

15<sup>th</sup> Edition

# Understanding Computers

Today and Tomorrow

Comprehensive

## Chapter 4

# Input and Output



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# Learning Objectives

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



# Learning Objectives

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



# Overview

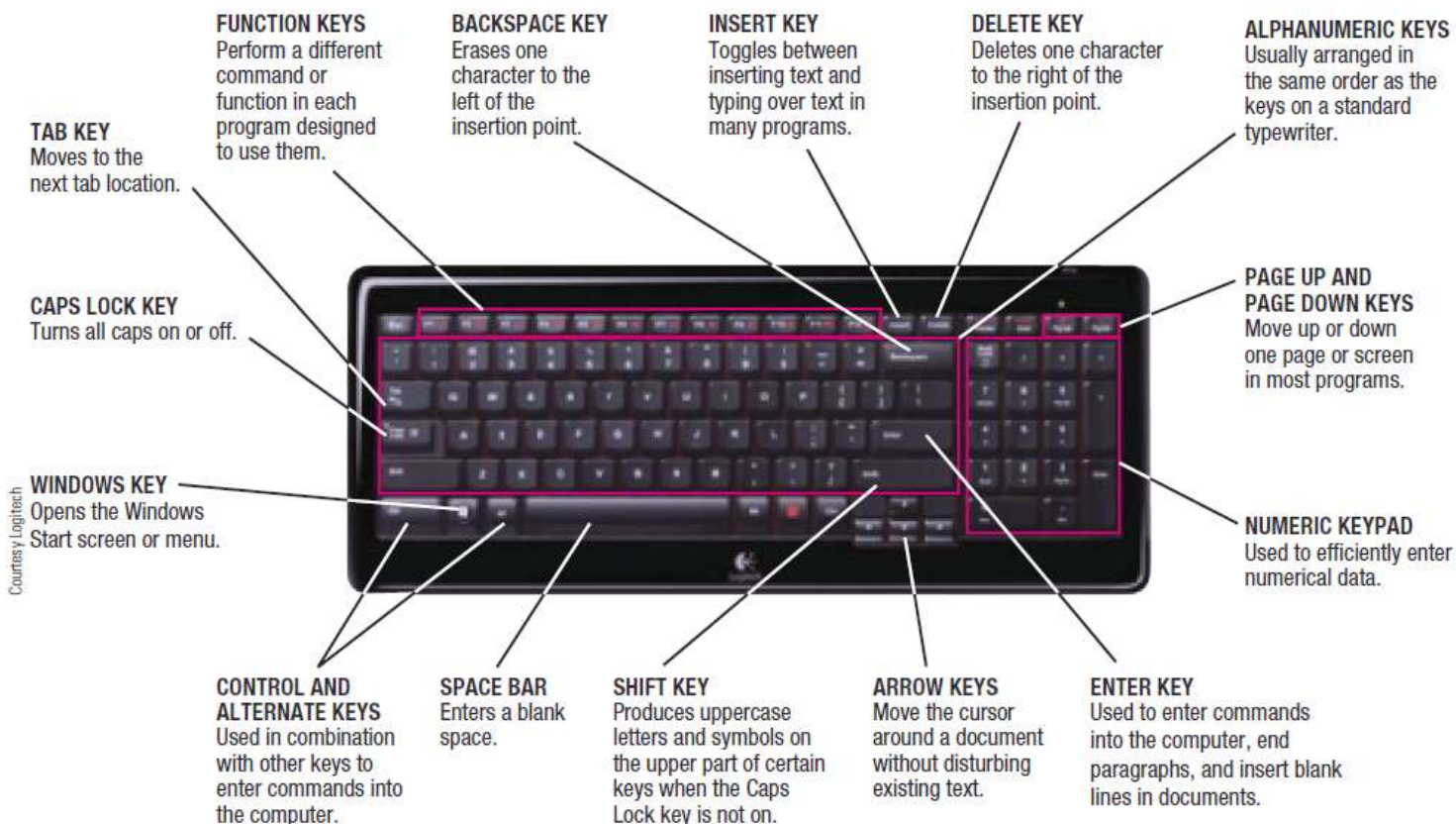
- This chapter covers:
  - The most common input devices
  - Hardware designed for capturing data in electronic form
  - Audio input
  - Types of display devices and how they work
  - Types of printers and how they work
  - Audio output devices



# Keyboards

- An input device used to enter characters at the location marked by the insertion point or cursor
  - Can be wired or wireless
  - Typically contains:
    - Standard alphanumeric keys
    - Numeric keypad
    - Function keys
    - Delete and Backspace keys
    - Control and Alternate keys
    - Arrow directional keys and special keys

# Keyboards



**FIGURE 4-1**

A typical desktop keyboard.

