Learning Objectives (1)

• Explain the purpose of a computer keyboard and the types of keyboards widely used today.
• List several different pointing devices and describe their functions.
• Describe the purposes of scanners and readers and list some types of scanners and readers in use today.
• Explain what digital cameras are and how they are used today.
• Understand the devices that can be used for audio input.
Learning Objectives (2)

• Describe the characteristics of a display device and explain some of the technologies used to display images.
• List several types of printers and explain their functions.
• Identify the hardware devices typically used for audio output.
Overview

• This chapter covers:
  – The most common input devices
  – Hardware designed for capturing data in electronic form
  – Audio input
  – Types of display devices and how they work
  – Types of printers and how they work
  – Audio output devices
Keyboards

- A **keyboard** is an input device used to enter characters at the location marked by the insertion point or cursor
  - Can be built-in, wired, or wireless
  - Typically contains:
    - Standard alphanumeric keys
    - Numeric keypad
    - Function keys
    - Delete and Backspace keys
    - Ctrl and Alt keys
    - Arrow keys
    - Special-purpose keys
A Typical Desktop Keyboard

**FUNCTION KEYS**
Performs a different command or function in each program designed to use them.

**BACKSPACE KEY**
Erases one character to the left of the insertion point.

**INSERT KEY**
Toggles between inserting text and typing over text in many programs.

**DELETE KEY**
Deletes one character to the right of the insertion point.

**ALPHANUMERIC KEYS**
Usually arranged in the same order as the keys on a standard typewriter.

**TAB KEY**
Moves to the next tab location.

**CAPS LOCK KEY**
Turns all caps on or off.

**WINDOWS KEY**
Opens the Windows Start screen or menu.

**CONTROL AND ALTERNATE KEYS**
Used in combination with other keys to enter commands into the computer.

**SPACE BAR**
Enter a blank space.

**SHIFT KEY**
Produces uppercase letters and symbols on the upper part of certain keys when the Caps Lock key is not on.

**ARROW KEYS**
Move the cursor around a document without disturbing existing text.

**ENTER KEY**
Used to enter commands into the computer, end paragraphs, and insert blank lines in documents.

**PAGE UP AND PAGE DOWN KEYS**
Move up or down one page or screen in most programs.

**NUMERIC KEYPAD**
Used to efficiently enter numerical data.

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**FIGURE 4-1**
A typical desktop keyboard.

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Keyboards for Mobile Devices

- Mobile devices often use:
  - Slide-out keyboard
  - Pen or touch input (on-screen keyboard)
- Can use an external keyboard (stand-alone or built into a case)
Pointing Devices

• **Pointing devices** are used to:
  – Select and manipulate objects
  – Input data
  – Issue commands to the computer

• Common types of pointing devices:
  – Mouse
  – Pen/stylus
  – Devices that use touch input
Mice

- A **mouse** is a common pointing device that the user slides to move a pointer around the screen and clicks to make selections
  - Older mechanical mice use a ball
  - Optical or laser mice track with light
  - Touch mice support two-dimensional gestures
  - Used to start programs; open, move around, and edit documents; draw or edit images; and more
  - Can be used with a variety of devices
  - Typically connect via a USB port or a wireless connection
Common Mice and Mouse Operations

**FIGURE 4-3**
Mice.

**TRADITIONAL MICE**
Support pointing, clicking, and scrolling.

**TOUCH MICE**
Support swiping, tapping, and other navigational gestures.

**FIGURE 4-4**
Common mouse operations.
Pens/Styluses

• A **stylus** is a pen-like device used to draw or write electronically on the screen
  – Also called digital pen, electronic pen, or pen
  – Pen input is being used for:
    • Photography, graphic design, animation
    • Industrial design, document processing, and healthcare applications
    • Navigating through a document
    • Issuing commands
    • Handwritten input and drawings
Pen-Based Computers and Mobile Devices

- Pen input is often used with mobile devices and tablets
- Can be used with desktop and portable computers if the display screen supports it

FIGURE 4-5
Pen-based computers and mobile devices.
Digital Forms

• With handwriting recognition, written text can be converted to editable typed text
• The use of digital forms is increasingly
Trend

