INPUT AND OUTPUT

Application of Information and Communication Technologies

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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

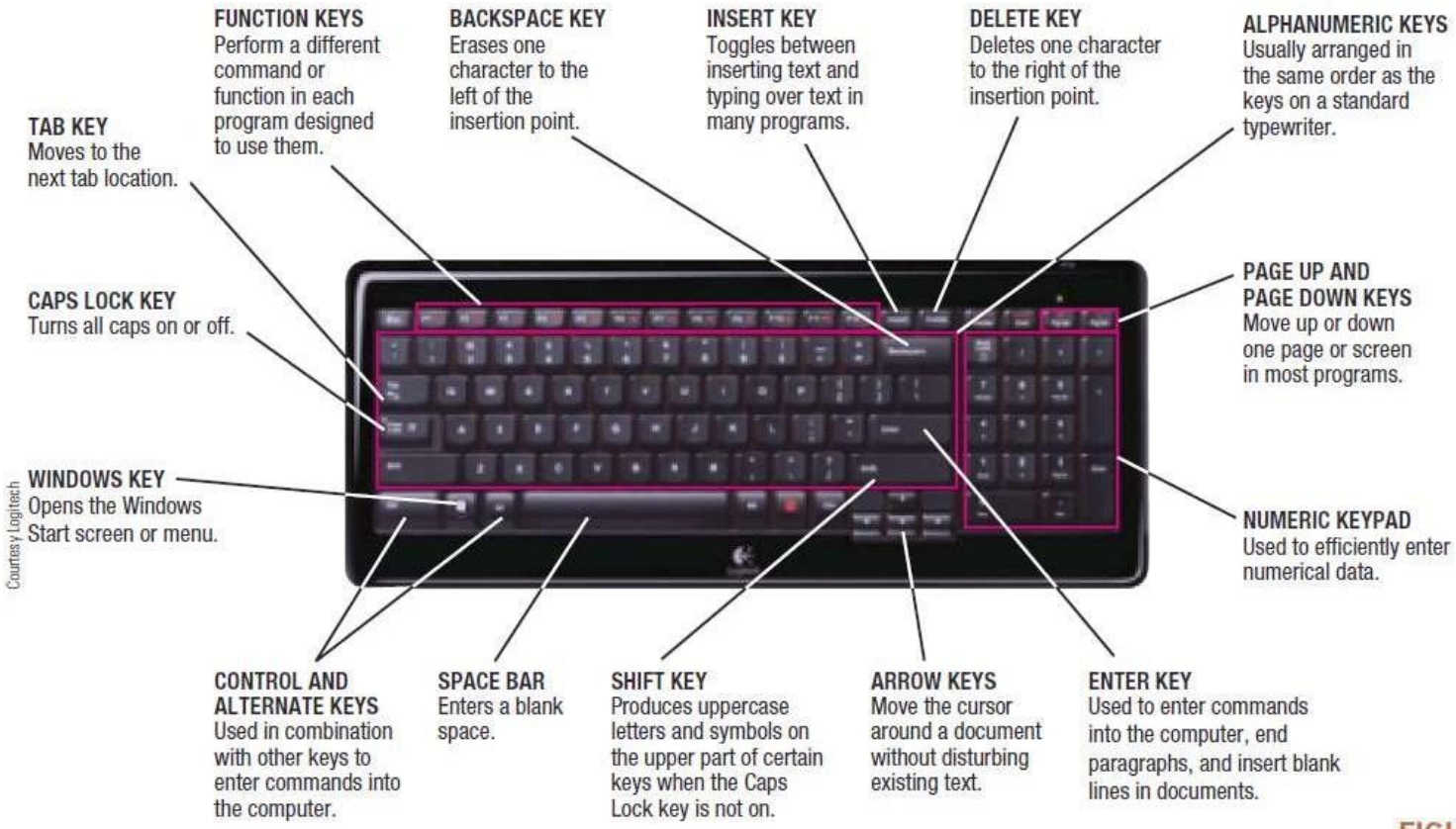

FIGURE 4-1
A typical desktop keyboard.

Keyboards

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

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.

Courtesy Logitech

TOUCH MICE
Support swiping, tapping, and other navigational movements.

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

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

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
  - 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.

Courtesy Motion Computing

RECORDING DATA DIRECTLY INTO A COMPUTER

Courtesy United Parcel Service of America, Inc.

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.

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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

FIGURE 4-13
Common types of barcodes.

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.