# Keyboards

- Mobile devices often use:
  - Slide-out keyboard
  - Pen or touch input (on-screen keyboard)
  - Keyboard dock



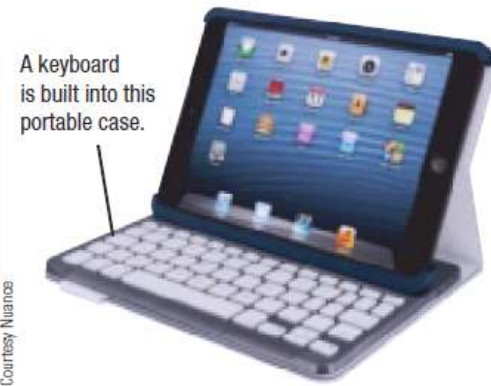
Courtesy Sprint

SLIDE-OUT KEYBOARDS



Courtesy Nuance

ON-SCREEN KEYBOARDS



A keyboard is built into this portable case.

Courtesy Logitech

KEYBOARD FOLIO

**FIGURE 4-2**  
Keyboards for mobile devices.



# Pointing and Touch 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

- Mouse
  - Common pointing device that the user slides along a flat surface to move a pointer around the screen and clicks its buttons to make selections
  - Older mechanical mice use a ball
  - Optical or laser mice track with light
  - Touch mice support two-dimensional gestures

# Mice



## TRADITIONAL MICE

Support pointing, clicking, and scrolling.



## TOUCH MICE

Support swiping, tapping, and other navigational movements.

Courtesy Logitech

**FIGURE 4-3**  
Mice.

### POINT

Move the mouse until the mouse pointer is at the desired location on the screen.



### CLICK

Press and release the left mouse button.



### RIGHT-CLICK

Press and release the right mouse button.



### DOUBLE-CLICK

Press and release the left mouse button twice, in rapid succession.



### DRAG-AND-DROP

When the mouse pointer is over the appropriate object, press and hold down the left mouse button, drag the object to the proper location on the screen by moving the mouse, and then drop the object by releasing the mouse button.



### SCROLL WHEEL/BUTTON

If your mouse has a wheel or button on top, use it to scroll through the displayed document.



### SWIPE

If your mouse supports gestures, swipe the surface in various directions with your fingers to scroll, flip, and zoom screen contents.



### TAP

If your mouse supports gestures, tap on the mouse to perform clicks.



**FIGURE 4-4**  
Common mouse operations.



# Trend Box

## 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





# Pens/Styluses

- Stylus
  - Pen-like device used to draw or write electronically on the screen
  - Also called digital pen, electronic pen, tablet pen
  - Pen input is being used for:
    - Photography, graphic design, animation
    - Industrial design, document processing, and healthcare applications
    - Navigating through a document
    - Issuing commands

# Pens/Styluses

- Pen-Based Computers and Mobile Devices
  - Pen input used with mobile devices and tablet computers
    - Used to input handwritten text and sketches and to manipulate objects
    - If handwriting recognition is used, written text can be converted to editable typed text



SMARTPHONES



TABLET COMPUTERS



DESKTOP COMPUTERS

**FIGURE 4-5**  
Pen-based computers  
and mobile devices.



# Pens/Styluses

- Digital Writing Systems
  - Pen-based systems that capture handwritten input as it is being written
  - Requires special paper with a grid of dots
  - Handwritten input can be transferred to computer
- Graphics Tablets
  - Pen tablets or digitizing devices
  - Flat, touch sensitive tablet typically connected to computer using a USB port

# Pens/Styluses

- Signature Capture Devices
  - Found at check out counters to record customer signatures



Courtesy: Lives of the

## 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.



© wavebreakmedia/Shutterstock.com

## 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.



© iStockphoto.com/Juanmonino

## 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
  - 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
    - Can recognize input from more than one finger at a time
  - Table PC
    - Large screen computer either built into a table or designed to be used on a table



# Touch Screens



Courtesy Dell Inc.

