Recall that there are four main functions of computer systems:

- Input
- Processing
- Output
- Secondary Storage

The computer user is very aware of inputting data and the output (processed information) that is the result.

**Inputting Data**

- Keyboard
- Mouse
- Trackball
- Magnetic-ink character recognition
- Scanner
- Optical mark recognition
- Optical character recognition
- Bar codes
- Handwritten characters
- Voice input
- Touch screens
- Looking

**Keyboard**

A keyboard is similar to a typewriter keyboard. Not all keyboards are traditional. Customized keyboards can be found in business, schools, and homes.

**Mouse**

The mouse movement corresponds to movement of the pointer (cursor) on the screen.

A mouse also has one or more buttons which allow selection of items on a screen.
Trackball

The trackball stays in one place while the user rolls the ball directly with one hand. Trackballs are ideal when a flat surface does not exist.

Magnetic-ink Recognition

The most common example of characters made of magnetic particles can be seen on personal checks.

Scanner

A scanner is an optical recognition system that uses light to scan an image and convert it into electrical signals. The signals are then processed so that the image appears on the computer monitor.

Optical Mark Recognition

This technique uses a machine to sense marks on a piece of paper. Computer-graded answer sheets rely on optical mark recognition (OMR) to score tests.

Optical Character Recognition (OCR)

OCR devices use a light source to read special characters or printed text. OCR devices can "read" pages in a book or sale tags on store merchandise.

Bar Codes

Bar codes appear on the product as a series of zebra-like stripes. Bar codes are used to identify a product when read by a device called a bar code reader.
Machines can read handwritten characters. However, the size, completeness, and legibility of the handwriting must follow rigid rules.

Speaking to a computer requires speech recognition devices. The computer processes the sounds into binary code and can “learn” what the code means.

Touch screens are designed so that if touched, the computer knows what the person has selected.

In the future, input might be gathered from our eye movements, and watching images that appear on our retina.

Useful information for the user can take on a variety of forms:
- Computer screens
- Printers
- Voice output
- Music and sound

Screen output is known as soft copy because it is intangible and temporary. Most computer screens are of the cathode ray variety.
Cathode Ray Tube (CRT)
Most CRT screens use raster scanning to produce the image. The image must be refreshed often. The rate of refreshing is called scan rate. The image we see actually consists of dots (pixels) on the screen that are either illuminated or not.

Pixels
Resolution is determined by the number of pixels on the screen. The amount of space between pixels is dot pitch, which determines image quality.

Resolution Just Gets Better
There are two common resolutions available today:
- SVGA - 800x600, 1024x768, 1280x1024, 1600x1200
- XGA - more colors

Flat Screens
Some computer screens use liquid crystal technology. LCDs are popular with laptop computers.

Terminals
Terminals integrate a monitor, keyboard and communications link. Smart terminals have their own CPU.

Printers
A printer is an output device that produces a hard copy of your work (a printout on paper). There are two ways to print onto paper:
- Impact
- Non-impact
Impact Printers

An impact printer makes physical contact with the paper to produce an image. Impact printers are practical for print jobs in which quantity matters or when multiple (carbon) copies are needed simultaneously.

Non-Impact Printers

Non-impact printers put the image on the page without physically striking the paper. These printers are best when quality is important.

Voice Output

Synthesizing speech is much easier for a computer than speech recognition. There are two methods:
• Synthesis by analysis
• Synthesis by rule

Synthesis by Analysis

In this method of speech synthesis, the output device analyzes the input of a human voice speaking words. The words are stored and the sounds are processed. Later, the computer “talks” by reproducing the words as needed.

Synthesis by Rule

In this method of speech synthesis, the output device applies a complex set of linguistic rules to create artificial speech.

Music and Sound Output

• May be as simple as attaching speakers to the computer.
• For more serious output, add sound chips to simulate different instruments or sound effects.
• Use MIDI to record and playback musical compositions
Examples of this kind of output include:

- Business graphics
- Video graphics
- CAD/CAM
- Education
- Computer art
- Science
- Sports

Business graphics is a powerful way to turn numerical data into more meaningful information.

The addition of color increases understanding.

Business Graphics

Video graphics combines computer graphics and sound, with the ability to animate a series of frames.

Video Graphics

Many television programs and movies rely on the special effects made possible with video graphics technology.

TV’s Special Effects

Computer-aided design (CAM) and computer-aided manufacturing use computers to design, build, and test products.

CAD/CAM

Digital cameras take photographs and store them internally. Photos are then sent to the computer for output, or stored on disk.

Digital Cameras
Ethics and Data

Just because a computer will allow you to input data and produce new information as output, doesn’t always mean it is legal or right to do so.

Ethics and Data

Is the situation described below ethical?

Use computer software to substitute one person for another in a photograph.

Ethics and Data

Is the situation described below ethical?

Erase contents of e-mails that may help someone filing suit against your company.

Conclusion

Newer input and output devices are announced regularly.
Users reap the benefits of improvements in performance and ease of use.