Perceptual Computing

- Users control devices with 3D gestures, voice commands, and facial expressions
- Noncontact system
- Allows for full body input and input from a slight distance away or through a glass window

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Other Uses for Digital Pens

• Digital writing systems are pen-based systems that capture handwritten input as it is being written
  – Requires special paper with a grid of dots
  – Transfers handwritten input to computer

• **Graphics tablets** are flat, touch sensitive tablets typically connected to computer using a USB port
  – Also called pen tablets or digitizing devices

• Signature capture devices are used to record signatures for credit card purchases, deliveries, etc.
Examples of Digital Pens in Use

**DIGITAL WRITING SYSTEMS**
Record all input written on the paper and transfer it to a device either in real time or when directed by the user.

**GRAPHICS/PEN TABLETS**
Transfer all input written or drawn on the tablet to the computer in real time and allow the use of pen navigation tools.

**SIGNATURE CAPTURE DEVICES**
Record signatures for purchases, deliveries, and other applications that require recorded authorization.

**FIGURE 4-7**
Other uses for digital pens.
Touch Screens

• **Touch screens** are display devices that are touched with the finger to select commands or otherwise provide input to the computer
  – Common on portable computers, smartphones, and other mobile devices
  – Multi-touch screens can recognize input from more than one finger at a time
  – Some support both touch and pen input
  – Surface Hub (large multi-touch wall-mounted display)
  – Table PC (large computer either built into a table or designed to be used on a table)
Examples of Touch Screens

**PERSONAL COMPUTERS**

**MOBILE DEVICES**

**SURFACE HUBS**

**TABLE PCS**

**FIGURE 4-8**

Touch screens.
Other Pointing Devices

- Gaming devices
- Trackballs
- Control buttons and wheels
- Touch pads
Augmented Reality

- Overlays computer generated images on top of real-time images
- Today, most often with smartphones using camera input, location info, and other data
- Displays appropriate information related to images captured by the smartphone
Quick Quiz (1)

1. Touch mice __________.
   a. support finger swipes and gestures
   b. navigate by a process called inking
   c. contain a scroll wheel on the top

2. True or False: With handwriting recognition, handwritten text can be converted to editable text.

3. On-screen forms that can convert handwritten text into editable typed text are called __________.

Answers:
1) a; 2) True; 3) digital forms
Scanners, Readers, and Digital Cameras

- Some devices capture data initially in digital form.
- Others capture data from source documents:
  - Already exist in physical form (photographs, checks, invoices, or product labels).
  - Source data automation:
    - Saves time
    - Increases accuracy
    - Utilizes scanning or reading devices

**FIGURE 4-10**
Source data automation.
Scanners

- A **scanner** (optical scanner) is an input device that captures an image of an object in digital form
  - Data is typically input as a single image
  - Can scan photos, documents, images, etc.
  - Types of scanners
    - **Flatbed scanners** (scan flat objects one page at a time)
    - **Portable scanners** (scan objects while on the go)
    - 3D scanners (scan objects in 3D)
    - There are also task-specific scanners, such as receipt and business card scanners
Examples of Scanners

**FIGURE 4-11**

**Scanners.**

**FLATBED SCANNERS**
Used to input digital copies of photos, sketches, slides, book pages, and other relatively flat documents into the computer.

**PORTABLE SCANNERS**
Used to capture digital copies of documents while on the go; the data is typically transferred to a computer at a later time.

**PORTABLE 3D SCANNERS**
Used to capture 3D digital images of a person or an object.
Scanning Quality and Resolution

• Quality of scanned images indicated by optical resolution
  – Measured in number of dots per inch (dpi)
  – Can often be specified when image is scanned
  – Can be changed when scanned image is edited
• Higher resolution means better quality but larger file size
Barcodes and Barcode Readers

• **Barcodes** are machine-readable optical codes that represent data as a set of bars
• **Barcode readers** are input devices that read barcodes
• Types of barcodes
  – Read by traditional barcode reader
    • Universal Product Code (UPC)
    • ISBN
    • Code 39
  – Read by mobile apps
    • QR Codes (two-dimensional; hold much more data)
    • Digital watermarks (icons)
Examples of Barcodes and Digital Watermark Icons