DESKTOP COMPUTERS



Courtesy Sony Electronics Inc.

NOTEBOOK COMPUTERS



Courtesy Dell Inc.

MOBILE DEVICES



Courtesy Lenovo

TABLE PCS

**FIGURE 4-8**  
Touch screens.

# Other Pointing Devices

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



**GAMING DEVICES**  
Most often used for gaming applications.



**TRACKBALLS**  
An alternative to a mouse that some individuals find easier to use.



**TOUCH PADS**  
Commonly found on notebook and netbook computers (left); also available as stand-alone devices (right).

**FIGURE 4-9**  
Other common pointing devices.



# Quick Quiz

1. An optical mouse is \_\_\_\_\_.
  - a. the same as a wireless mouse
  - b. a mouse that tracks movements with light instead of a ball
  - c. a mouse that contains a scroll wheel on the top
2. True or False: With handwriting recognition, text is input as a graphical image so the text cannot later be edited as text.
3. An input device that looks like an upside-down mouse with the ball on top is a(n) \_\_\_\_\_.

*Answers:*

*1) b; 2) False; 3) trackball*



# How It Works Box

## Augmented Reality

- Computer generated images are overlaid 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



# Scanners, Readers, and Digital Cameras

- Source documents
  - Already exists in physical form (photographs, checks, or product label)
- Source data automation
  - Captures data directly from a source document
    - Saves time
    - Increases accuracy
    - Utilizes scanning or reading devices

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



RECORDING DATA DIRECTLY INTO  
A COMPUTER



CAPTURING DATA FROM ITS SOURCE  
DOCUMENT



# Scanners

- Scanners (Optical Scanners)
  - Input devices that read printed text and graphics and transfers them to a computer in digital form
  - Data is typically input as a single image
  - Can scan photos, documents, images
  - Types of scanners
    - Flatbed
    - Portable
    - 3D
    - Receipt and business card scanners

# Scanners

**FIGURE 4-11**  
Scanners.



© BlueSkyImage/Shutterstock.com

## **FLATBED SCANNERS**

Used to input photos, sketches, slides, book pages, and other relatively flat documents into the computer.



Courtesy WizCom Technologies

## **PORTABLE SCANNERS**

Used to capture documents or other data while on the go; the data is typically transferred to a computer at a later time.



Courtesy NCR Corporation

## **INTEGRATED SCANNERS**

Built into other devices, such as into the ATM machine shown here to capture images of deposited checks.

# Scanners

- 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

**FIGURE 4-12**  
Scanning resolution.



## RESOLUTION

Most scanners let you specify the resolution (in dpi) to use for the scan. High-resolution images look sharper but result in larger file sizes.





# Readers

- Barcode Readers
  - Input devices that read barcodes
- Barcodes
  - Machine-readable codes that represent data as a set of bars
  - Common Types
    - Universal Product Code (UPC)
    - ISBN
    - DataBar
    - QR Codes