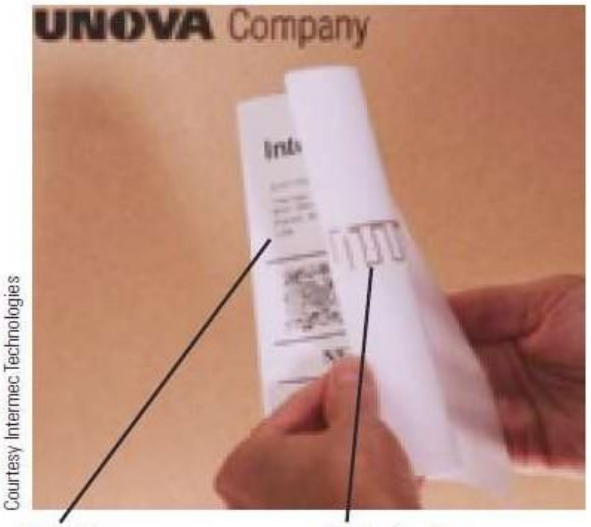
Courtesy SPARQCode

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 Intermec Technologies

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

Courtesy of teamaxess.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 Poroy

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

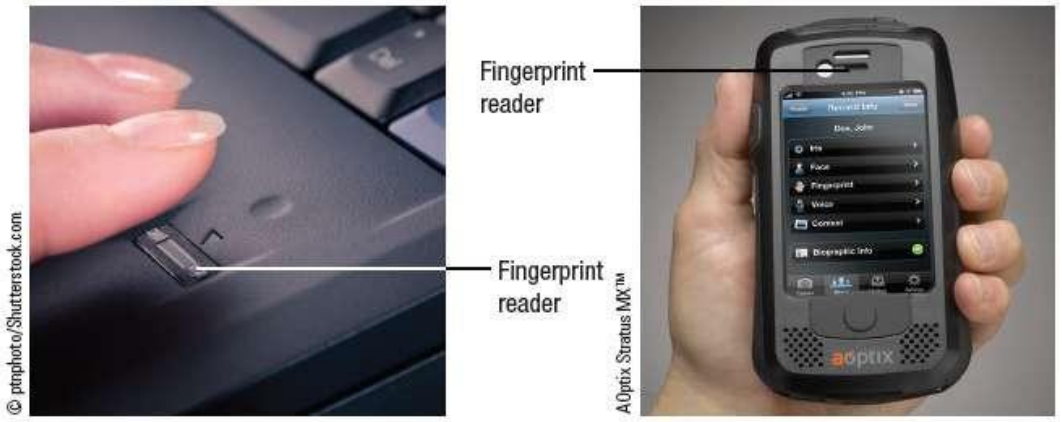
- Magnetic Ink Character Recognition (MICR) Readers
  - Also called check scanners
  - Used primarily for banking
  - Read the special magnetic characters printed at the bottom of checks
  - High volume readers process deposited checks
  - Used to facilitate remote deposits and electronic check processing

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.

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.

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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.

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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.

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

Courtesy ASUSTeK Computer Inc.

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

©iStockphoto.com/gl0dx; 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
  - Portable gaming devices
  - Mobile phones and media tablets

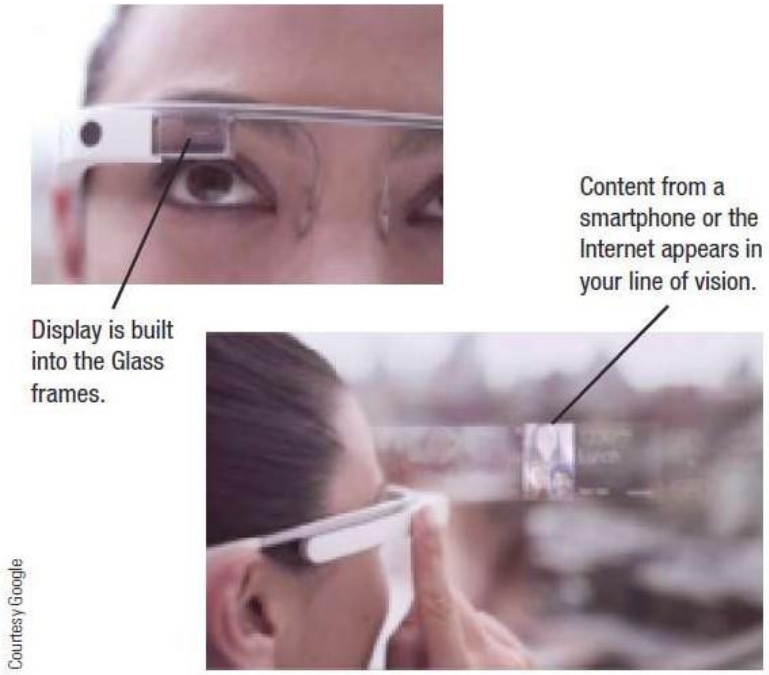


FIGURE 4-30
Google Glass.