**FIGURE 4-13**
Barcodes and digital watermark icons.
Examples of Barcode Readers

**FIGURE 4-14**
Barcode readers.

**FIXED BARCODE READERS**
Used most often in retail point-of-sale applications.

**PORTABLE BARCODE READERS**
Used when portability is needed.

**INTEGRATED BARCODE READERS**
Used most often for consumer applications.
Radio Frequency ID (RFID)

- **Radio Frequency Identification (RFID)** is a technology that stores, reads, and transmits data located in RFID tags

- **RFID tags** contain tiny chips and radio antennas
  - Can be attached to objects
  - Read by **RFID readers**
    - Handheld, portal, and stationary
  - Tags only need to be within range of the reader, rather than in line of sight

- **Used for a variety of applications**
  - Tracking inventory and assets
  - Electronic toll collection
  - Tracking patients in hospitals
  - Ticketing applications
  - IDs (driver licenses, U.S. passports, etc.)

![RFID tags](Image)
Near Field Communications (NFC) is a short-range wireless communication standard based on RFID

- Used to transfer information between smartphones or between a smartphone and an NFC-enable reader
- Used for contactless mobile payments

- Credit card or smartphone containing the NFC technology needs to be within an inch or so of the NFC-enabled payment terminal
  - More appropriate than conventional RFID for mobile payments
Examples of RFID and NFC Applications

**SHIPPING**
This portal RFID reader reads RFID tags attached to the shipping container or to items inside the container as it passes through the portal.

**WAREHOUSING**
This handheld RFID reader is used to read the RFID tags located on the warehouse shelves, as well as on the pallets currently stored there.

**MOBILE PAYMENTS**
This stationary NFC reader is used at checkout locations to process payments via NFC-enabled credit cards or smartphones.

**TICKETING**
This stationary RFID reader is used to automatically open ski lift entry gates for valid lift ticket holders at a ski resort in Utah.

FIGURE 4-16
RFID and NFC applications.
Optical Mark Readers (OMR) and Optical Character Recognition (OCR)

- Optical mark readers (OMRs) input data from optical forms to score or tally exams, questionnaires, ballots
- **Optical character recognition (OCR)** recognizes text characters and converts them to electronic form as text, not images
  - Identifies each character and convert it to editable text
  - Used to process turnaround documents like monthly bills
  - Read by OCR devices
  - Optical characters are designed to be read by OCR devices but can still be read by humans
OMR Readers and Optical Characters

**FIGURE 4-17**
Optical mark readers (OMRs). Are commonly used to score tests and tally questionnaires.

**FIGURE 4-18**
Optical characters. Are often used in turnaround documents, such as on this utility bill.

---

Optical Characters

These OCR characters indicate the customer account number and amount due and can be read by both computers and human beings.
Magnetic Ink Character Recognition (MICR) Readers

- **Magnetic ink character recognition (MICR)** is used primarily for banking to facilitate check processing
  - MICR readers (check scanners) read the MICR characters printed at the bottom of checks
  - Used by banks
  - Used by businesses to remotely deposit checks
  - Individuals typically use ATMs or mobile deposit instead
Mobile Payments and Digital Wallets

- Digital wallets, like Apple Pay and Google Wallet, store payment information to pay for purchases
- Mobile digital wallets are stored on mobile devices
  - Typically use NFC
  - Competing NFC readers
- Mobile payments can also be made via mobile credit card readers, mobile banking apps, or mobile payment apps (Square Cash or PayPal)
Biometric Readers

- **Biometric readers** are used to input biometric data such as an individual’s fingerprint or voice
  - Can be stand-alone readers or built into another piece of hardware
  - Most often used for access control, to authorize electronic payments, and to log on to secure Web sites

*FIGURE 4-20*
Biometric readers.
Digital Cameras

• **Digital cameras** take pictures and records them as digital images
  – Can be still cameras and/or video cameras
  – Integrated into portable computers, smartphones, and tablets

• Digital still cameras
  – Primary appeal is that images are immediately available
  – Camera quality is measured in megapixels
  – Typically use flash memory for storage
  – Slight delay when taking photos
Examples of Digital Still Cameras