# Readers



ISBN CODES



UPC (UNIVERSAL  
PRODUCT CODE) CODES



DATABAR CODES



INTELLIGENT MAIL CODES



CODE 39 CODES



QR CODES

**FIGURE 4-13**  
Common types of  
barcodes.

Courtesy Motorola Solutions; Copyright © 2015 Cengage Learning®

# Readers

**FIGURE 4-14**  
Barcode readers.



Courtesy NCR Corporation

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



Courtesy Intermec Technologies

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



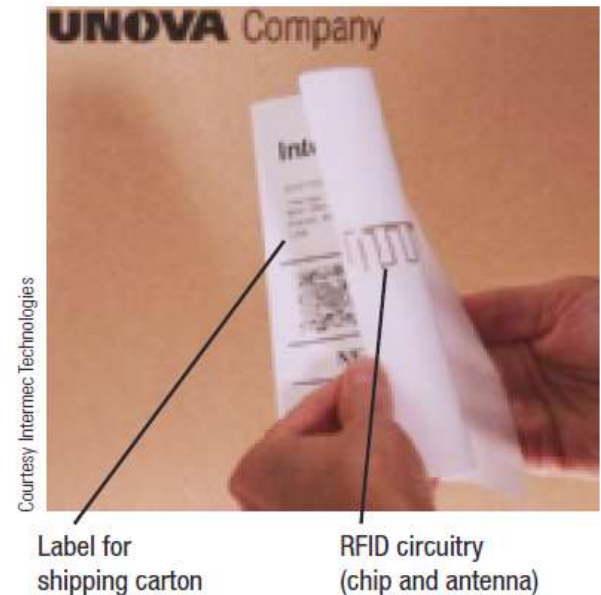
Courtesy SPARCode

**INTEGRATED BARCODE READERS**  
Used most often for consumer applications.

# Readers

- Radio Frequency Identification (RFID) Readers
  - Technology used to store and transmit data located in RFID tags
  - RFID tags contain tiny chips and radio antennas
    - Can be attached to objects
    - Read by RFID readers
    - Tags only need to be within range of the reader, rather than in the line of sight

**FIGURE 4-15**  
RFID tags.





# Readers

- Applications
  - Tracking inventory and assets
  - Electronic toll collection
  - Tracking patients in hospitals
  - Ticketing applications
  - Speeding up ID process of travelers at border crossings
- Types of RFID Readers
  - Handheld, portal, and stationary
- Slow to catch on in retail industry due to privacy and security issues

# Readers



Courtesy Internet Technologies

## INVENTORY TRACKING

This portal RFID reader reads all of the RFID tags attached to all of the items on the pallet at one time.



Courtesy of teamswest.com

## TICKETING APPLICATIONS

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



Courtesy MasterCard Worldwide

## MOBILE PAYMENTS

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



© AP Images/Denis Flory

## BORDER SECURITY

This stationary RFID reader is used at the U.S.-Mexico border crossing located in San Diego to reduce wait time.

**FIGURE 4-16**  
RFID applications.



# Readers

- Optical Mark Readers (OMRs)
  - Input data from special forms to score or tally exams, questionnaires, ballots
- Optical Character Recognition (OCR) Devices
  - OCR is the ability of a computer to recognize scanned text characters and convert them to electronic form as text, not images
  - OCR software is used to identify each character and convert it to editable text
  - Used to process turnaround documents like monthly bills

# Readers

- Magnetic Ink Character Recognition (MICR) Readers
  - Also called check scanners
  - Used primarily for banking
  - Read the special magnetic characters printed at the bottom of checks
  - High volume readers process deposited checks
  - Used to facilitate remote deposits and electronic check processing



Courtesy Epson America

**FIGURE 4-19**  
Magnetic ink character recognition (MICR) readers are used primarily to process checks.



# Readers

- Biometric Readers

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



#### PERSONAL COMPUTERS

Often used to control access to the device (such as the notebook computer shown here), as well as to log on to secure Web sites.

Fingerprint reader

Fingerprint reader



#### MOBILE DEVICES

Often used to record or verify an individual's identity (such as with the device shown here that has fully integrated iris, face, fingerprint, and voice biometric capabilities).

**FIGURE 4-20**

Biometric readers.



# Technology and You Box

## Mobile Deposits

- Mobile remote deposit capture
- Transmit check information via smartphone app and camera
- App optimizes the check front and back images and transmits images and deposit data to your bank



Smartphone cameras can be used to submit check images for remote deposit.



# Digital Cameras

- Digital Cameras
  - Take pictures and records them as digital images
  - Can either be still cameras or video cameras
  - Integrated into many portable computers and mobile phones
- Digital Still Cameras
  - Primary appeal is that images are immediately available
  - Camera quality is measured in megapixels
  - Typically use flash memory for storage
  - Camera phones can be used to read barcodes, remotely deposit checks, etc.

# Digital Cameras



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

# Digital Cameras

- Digital Video Cameras
  - Digital camcorders, PC video cameras (PC cams, webcams)
  - Built-in or stand alone
  - Store images on digital media (flash memory, DVDs, hard drives, etc.)
- Applications
  - Surveillance video cameras
  - Video conferences and Webinars
  - Face recognition systems



Courtesy Sony Electronics Inc.

#### DIGITAL CAMCORDERS

Typically store video on a built-in hard drive (as in this camera) or on DVD discs.



U.S. Air Force photo/Staff Sgt. Levi Riendeau

#### PC VIDEO CAMERAS

Commonly used to deliver video over the Internet, such as during a video phone call as shown here.

