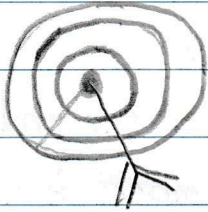


Chapter Two $\Rightarrow$ Input & Output Devices

Objectives :-



* Input, Direct Data Entry and out-put- Devices

* Advantages, Disadvantages, uses and Characteristics for each device

[1] Input Devices $\Rightarrow$ any hardware device that allows a user to enter data or instructions into a computer

- can send data to another device but cannot receive data
- receive commands from its users and data to process
- can be complicated because they have to ensure that the user can interact with the computer correctly.

* **Keyboards:-** most common input device method used for data entry. There are different types of keyboards such as: Wired, Wireless, virtual & Ergonomic keyboard.

$\downarrow$
gives more support to the wrists & hands, helps to overcome RSI

Uses	Advantages	Disadvantages
• Input data into applications software. • Typing in commands to the computer.	• Fast entry of new text • Well-known method • Easy to use • Easier to do verification checks as data is entered	• Can be difficult to use if the user has problems • Slow method when compared to DDE • Uses up valuable desk space.

* Numeric Keypads : used to enter numbers only.

Uses	Advantages	Disadvantages
• Automatic Teller Machines (ATMs) • Mobile Phones • Point of Sale Terminals (POS) • Chip & PIN Devices • Fast entry of numeric data	• Faster than keyboards • They are very easy to carry out because many are small devices	• Sometimes they have small keys • Sometimes the order of the numbers is not intuitive.

* Pointing Devices :-

→ Mouse :- Controls the position of a pointer on the screen. There are usually two buttons (Left button used to select items by double clicking Right button brings up drop-down menus)

Uses	Advantages	Disadvantages
• Open / close & minimize • Group / Move & delete • Image Editing • Controlling the position of a pointer on the screen	• Faster method for choosing an option • Very quick way of navigating • Doesn't need a large desk area.	• Can be more difficult for people with problems • Easy to damage • Difficult to use if no flat surface available

→ **Touchpad**: used as a pointing device in many laptops. They also have buttons under the touchpad (**Left & Right buttons**)

Note ⇒ It has the same uses of a mouse

Advantages	Disadvantages
• Faster than a keyboard for choosing options, used to navigate applications & the internet. • There is no need for a separate mouse because it is integrated into the laptop.	• People with limited movement find it difficult to use • More difficult to control the pointer • More difficult to use when doing certain operations such as drag & drop

→ **Trackerball**: similar to a mouse, except that a ball is on the top or the side of the device to control the pointer by rotating it-

Uses	Advantages	Disadvantages
• Can be good alternative for people with conditions • Used in an industrial control room where it is faster than a mouse • Used in some luxury cars to select functions	• Doesn't need the same fine control as a mouse • Easier to use than a mouse • More accurate positioning of the pointer on screen • More robust • Needs less desk space	• More costly as it's not supplied with the computer as standard • User may need training

* Remote Control:- used for the operation of other devices using infrared signals

Uses	Advantages	Disadvantages
• TVs, satellite systems, DVD/Blu-ray players and Hi-Fi systems • Used to control multi-media systems • Used in industrial applications to remotely control processes	• Can be operated from any reasonable distance	• Difficult to use if the operator has limited hand/wrist movement • It is easier to block the signal if the walls in the building are thick

* Joysticks & Driving Wheels:-

→ Joysticks:- have similar functions to a mouse. By gripping the stick a pointer can be controlled. Buttons are used to make selections. Often they have a button on the top used for gaming purposes.

Uses	Advantages	Disadvantages
• Used in video/computer games • Used in simulators	• Easier than a keyboard to navigate • Control is more realistic	• More difficult to control the on-screen pointer

→ Driving Wheel:- similar to a joystick. The wheel allows you to simulate the turning of a steering wheel & there are associated devices which allow you to accelerate & brake. Sensors are used to pickup left/right movement.

Note ⇒ It has the same uses as Joystick

Advantages	Disadvantages
• Easier than a keyboard or Joystick to control steering movements • The experience is nearer to how an actual steering wheel operates	• It can be more expensive • Movements can be too sensitive • Unless it is an expensive simulator, feedback is non-existent

* **Touch Screens** : - user can choose an option by simply touching a button/icon on the screen

Uses	Advantages	Disadvantages
• Self-service tills • ATMs • Point of Sale terminals • Mobile phones • Public info systems • Interactive white boards	• Faster entry of options • very easy method for choosing options • User-friendly method • Option to expand the size of the display	• limited number of input options • Can lead to problems - RSI • Screen can get very dirty

* **Scanners** : - used to enter information from hard copy into a computer.

Uses	Advantages	Disadvantages
• Scan & convert documents • Scan in old / valuable documents / books • Scan in photographs • Scan in barcodes	• Images can be stored for later editing • Much faster & more accurate when using with OCR • Possible to recover damaged documents & photos	• Quality can be limited depending on the scanner resolution • They can be slow

* Digital Cameras: Images are stored on a memory card & can be transferred to a computer by USB, bluetooth, Wi-Fi

Uses	Advantages	Disadvantages
• Taking photographs • Used as a data-capture device • Dentists use them to take photos of teeth • The creation of virtual reality tours	• Easier to produce better quality photos • Easier & faster to upload photos to a computer • No need to develop film & print out-photos • Can store thousands of photos	• Need to be computer literate to use it properly. • Images often need to be compressed • There is some artistry lost because clever software now corrects errors

* Microphones: are either built into the computer or are external devices connected through USB or Bluetooth.

