Topic 3: Output Devices

3.1 Introduction

Output devices are used to translate computer signals into human readable forms. These devices enable the computer to communicate with the user:

- **Output**: Information that comes out of the computer
- **Output Devices**: Devices through which information comes out. For example: Printer, Plotters, Monitors, Projector, Speakers etc.

3.2 Hard-Copy vs. Soft-Copy

**Hard Copy** output refers to that output produced on a tangible medium. A very popular example of this is output from a Printer. **Soft Copy** output is produced by using electronic signals to display a temporary image. A very popular example of this is the output from a Monitor.

3.3 Raster vs. Vector Devices

**Raster Devices** produce raster graphics, i.e. images are drawn out of series dots. These devices may draw graphics, but when drawing slanting lines, this is not done smoothly. Examples of such devices include printers and monitors.

**Vector Devices** produce vector graphics, i.e. each line required is produced individually in any direction. Therefore, they are much more accurate and the lines are much smoother. An example of such devices is the Plotter.
3.4 Printers

Printers produce **hard copy** of information. The printing speed is calculated in pages per minute, lines per second or characters per second, depending on the type of printer. The **resolution** is calculated in Dots per inch (dpi). The higher the dpi, the better the print quality.

![Image of 600dpi and 1200dpi resolutions]

**Advantages and Disadvantages of Printers**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>- Permanent output</td>
<td>- Time</td>
</tr>
<tr>
<td></td>
<td>- Use of paper</td>
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<td>- Noise</td>
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**Impact vs. Non-Impact Printers**

**Impact Printers**: With this technology, the head of the printer must hit an inked ribbon in order to print. This ribbon is pressured against the paper and imprints it. Example: Dot Matrix Printer

**Non-Impact Printers**: On the other hand, with this technology, the head of the printer does not touch the paper. Other technologies such as ink spray, laser, heat etc. are used. This will result in a much better quality printout and less noise. Examples: Ink Jet Printer and Laser Printer.
**Character, Line or Page Printers**

- **Character Printer:**
  - prints one **character** at a time
  - Example: Dot Matrix Printer

- **Line Printer:**
  - prints one **line** at a time
  - Example: Ink Jet Printer

- **Page Printer:**
  - prints one **page** at a time
  - Example: Laser Printer

**Dot Matrix Printer**

The Dot Matrix Printer has a number of pins in its head (example: 9 pins). These pins are configured in such a way so as to form a shape. These pins hit the ink ribbon into the paper. Thus, all characters are made up of a pattern of dots. Of course, the more pins, the better the quality of the printout.