**PREVIEWS**
 Virtually all digital cameras let you display and erase images.

**STORAGE MEDIA**
 Most cameras use removable storage media in addition to, or instead of, built-in storage.

**TYPICAL CONSUMER DIGITAL CAMERAS**

**DIGITAL CAMERAS INTEGRATED INTO SMARTPHONES**

![Digital cameras image]

**FIGURE 4-21**
Digital still cameras.
Digital Video Cameras

• Digital video cameras
  – Digital camcorders, PC video cameras (PC cams, webcams)
  – Built-in and stand-alone cameras
  – Store images on digital media (flash memory, DVDs, hard drives, etc.)

• Applications
  – Live video feeds and recorded video
  – Surveillance
  – Video conferences, phone calls, and Webinars
  – Face recognition systems
Audio Input

• Audio input
  – The process of entering audio data into the computer

• Voice input
  – Inputting spoken words and converting them to digital form via microphone or headset
  – Used in conjunction with sound recorder software
  – **Speech recognition systems** enable the device being used to recognize voice input as spoken words
    • Can be used for dictation as well to as to issue commands to the device
  – Usually incorporated into smartphones, GPS systems, and other mobile devices
Example of a Speech Recognition System

1. The user speaks into a microphone that cancels out background noise and inputs the speech into the computer.

2. An analog-to-digital converter on the sound card or integrated sound component located inside the system unit converts the spoken words to digital form.

3. Voice recognition software converts the words to phonemes and then determines the words that were spoken.

4. The spoken words appear on the screen in the application program (such as a word processor or an e-mail program) being used.

FIGURE 4-23
Speech recognition systems.
Music Input Systems

- Music input systems input music into a computer or other device
  - Existing music can be input using CDs or a Web download
  - For original compositions, microphones, keyboard controllers, and guitar controllers can be used to input music
  - Inputted music can be edited, saved, played, etc.
Quick Quiz (2)

1. Which technology is used primarily by the banking industry to facilitate check processing?
   a. OCR
   b. MICR
   c. OMR

2. True or False: One disadvantage of digital cameras is the slight delay between when the user presses the button and when the camera takes the photo.

3. A voice input system typically requires software and a(n) ___________ in order to input voice data or commands into a computer.

Answers:
1) b; 2) True; 3) microphone
Display Devices

- **Display devices** present output visually on some type of screen
  - **Monitors** are display devices typically used with a desktop computer
  - **Display screens** are built into a variety of devices
    - Notebook and other portable computers
    - Smartphones and mobile devices
    - Handheld gaming devices, home entertainment devices, kitchen appliances
    - Digital photo frames, e-book readers, smart watches
    - Digital signage systems, digital billboards
Examples of Display Devices

PORTABLE COMPUTERS

E-READERS

HOME APPLIANCE CONTROL PANELS

MOBILE DEVICES
Include smart watches (left) and smartphones (right).

DIGITAL SIGNAGE SYSTEMS

FIGURE 4-25
Uses for display devices.
Display Device Characteristics

• Color vs. monochrome displays
  – Images are formed using **pixels**
  – Most displays today are color displays

• CRT vs. flat-panel displays
  – Cathode ray tube (CRT) displays: large, bulky, and heavy
  – Flat-panel displays: take up less desk space; use less power
Size, Aspect Ratio, and Screen Resolution

• Size and aspect ratio
  – Device size measured diagonally from corner to corner
  – Wide variety of sizes available
  – Most are wide-screen displays (16:9 aspect ratio)

• Screen resolution
  – The number of pixels used on a display determines its resolution
  – Affects the amount of information that can be displayed on the screen at one time
  – Can be changed to match users’ preference
Video Adapters, Interfaces, and Ports

- Video cards determine the graphic capabilities of a computer
- VGA, DVI, and HDMI are the three most common interfaces to connect monitors to a computer
- Ports exposed in the system unit cases connect monitors to computers
  - Newer option is to use USB ports
Example of a Video Card

FIGURE 4-27
Video cards. Provide a connection to a monitor, as well as determine video capabilities.

