2.2 Output devices

As the name suggests, output devices are hardware devices that allow data to be output from a computer. Some devices hold the data temporarily (such as a printer) whereas other devices produce permanent output in the form of a hard copy (such as a printer producing output on paper). There is a third type of output device which is used to control processes in conjunction with sensor input devices. These are covered separately in Section 1.3.

CRT monitors

CRT monitors are the least expensive type of monitor, although they are becoming increasingly rare as TFT monitors are now taking over. They come in various sizes. They use an electron gun to fire against a phosphor screen, which creates a picture that is made up of tiny dots. Each dot is coloured red, green or blue – the intensity of each coloured dot makes up the vast range of colours interpreted by the eye.

Uses

- CRT monitors are used as the primary output device for computers so the user can see immediately what they are typing in.
- They are used with light pens, for example to allow designs to be created on screen.

Advantages

- CRT monitors still produce a higher quality image than TFT monitors.
- The angle of viewing is still better than with a TFT monitor.
- They work with light pens in computer-aided design and computer-aided manufacturing (CAD/CAM) applications.

Disadvantages

- CRT monitors tend to be rather heavy and are a weight hazard if not supported properly.
- They run very hot and can cause fires if left unattended (especially as they get older).
- They consume considerably more power than the modern TFT monitors.
- They can flicker, which can lead to headaches and eyesight problems with prolonged use.

TFT monitors

TFT monitors are taking over from CRT monitors as the main output device. One of the reasons for the rapid development of laptop computers can be attributed to the advancements made in TFT technology. The screen is made up of thousands of tiny pixels, which are made up of transistors controlled by a microprocessor. Each pixel has three transistors, coloured red, green or blue; the intensity of each governs the effective colour of the pixel seen by the eye.

Uses

- TFT monitors are used as the primary output device for computers so the user can see immediately what they are typing in.
- They are an integral part of laptop computers.

Advantages

- TFT monitors are lightweight, so do not pose the same risks as CRT monitors.
- They produce less glare than CRT monitors and also emit less radiation.
- They consume much less power and do not generate as much heat as a CRT monitor.

Disadvantages

- The angle of viewing a TFT monitor is fairly critical, with the image appearing unclear when viewed slightly from the side. This can be an issue if several people are looking at a screen at the same time.
- The definition is sometimes not as good as CRT monitors.
- TFT monitors cannot yet be used with light pens, so these monitors cannot be used in CAD if light pens are used to create and edit drawings.

Laser printers

Laser printers produce very high-quality hard copy output. The print rate per page is very quick if a large number of pages are being printed. They rely on large buffer memories, where the data for the whole document is stored before the pages can be printed out.

Uses

- Laser printers are used where noise levels need to be kept low (e.g. in an office).
- They are the best option for fast high quality high volume printing.

Advantages

- Printing is fast for high volumes. If only a few pages are to be printed they are little faster than inkjet printers.
- They can handle very large print jobs.
- The quality is consistently high.
- Toner cartridges last for a long time, so laser printers can be a cost effective option, particularly if colour outputs are not required.

Disadvantages

- Laser printers are expensive to buy.
- They are only really fast if several copies are being made.
- Colour laser printers tend to be expensive to run, since four cartridges (three colours plus black) are needed as well as diffuser kits, etc.
- They produce ozone and volatile organic compounds because of their method of printing and type of toner/ink used. These have been linked to health hazards in the office.

Inkjet printers

Inkjet printers are used to produce good quality hard copies. Although the quality is not quite as good as that from laser printers, it is far better than that from dot matrix printers. Unlike laser printers, inkjet printers do not have large buffers, so printing is done a bit at a time. This is why printing is sometimes paused, since the whole page can't be stored in the buffer and it has to wait for the computer to send more data.

Uses

- Inkjet printers are used where low output volumes are required.
- If high-quality printing is required for single pages (or only a small print job) then these printers are ideal, for example they are very good at producing photo quality printouts.
- 3D inkjet printers are now being used in industry to produce prototypes (see below).

Advantages

- The output is of high quality.
- Inkjet printers are cheaper to buy than laser printers.
- They are very lightweight and have a small footprint (i.e. take up little space).
- They do not produce ozone and volatile organic compounds, unlike laser printers.

Disadvantages

- The output is slow if several copies needed, as there is little buffer capacity to store the pages.
- The ink cartridges run out too quickly to be used for large print jobs.
- Printing can 'smudge' if the user is not careful.
- Inkjet printers can be expensive to run if they are used a lot, since original ink cartridges are expensive.

3D inkjet printers

These are a new type of printer that produce solid 3D models using modified inkjet technology. In this technology, known as 'tomography', thin layers of fine powder (plaster, resin and starch) are bonded together as a 3D model is slowly built up (each layer is only about 0.25 mm thick). Figure 2.7 shows some items produced on a **3D inkjet printer** – these are known as prototypes.

Figure 2.7 A prototype produced on a 3D inkjet printer

Uses

- Inkjet printers are used to produce prototypes which actually work from CAD packages, photograph images, stored drawings, etc.
- Scale models are produced in colour before the real thing is manufactured.
- The ultimate objective is to produce organic objects (such as replacement human organs) using this layering technology.

