP: An encryption method included in router setup to support old networks
  – WPA2: An encryption method that provides better protection

• Router’s settings affect network safety and availability.
  • To look up and edit router settings, start a Web browser.
  • Enter the router’s **IP address** (numbers that identify the router on the network), a URL provided by the manufacturer in the installation and startup instructions.
  • Router requests a password and displays an interface for reviewing the router’s status and changing settings.

• Router password
  • A manufacturer’s routers have the same IP address, account name, and password.
  • When you install a router and log in, change the user name and password.

• SSID (**service set identifier**) broadcast
  • The SSID is a name that identifies the wireless router.
  • The wireless router can continuously broadcast the SSID to the nearby area, so visitors can find and connect to the network.
  • If the SSID broadcast is turned off, the router will announce its presence without the name. For visitors to gain access, they need to find out the name. This deters only people with a passing interest; a hacker can easily learn the name.

• Network access password
  • Providers offering the Internet connection to visitors often provide an **unsecured** connection, meaning anyone within range can simply connect and gain access.
  • If the wireless connection is to be available for specific visitors and not the general public, then the connection must be secured with a password. Secured router connections are encrypted.
  • **Wired Equivalent Privacy (WEP):** An encryption method included in router setup to support old networks, but its encryption is easily defeated.
  • **Wi-Fi Protected Access (WPA2):** An encryption method that provides better protection. The router owner gives the router a passphrase to require before network users can log in.

• Placing the router may be a trial-and-error process based on how well the signal is received.
### Storage on the Home Network

**For users with a small set of computers**

**Advantages:**
- Cuts storage costs, increases access to data, and improves data security.
- Any computer on the network can access the data.
- Only one copy of each file is needed.

**Drawbacks:**
- Cost for the extra hardware.
- User must make sure the server is running whenever data may be needed.

**Mobile Access to Your Data**

Most people want to store data they can use in more than one place. USB flash drives are readily available but insecure and easy to misplace; networks offer attractive alternatives.

**Storage on your home network: for users with a small set of computers**

**Advantages**
- Centralized data storage cuts down on storage costs, increases access to data, and improves data security.
- Any computer on the network can access the data.
- Only one copy of each file is needed, removing concern over which computer has the latest version.
- For large files, such as videos, storing one copy significantly reduces the amount of storage needed.
- Can be combined with automatic backup systems.
- Storage hardware, e.g., Drobo unit
  - User plugs in sets of hard disk drives for storage.
  - The unit monitors the available space on the drives and notifies the user to add more storage when needed.
  - For critical data, the unit can spread or duplicate data across hard drives, so if one fails, others can provide the data.
  - Large units hold as much as 24 terabytes.
- Systems with more than storage, e.g., Windows Home Server (WHS)
  - Software that runs on a server, a Windows-based computer.
  - With the computer online and data saved to the server’s hard drives, WHS performs automatic backups and manages data on the drives.
  - Provides ways for users to access data across the Internet.

**Drawbacks**
- Cost for the extra hardware (hard drives, storage unit, server).
- The user must make sure the server stays up and running whenever data may be needed.

### Cloud-based Storage

**Advantages**
- No hardware required; users transfer data to the service company’s servers.
- Some services provide limited data storage for free (others charge a monthly or annual fee).
- Costs may be reasonable for the benefits provided.

**Risks of cloud-based storage**
- Anytime data leaves a computer, it is placed at risk of theft.
- Cloud companies have a vested interested in providing secure storage, but it is impossible to be absolutely certain data will be completely unavailable to intruders.
- Example: Carbonite
  - Automatic data backup
  - Data can be retrieved at the company’s website for recovery of lost files or to download them to a different device.
  - Data sharing is simple
  - Recovery of data following a disaster, such as a flood or fire, is more likely.
  - Collaboration tools are minimal.
- Cloud services that enable greater collaboration: Windows Live SkyDrive, Dropbox, Google Docs.
  - User uploads documents from computer to central storage facility.
  - Service manages access and changes made to documents.
  - Dropbox maintains a list of devices and users connected to the subscriber’s account. Any change is delivered immediately to all the participating devices.
    - Convenient way for one person to distribute changes to many devices.
    - May be impractical when many people make changes offline; others will not see the changes until the user is connected to the Internet.
  - Windows Live SkyDrive and Google Docs are more focused on collaboration.
    - Users can upload, store, and change documents.
    - Both the data and the software are hosted by the service company.
    - Users can keep documents private or permit viewing and editing to selected users.