**FIGURE 4-22**  
Digital video cameras.



# Audio Input

- Voice Input and Speech Recognition Systems
  - 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
    - Can be used for podcasts and with VoIP (Voice over IP) systems
    - Provides spoken instructions to computer when used with speech recognition systems

# Audio Input

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 located inside the system unit converts the spoken words to phonemes, the fundamental sounds in the language being used, and digitizes them.



3. Voice recognition software 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.

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**FIGURE 4-23**

Speech recognition systems.

# Audio Input

- Music Input Systems
  - Used to input music
    - 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



**FIGURE 4-24**  
**Music input systems.** Musicians can input original compositions into a computer via microphones, MIDI keyboards and guitars, and other devices.





# Quick Quiz

1. Which of the following is used in conjunction with Scantron test forms, voting ballots, and other documents in which the selection is bubbled in?
  - a. OCR
  - b. MICR
  - c. OMR
2. True or False: Flatbed scanners can be used to scan photos, as well as documents on conventional paper.
3. A voice input system requires software and a(n) \_\_\_\_\_ in order to input voice data or commands into a computer.

*Answers:*

*1) c; 2) True; 3) microphone*



# Display Devices

- Display Device
  - Presents output visually on some type of screen
  - Monitor
    - Display device for a desktop computer
  - Display Screen
    - Screen built into a variety of devices
      - Notebook and other portable computers
      - Mobile phones and mobile devices
      - Handheld gaming devices, home entertainment devices, kitchen appliances
      - Digital photo frames, e-book readers, smart watches
      - Digital signage systems, digital billboards

# 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



**ADDITIONAL DISPLAYS FOR MOBILE DEVICES**  
Typically duplicate the content displayed on the mobile device.

©iStockphoto.com/gflob; Used with permission from Microsoft Corporation



**MULTIPLE MONITORS**  
Can be used with a single computer to extend a desktop, which can increase productivity.

**FIGURE 4-26**  
Flat-panel displays.



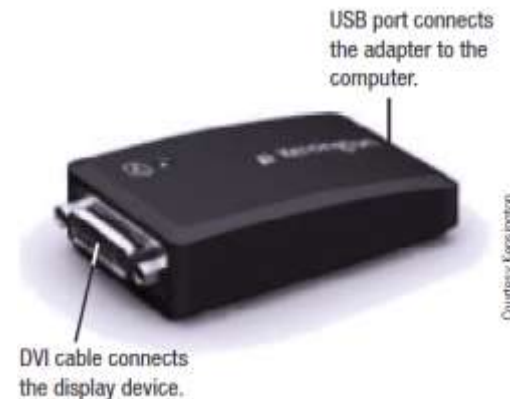
# Display Devices

- Size and Aspect Ratio
  - Device size measured diagonally from corner to corner
- Screen Resolution
  - Number of pixels used on a display determines resolution
  - Affects the amount of information that can be displayed on the screen at one time
  - Can be changed to match users' preference

# Display Devices

- 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 are to connect monitors to computers
    - New option is to use USB ports

**FIGURE 4-28**  
A USB display adapter.



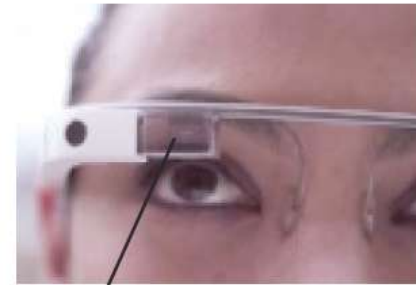


# Display Devices

- 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)
- 2D vs. 3D Displays
  - Most displays are 2D
  - 3D displays use filters, prisms, and multiple lenses to create the 3D effects

# Display Devices

- Wearable Displays
  - Project images from a mobile device to a display screen built into glasses
- Touch and Gesture Capabilities
  - Kiosks and portable gaming devices
  - Mobile phones and media tablets



Display is built into the Glass frames.

Content from a smartphone or the Internet appears in your line of vision.