**Typical Output:**

```
system where a sti
dld allow us to get
mercial supplier.
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The Dot Matrix printer does not produce high quality printouts. Yet, a 24 pin head is much better than a 9 pin head. Its typical speed is 50-350 characters per second (cps).
Typical Use: used to generate POS receipts and Carbon copy documents.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Cheap</td>
<td>Simple graphics</td>
</tr>
<tr>
<td>Easy maintenance</td>
<td>Low quality</td>
</tr>
<tr>
<td>Can print graphics</td>
<td>Slow</td>
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<td></td>
<td>Noisy</td>
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**Inkjet Printer**

Inkjet printers work by placing extremely small droplets of ink onto the paper, thus creating an image/character. The inkjet printer is made up of the following parts: Print Head, Ink Cartridges, Print Head Stepper Motor, Belt, Rollers and Paper Feed Stepper Motor.

**The Process**

The head contains tiny nozzles. Bubbles of electronically charged and quick-drying ink are injected from the nozzle onto paper. Ink passes through electrostatic field and deflected towards proper position.

But how is ink passed from the nozzle? There are two ways in which this can be done:

- Through Heat: **Thermal Bubble**
- Through Vibration: **Piezoelectric**
Thermal Bubble

Ink pulled from cartridge to nozzle reservoirs and the resistors create heat. The heat vaporises ink to create bubble. This bubble expands and as a result, ink is pushed out of the nozzle and onto the paper.

Piezoelectric

This technology makes use of piezo crystals. These crystals are placed in the ink reservoirs of each nozzle. Crystals are electrically charged, they start to vibrate, thus forcing the ink out of the nozzle and onto the paper.

Typical Uses: Home Computers (few documents), Printing Photos

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>- Relatively quiet</td>
<td>- Color printing can be extremely slow</td>
</tr>
<tr>
<td>- Faster than Dot Matrix printer</td>
<td>- Ink may be smudged</td>
</tr>
<tr>
<td>- Cheaper than Laser Printer</td>
<td>- Cartridges need to be replaced more often</td>
</tr>
<tr>
<td>- Good quality</td>
<td>- than toner in a laser printer</td>
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</table>

Laser Printer

The following are the steps involved, every time that a page needs to be printer:

- Printer creates an image of the whole page on the drum
- Drum is given a +ve charge
- Drum revolves
- Laser beam shines across the drum
- This will cause image to become -vely charged
- Printer coats the image with +vely charged toner (black powder)
- Therefore we have:
  - Image is –vely charged
  - Toner is +vely charged

Consequently what will happen?
- Toner will cling to the image on the drum
- Toner will not cling to the background

Paper is –vely charged
- Drum rolls over sheet of paper
- What happens?
  - Paper pulls toner away from the drum
- Paper passes through fuser

What does the fuser do?
- Fuser is a pair of heated rollers
- Toner powder on paper melts and is sealed (fused) into the paper

Typical Uses: School Computer Labs and Workplaces (offices) since laser printers are quiet, print a large number of sheets very quickly and produce high quality documents.
### Advantages
- High quality of printouts
- Fast: They print 1 page at a time
- Quiet: No impact
- Cost per page is low

### Disadvantages
- Colour laser printers are expensive
- Expensive Maintenance
- Fairly bulky

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**Printer Buffer/Spooler**

The term printer buffer refers to a small memory area within the printer (or computer memory), where files to be printed are placed. It is like a queue of print jobs. The printer always prints the first print job in the queue. When the printer is free, the next print job in the buffer is sent to the printer.

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### 3.5 Plotters

Plotters are large printer, which print on large paper. A pen is used (like drawing) to draw on the whole paper. Plotters are mostly used with CAD (Computer Aided Design) and to print sketch diagrams and maps.

There are two types of plotters:

- **Flat bed Plotter** – This type of plotter will have the paper which will remain fixed and the pen will move vertically and horizontally.

- **Drum Plotter** – This type of plotter will have the paper moving vertically and the pen moving horizontally.

**Typical Uses:** Engineers, architects and map-makers to draw plans of buildings, diagrams of machines or large scale maps
### 3.6 Visual Display Units (VDUs)

VDUs, also called screens or monitors, produce **soft copy** of information. VDUs may be monochrome (use only a single colour but vary intensity) or use a range of colors. The images on VDUs are made up of dots/pixels very close to each other. The more pixels, the sharper the image.

**Typical Uses:** to display aids (menus, icons etc) to help the user navigate, as well as for the user to view data input.

<table>
<thead>
<tr>
<th>Advantages</th>
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</thead>
<tbody>
<tr>
<td>- High speed change of display</td>
<td>- Need of separate device for hard copy output</td>
</tr>
<tr>
<td>- No noise</td>
<td>- Not permanent</td>
</tr>
<tr>
<td>- No waste of paper</td>
<td></td>
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Common types of VDUs include:

- Cathode Ray Tube (CRT)
- Liquid Crystal Display (LCD)
**Cathode Ray Tube (CRT)**

Cathode Ray Tube contains a vacuum glass tube. It uses the same technology as in TVs. The screen’s inside surface has a phosphorescent coating, which temporarily lights up when electrons hit it.

The electron gun at the back of the CRT generates electrons, which are directed to the screen as a beam. This beam light up one dot at a time. It moves from left to right across screen, drops down one pixel and moves across the screen again. It must pass quickly around the screen to refresh the illuminated dots before they disappear. The screen must refresh at least 60 times per second.

**Liquid Crystal Display (LCD)**

The LCD is a new technology which is thinner, lighter and consume less power. They are made up of two polarized plates of glass, with liquid crystals between them. The light passes through the first polarized glass and an electric field is emitted on the liquid crystals. This causes them to align accordingly to allow the needed level of light. They then pass through another glass and on to the screen.

**Color Depth**

The term color depth refers to the number of bits used to represent the color of a single pixel. This concept is also known as bits per pixel (bpp). The higher the colour depth, the broader the range of distinct colors which can be represented in one pixel. The formula used is:

\[ 2^{\text{number of bits}} = \text{number of different colors} \]
Demonstration:

- 1 bit colour depth ($2^1 = 2$ colors): Monochrome i.e. Black and white

- 2 bit colour depth ($2^2 = 4$ colors): Greyscale

- 4 bit colour depth ($2^4 = 16$ colors)

- 8 bit colour depth ($2^8 = 256$ colors)

- 24 bit colour depth ($2^{24} = \text{over 16 million colors}$)
3.7 LCD Projectors

LCD Projectors, project/show large images on a large screen area. This projection screen must be a white blank surface.

Typical Uses: They are often used to address an audience, for example a teacher addressing a class of students or a manager giving a presentation to colleagues.

How does a projector work?

White light is emitted from projector lamp, which is split into 3 colors: red, green and blue. This split takes place using two dichroic mirrors (which are special mirrors that only transmit light of a specific wavelength).

Each colour beam then passes through dedicated LCD panel (in all there are 3 LCD panels in the projector, each made up of thousands of pixels). The three colors are recombined in a prism and projected through the projector lenses and onto the screen.

Why red, green and blue?

- They are the three primary colours of light – RGB
- Various colours can be displayed through a combination of these 3

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>- Large screen size</td>
<td>- Image quality decreases as size of screen increases.</td>
</tr>
<tr>
<td>- Small in size – Portable</td>
<td>- The colour of images varies</td>
</tr>
<tr>
<td></td>
<td>- Not suitable for well-lit places</td>
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</tbody>
</table>
3.8 Special Purpose I/O

People with different impairments may face a series of obstacles throughout their lives which prevent them from doing even the simplest of things. Nowadays, the computer has become an indispensible tool in every person's life. With the help of special I/O devices, persons with impairment will also be able to make use it. The following are some special purpose I/O devices:

**Braille Printers**

Braille printers emboss Braille onto thick (heavyweight) paper. They work like a regular computer printer does, in that the user can print out letters, reports, and other files from the computer, however, the corresponding Braille representation of each character is embossed.

**Braille Keyboards**

Like Braille Printers, Braille Keyboards are useful for persons with a visual impairment. Each key on the keyboard will also have the Braille representation embossed.