VGA
HDMI
DVI

GPU
Renders images on the display screen (this GPU is located inside the fan enclosure for cooling purposes).

FAN
Cools the components on the video card.

VIDEO RAM CHIPS
Provide memory for video display (this card contains 2 GB of video RAM inside the fan enclosure).

PORTS
Determine how a monitor can connect.

PCI EXPRESS (PCIe) CONNECTOR
Plugs into the PCIe slot on the motherboard.
Wired, Wireless, and High-Definition Displays

• Wired vs. wireless displays
  – Wired display are physically connected to the system via a cable
  – Wireless displays connect using a wireless network connection (Wi-Fi, Bluetooth)

• High-definition displays
  – Most common HD format is 1080p
  – **Ultra HD (4K)** uses about four times as many pixels as 1080p displays
Figure 4-29
Wireless displays.
Display content from a device (such as the smartphone shown here) to the display via a wireless signal.
Wearable and Touch Displays

• Wearable displays project images from a mobile device to a display screen
  – Smart glasses
• Touch and gesture capabilities
  – Kiosks
  – Portable gaming devices
  – Smartphones
  – Tablets
Flat Panel Display Technologies

- **Liquid crystal displays (LCDs)** use charged liquid crystals between sheets of glass or plastic
  - Requires backlighting
- **Light emitting diode (LED)** displays use LCD panels and LED backlighting
- **Organic light emitting diode (OLED)** displays use layers of organic material
  - Emit visible light so do not require backlighting
  - More energy efficient
  - Are thinner and have a wider viewing angle
  - Incorporated into many digital cameras, smartphones, TVs, and other consumer devices
Organic Light Emitting Diode (OLED) Displays

**FIGURE 4-31**
How OLED displays work.
Other Types of OLEDs

- **FOLED (Flexible OLED)**
  - OLED displays built on flexible surfaces such as plastic or metallic foil

- **TOLED (Transparent OLED)**
  - Displays are transparent
  - Emit light toward top and bottom of display surface

- **PHOLED (Phosphorescent OLED)**
  - Process that results in much more conversion of electrical energy into light instead of heat
Examples of Special Types of OLEDs

**FIGURE 4-32**
Special types of OLEDs.

**FLEXIBLE OLEDS**
Used to create flexible displays on plastic or another type of flexible material.

**TRANSPARENT OLEDS**
Used to create transparent displays.

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Inside the Industry

Wearable Holographic Displays

• Project images on top of what the person wearing the display is already seeing
• Microsoft HoloLens
  – Essentially a head-mounted computer
  – Does not need to connect to a smartphone or computer to function
Electronic Paper (E-Paper) Displays

- **Electronic paper (e-paper)** displays use electronic ink (e-ink)
  - Used for e-readers and other devices
  - Easier to read in direct sunlight
  - Content can change wireless
  - Only uses power to change images, not maintain an image
  - Can be monochrome or color
Other Types of Flat Panel Displays

- **Interferometric Modulator (IMOD) displays**
  - Essentially a complex mirror that uses external light to display images
  - Designed initially for mobile phones and portable devices
  - Images are bright and clear, even in sunlight
- **Plasma displays** use layers of gas between two plates of glass
  - Being replaced by LCDs
Data and Multimedia Projectors

- **Data projectors** (multimedia projectors) display output from a computer to a wall or projection screen
  - Found in classrooms and conference rooms
  - Can be wireless or integrated into devices
  - Some contain an iPod dock

- Pico projectors are pocket-size and connect to mobile and portable devices

- Keyboard projectors project virtual keyboards

- 3D projectors can project images used with 3D glasses or holograms
Examples of Data Projectors

**CONVENTIONAL DATA PROJECTORS**
The projector shown here is ceiling mounted and Wi-Fi-enabled.

**PICO PROJECTORS**
Are very portable; images from the device connected to the projector can be displayed on any surface.

**KEYBOARD PROJECTORS**
The projector shown here projects a virtual keyboard that can be used with any Bluetooth-compatible device.