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

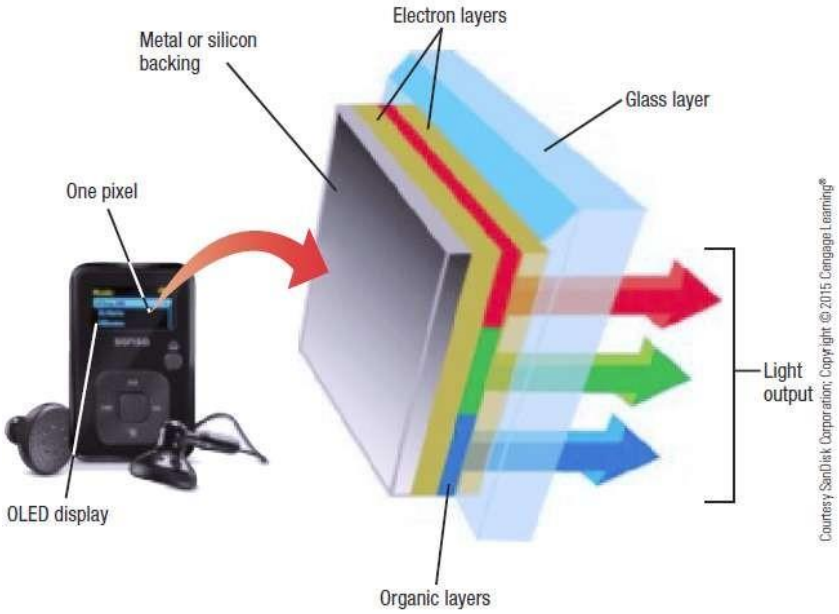


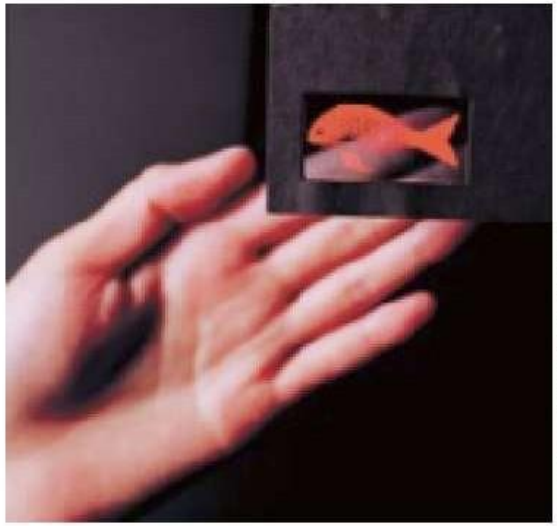
FIGURE 4-31
How OLED displays work. Each pixel on an OLED display emits light in the necessary color.

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

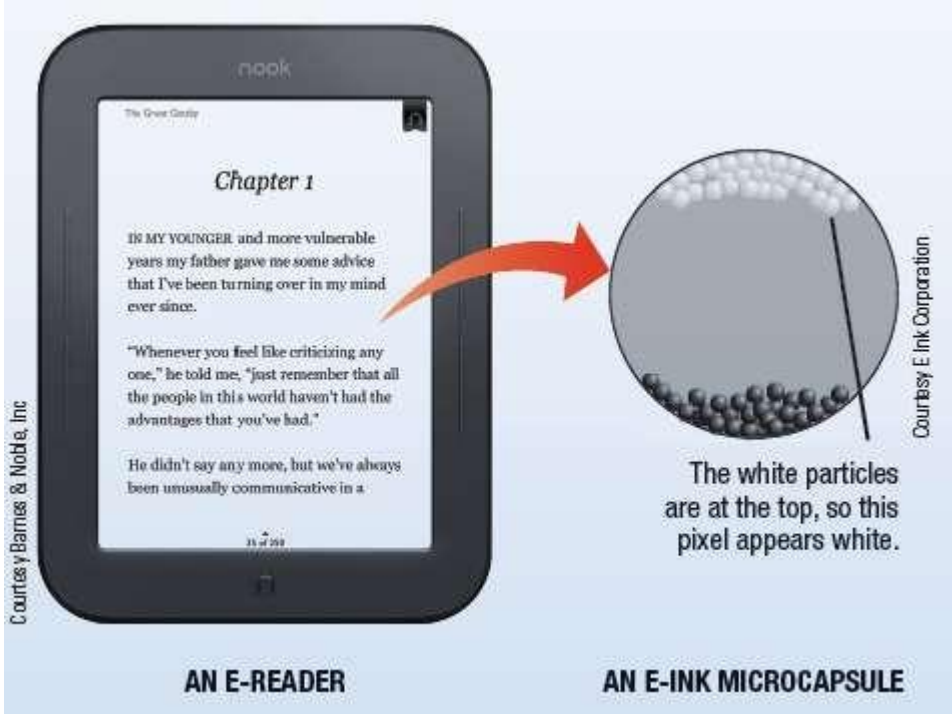
- Interferometric Modulator (IMOD) Displays
  - Essentially a complex mirror that uses external light to display images
  - Designed initially for mobile phones and portable devices
  - Images are bright and clear, even in sunlight
- Plasma Displays
  - Use layers of gas between two plates of glass
  - 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.