Courtesy Google

**FIGURE 4-30**  
Google Glass.



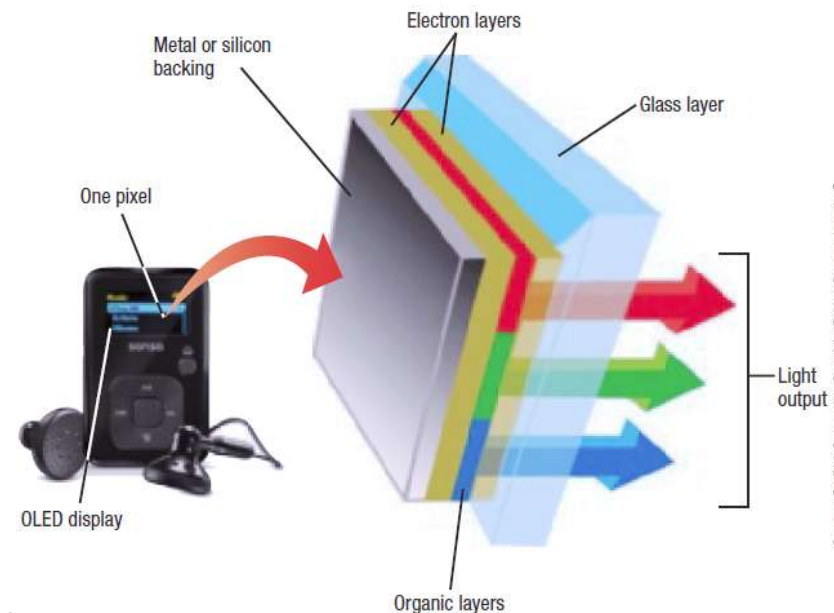
# Flat Panel Display Technologies

- Liquid Crystal Displays (LCDs)
  - Use charged liquid crystals between sheets of glass or plastic
  - Requires backlighting
- Light Emitting Diode (LED) Displays
  - Used in alarm clocks and Christmas lights
  - Currently used to backlight LCD panels



# Flat Panel Display Technologies

- Organic Light Emitting Diode (OLED) Displays
  - Use layers of organic material
  - Emit visible light when current is applied
  - Are thinner than LCDs
  - Have a wider viewing angle
  - Incorporated into many digital cameras, mobile phones, and portable digital media players



**FIGURE 4-31**  
How OLED displays work. Each pixel on an OLED display emits light in the necessary color.

Courtesy Sandisk Corporation. Copyright © 2015 Cengage Learning®



# Flat Panel Display Technologies

- Special 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

# Flat Panel Display Technologies



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



Courtesy of Universal Display Corporation

**TOLEDs**  
Used to create transparent displays.

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

# Flat Panel Display Technologies

- 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

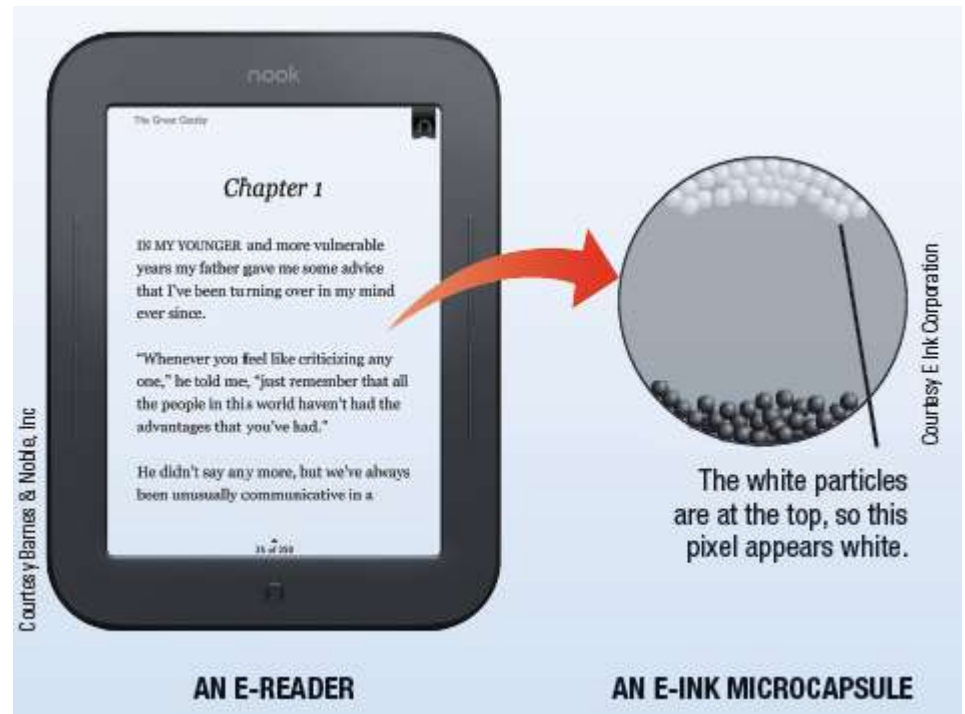


**FIGURE 4-33**  
An IMOD display is bright and readable, even in direct sunlight.

# Inside the Industry Box

## E-Paper

- 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
- Use electronic ink
- Monochrome or color