*Figure 4-35*
Data projectors.
Printers

- **Printers** produce hard copy
  - Impact printers (dot-matrix)
    - Print mechanism strikes an inked ribbon to transfer ink to the paper
    - Used to produce multipart forms
  - Non-impact printers (ink-jet/laser)
    - Use liquid ink or toner
    - Produce higher quality images
    - Much quieter than impact printers
  - Can be color or black-and-white printers
Examples of Dot-Matrix and Color Printers

**FIGURE 4-36**
Dot-matrix printers.

**FIGURE 4-37**
Color printing.
Requires four colors.
Printer Characteristics

• Print resolution
  – Measured in dpi (dots per inch) or images per minute (IPM)
  – More dots per inch results in higher quality output
  – 300 dpi for general purpose printing; 1,200 dpi for photographs; 2,400 dpi for professional applications

• Print speed
  – Measured in pages per minute (PPM)
  – Range from about 15 to 65 ppm
Printer Capabilities

• Personal vs. network printers
  – Personal printers connect directly to a single computer
  – Network printers connect directly to a home or an office network; some can perform cloud printing

• Connection options
  – USB connection, wired network, Wi-Fi, Internet

• Multifunction devices (MFDs) or all-in-ones
  – Copy, fax, scan, print
Cloud Printing

FIGURE 4-38
Cloud printing. Allows you to send documents to a printer via the Internet.
Laser Printers

- **Laser printers** use toner powder and technology similar to that of a photocopier to produce images on paper.
- The standard for business documents:
  - Print one entire page at a time
  - Generally faster and have better quality output than ink-jet printers
- Use toner cartridges; toner is transferred to the paper and fused with heat.
- Color printers use four toner cartridges.
1. The laser beam and a rotating mirror charge the appropriate locations on each drum to form the necessary image.

2. Toner sticks to the charged area and is transferred to the paper as it rolls over the drums.

3. The fuser melts the toner to fuse it to the paper.

**FIGURE 4-40**

Laser printers.
Ink-Jet Printers

- **Ink-jet printers** spray droplets of ink to produce images on paper
  - Use ink cartridges
  - Usually print in color
  - Often the choice for home use
  - Relatively inexpensive with good-quality output
  - Print more slowly than laser printers
  - Potential applications for the future
    - Dispensing liquid metal, computer chips, “printing” human tissue, silk and protein ink, etc.
How Ink-Jet Printers Work

FIGURE 4-41
How ink-jet printers work.

1. A heating element makes the ink boil, which causes a steam bubble to form.
2. As the steam bubble expands, it pushes ink through the firing chamber.
3. The ink droplet is ejected onto the paper and the steam bubble collapses, pulling more ink into the firing chamber.
Special Purpose Printers

- **Barcode printers** (print a variety of barcodes)
- RFID printers (encode RFID tabs)
- Label printers (print labels and/or postage)
- **Photo printers**
- **Portable printers** (used while on the go or by service professionals)
Integrated and Large-Format Ink-Jet Printers

• Integrated printers (built into a smartphone, digital camera, etc.)
• Large-format ink-jet printers (print posters, maps, signs, blueprints, etc.)
  – Sometimes called plotters
  – Print up to about 120 inches in width
  – Some print on fabric
3D Printers

- **3D printers** form output in layers to build a 3D version of the desired output
  - Can print using plastic, metal, ceramic, wood, glass, sugar, etc.
  - Additive manufacturing
  - Print customized objects on demand
    - Personal products
    - Medical products
    - Prototypes or custom parts
    - Can contain moving parts
  - Issues such as 3D-printed weapons

**FIGURE 4-45**
3D printers. Can print using a variety of materials (plastic is shown here).
Audio Output

- Audio output includes voice, music, and other audible sounds
  - Common audio output devices
    - **Computer speakers**
    - **Headphones, headsets, and earbuds**
Quick Quiz (3)

1. Which display devices takes up the largest amount of room on a desk?
   a. CRT monitor
   b. OLED display
   c. LCD display

2. True or False: Laser printers can only print in black and white.

3. 3D printers typically form output in layers with a process known as __________ manufacturing.

Answers:
1) a; 2) False; 3) additive
Summary

• Keyboards
• Pointing and Touch Devices
• Scanners, Readers, and Digital Cameras
• Audio Input
• Display Devices
• Printers
• Audio Output