Courtesy Epson America

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

Courtesy Samsung

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

Courtesy Epson America

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

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

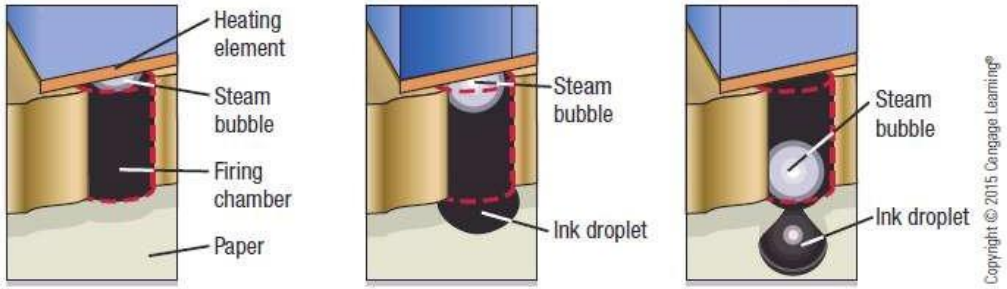
Ink-Jet Printers

- 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

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.

INK-JET PRINTER



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.

FIGURE 4-40
How ink-jet printers work.

Special Purpose Printers

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

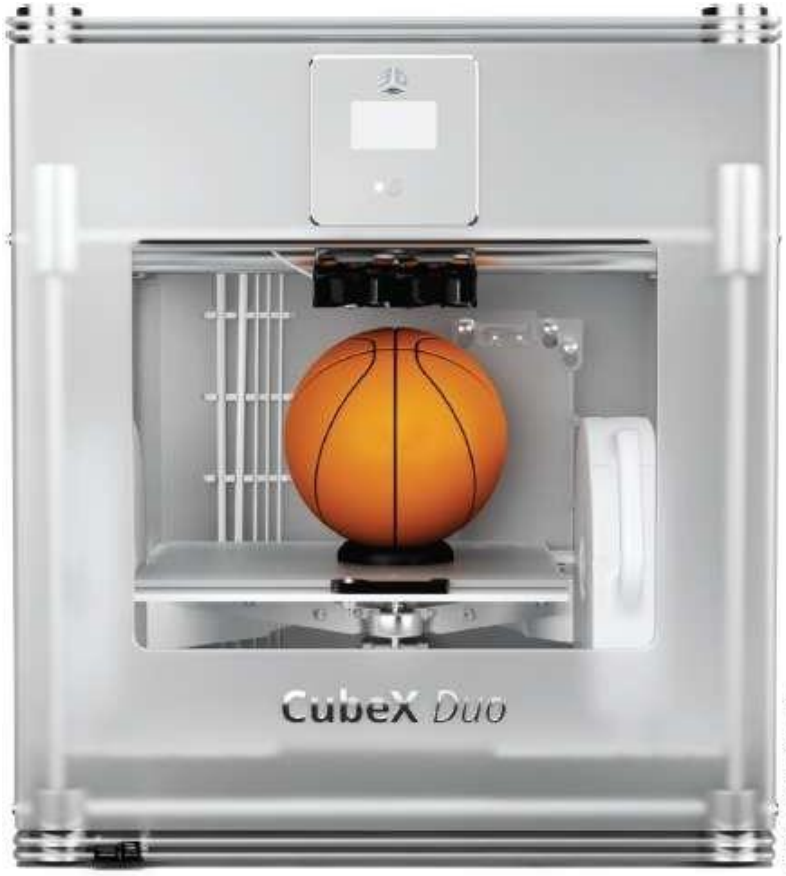


FIGURE 4-44
3D printers. This printer can print objects up to the size of a standard basketball.

Audio Output

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

Courtesy Altec Lansing

COMPUTER SPEAKERS
Used to output sound from a computer.

Courtesy Altec Lansing

TABLET DOCK
Used to output sound from a media tablet.

Courtesy Nuance

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