# Data and 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 mobile and portable devices
- Hologram projectors used to display 3D images
- 3D projectors are designed to project 3D images that are viewed with 3D glasses

# Data and Multimedia Projectors

**FIGURE 4-34**  
Data projectors.



## CONVENTIONAL DATA PROJECTORS

Frequently used for both business and classroom presentations; the projector shown here is ceiling mounted and Wi-Fi-enabled.



## PICO PROJECTORS

Can be stand-alone or built into a mobile device; images from the mobile device (such as the smartphone shown here) are projected onto any surface.

# Printers

- Printing Technology
  - 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



Courtesy / InfoPrint Solutions Company

**FIGURE 4-35**

**Dot-matrix printers.**

Dot-matrix printers are impact printers; today they are typically high-speed printers used in manufacturing, shipping, or similar applications.





# Printers

- Color vs. Black and White
  - Colors printers use magenta, cyan, yellow, and black ink
- Print Resolution
  - Measured in dpi (dots per inch)
  - 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

# Printers

- 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 most comm
- Multifunction Capabilities
  - Copy, fax, scan, print
  - All-in-ones

**FIGURE 4-37**  
Cloud printing.  
Allows you to send documents to a printer via the Internet.

Courtesy Epson America





# 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
- Can be black and white or color
- Common print resolution for laser printers is between 600 and 2,400 dpi
- Use toner cartridges



# Ink-Jet Printers

- Sprays 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, aromas, computer chips and other circuitry, “printing” human tissue

# Ink-Jet Printers



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Each ink cartridge is made up of multiple tiny ink-filled firing chambers; to print images, the appropriate color ink is ejected through the appropriate firing chamber.

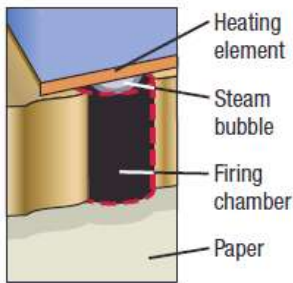


Courtesy, Hewlett-Packard Company

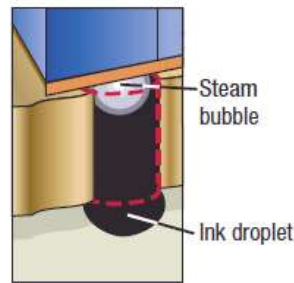
INK-JET PRINTER

**FIGURE 4-40**

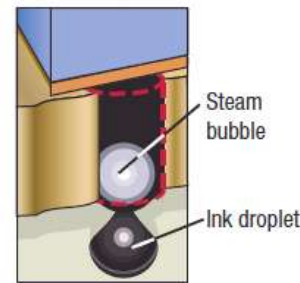
How ink-jet printers work.



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.

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# Special Purpose Printers

- Barcode, label, and postage printers
- Photo printers
- Portable and integrated printers
- Wide-format ink-jet printers
- 3D printers

**FIGURE 4-44**  
**3D printers.** This printer can print objects up to the size of a standard basketball.



Courtesy 3D Systems, Inc.

# Audio Output

- Audio Output
  - Voice, music, and other audible sounds
  - Common audio output devices
    - Computer speakers
    - Headphones and headsets
    - Earphones and earbuds



**COMPUTER SPEAKERS**

Used to output sound from a computer.

**TABLET DOCK**

Used to output sound from a media tablet.

**HEADSETS**

Used when both voice input and audio output are required.

**FIGURE 4-45**  
Audio output devices.



# Quick Quiz

1. Which of the following types of display devices should have the largest footprint (the amount of room taken up 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. \_\_\_\_\_ printers form images with drops of liquid ink.

*Answers:*

*1) a; 2) False; 3) Ink-jet printers*





# Summary

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