Advantages

- 3D inkjet printers save a lot of money, since making prototypes by other methods is very time consuming and expensive.
- Physical scale models are produced with working parts, which gives a better idea of how the end product will look.
- The powders used can often be ground up and re-used.

Disadvantages

- 3D inkjet printers are expensive to buy.
- They are slow at producing their output.
- The end product can sometimes be a little rough and often needs further work to be done on it.

Dot matrix printers

Dot matrix printers are a type of impact printer, where a printhead (made up of a matrix of pins) presses against an inked ribbon. They tend to be slow, noisy and the output is not good quality. They are still useful, however, where multi-part or continuous stationery (e.g. long reams of perforated paper) is being used.

Uses

- They can be used in noisy environments (e.g. garage workshops) and in applications where print quality is not very important.

Advantages

- Dot matrix printers can be used in environments which would be a problem for laser or inkjet printers (e.g. dusty, dirty or moist atmospheres).
- Carbon copies or multi-part outputs can be produced.
- They are very cheap to run and maintain.
- They are easy to use if continuous stationery is required (e.g. long print jobs such as wages slips).

Disadvantages

- They are very noisy and so not good in an office environment.
- They cost more than an inkjet printer to buy.
- They are very slow and the printing is of poor quality.

Plotters

Plotters (also known as graph plotters) are devices that produce hard copies, but operate in a different way to printers. They are not limited to normal printer paper size and are capable of producing highly accurate, very large drawings and posters. The most common types are pen plotters (which use coloured pens to draw), electrostatic (similar method to laser printers) and inkjet plotters. With pen plotters the coloured pens are controlled by a computer and the paper can move backwards and forwards to allow accurate shapes to be drawn.

Uses

- Plotters are used to produce large drawings (e.g. blueprints of buildings, factories, etc.) and are often used with CAD applications.
- They are used to produce large pictures for use on billboards or giant posters. They can also print on plastic-coated paper.
- If the pens are replaced with cutting tools, it is also possible to make large signs.

Advantages

- They can produce huge printouts.
- The print quality is extremely high.

Disadvantages

- They are slow in operation.
- They are expensive, both to buy and to maintain.

Speakers

Speakers can be connected directly to a computer or are built into the monitor or casing (as in a laptop computer). Digital data from the computer is converted into analogue form, using a digital to analogue converter (DAC). The signal is then amplified through the speakers.

Uses

- Speakers are used to output sound from multimedia presentations.
- They are used in home entertainment centres.
- They can help blind people (together with speech generation software) through audio output of text on the screen.
- They are used to play downloaded sound files.

Multimedia projectors

Multimedia projectors receive signals that can be either analogue or digital, although most modern projectors only work with digital inputs. The signal source is usually from a computer, television or DVD player. The image from the source is magnified and projected onto a large screen. The devices usually work with a remote control, but can also use virtual mouse technology which actually becomes a cordless PC mouse with the same features as a mouse. It is then possible to direct the computer presentation without being tied to the computer. Another feature of the virtual mouse is the laser pointer. Most multimedia projectors take input from various types of video format such as NTSC, PAL or SECAM.

Uses

- Multimedia projectors are used for training presentations (to allow the whole audience to see the images from a computer).
- They are also used for advertising presentations (large images showing product features of, for example, a new car, can be shown at exhibitions, shopping malls, etc.).
- Home cinema systems (projecting the images from a DVD or television) use multimedia projectors.

Advantages

- They enable many people to see a presentation rather than all of them crowding round a small computer screen.
- They avoid the need for several networked computers. For example, when looking at a video clip on an internet site, everybody can see the video on the large screen rather than logging on to a number of computers.

Disadvantages

- Images can sometimes be fuzzy.
- Multimedia projectors are expensive to buy.
- Setting up projectors can be a little difficult.

2.3 Control devices

Control devices are another type of output device. They are used to control processes in conjunction with sensor input devices. This section gives an overview of actuators and the devices that they operate, but the use of sensors and actuators are covered in more depth in Section 7.7.

Actuators

Actuators are **transducers** and are used to take signals from a computer and convert them into some form of motion, for example operating motors, pumps, switches and valves. As part of the control process, digital signals are sent from the computer to an actuator to operate a device. Usually, conversion of the digital signal to analogue is required first (using a DAC).

Motors

The motor is turned on or off by the actuator.

Uses

- Motors are used in many domestic appliances, such as automatic washing machines (to make the drum rotate), cookers (to switch on fans), water pumps in central heating systems and automatic greenhouses to open windows and switch on fans.
- In industry, they are used to control robot arms.
- In computers, they operate fans, disk drives and DVD drives.

Buzzers

The buzzers are switched on or off by the actuator.

Uses

- Buzzers are used in cookers and microwave ovens to tell the operator when the cooking process is complete.
- They are used in burglar alarm systems to warn if intruders are present.

Lights

The actuator is connected to the switch that turns the lights on or off.

Uses

- They are used for security lights.
- Lights are used in greenhouses to control the lighting conditions.

Heaters

Actuators are connected to switches which turn the heater on or off.

Uses

- Heaters are used in automatic washing machines, cookers and central heating systems.
- Heaters are used in automatic greenhouses to control the temperature.