Uses	Advantages	Disadvantages
• Input sounds to be used in various applications • Input in voice recognition software • Can be used as a sensor to pick up sound • Used in video-conferencing or VoIP applications	• Faster to read in text than to type it in • Possible to manipulate sound in real time • It has the advantage of improving safety if used in a voice activation system	• Sound files can use up a lot of memory • Voice recognition software is not as accurate as typing in manually

* **Sensors**:- device that inputs data to a computer. Data is a measurement of some physical quantity that is continuously changing.

The information from the sensors needs to be converted as they are analogue in nature & computers only understand digital data.

Uses of sensors $\Rightarrow$

Type of Sensor	Applications
Temperature	Automatic Washing machine, central heating, automatic glasshouses, ovens
Pressure	Intruder alarm systems, washing machines, robotics, environmental monitoring
Light-	Automatic glasshouses, automatic doors, intruder alarm systems, Street lighting control
Sound / Acoustic	Intruder alarm systems, monitoring liquid & powder flow in pipes
Humidity / Moisture	Automatic glasshouses, environmental monitoring, in factories where moisture levels are crucial.
pH	Automatic glasshouses, chemical processes, environmental monitoring

Advantages of using sensors $\Rightarrow$

- More accurate readings taken
- Readings are continuous - no breaks.
- Any necessary action or warning will be initiated immediately
- Systems can be automatic, removing the need for human intervention

Disadvantages of using sensors $\Rightarrow$

- Faulty sensors can give spurious results
- Most sensors are analogue so they require a converter

* **Light Pens:** This device only works with CRT monitors. Contain sensors that send signals to a computer whenever light changes are detected.

Uses	Advantages	Disadvantages
• Selecting objects on CRT screens	• Greater accuracy than touch screen	• Problems with lag
• Drawing on screen	• Small	• Only works with CRT monitors
	• Easy-to-use	• Not that accurate when drawing
		• Rather dated technology

Input Devices

Keyboard



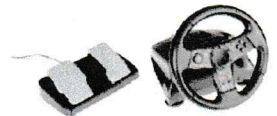
Joystick



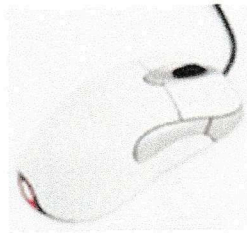
Numeric keypad



Driving Wheel



Mouse



Touch Screen



Touchpad



Scanner



Trackball



Digital Camera



Remote Control



Microphone

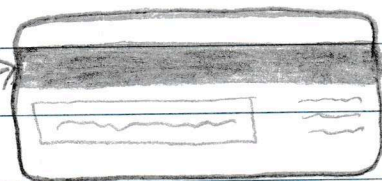


[2] Direct Data Entry (DDE) Devices $\Rightarrow$ devices used to input data into a computer without the need for very much human interaction.

* Card Readers:-

• **Magnetic Stripe Readers** $\Rightarrow$ used to read information on the magnetic stripe found on the back of a credit or debit card. The stripe contains useful information such as account No, sort code, expiry date & start date.

Magnetic Stripe $\rightarrow$



Uses:-

- $\rightarrow$ On credit / debit cards for use at ATMs or EFTPOS
- $\rightarrow$ Security devices to allow entry to buildings, hotel rooms...

Advantages:-

- | | |
|---|---|
| $\rightarrow$ Fast data entry | $\rightarrow$ Error-free (no typing) |
| $\rightarrow$ Secure | $\rightarrow$ Prevents access to restricted areas |
| $\rightarrow$ Not affected by oil, water... | $\rightarrow$ Very robust (no moving parts) |

Disadvantages:-

- $\rightarrow$ If the magnetic stripe gets damaged, the data is lost.
- $\rightarrow$ Does not work at a distance
- $\rightarrow$ Because the info is not human readable, this can be a disadvantage

• **Contactless debit card readers** $\Rightarrow$ allow customers to pay for items worth up to a certain amount of money without entering their PIN, have a small chip that emits radio waves embedded in them.

The steps taken are:-

- Customers look out for the contactless symbol
- The shop assistant enters the amount for payment
- The card reader informs the customer to present their card
- The customer holds their card close to the front of the card reader
- The terminal display will indicate that the card has been read.

Advantages:-

- Faster transaction
- The system uses 128-bit encryption systems to protect the data
- Customers don't have to worry about typing errors
- Retailers no longer have access to the customer's card info
- The chip on the card responds to the payment terminal reader with a unique number used for that transaction only, this number is encrypted.

Disadvantages:-

- More expensive than normal credit/debit cards
- A thief with a suitable reader could monitor your transaction
- Can take the money twice if the customer uses it as a chip & PIN
- Transactions are usually limited to a small maximum value.

• **Chip & PIN readers** ⇒ similar to smart-card readers but are used at EFTPOS terminals. The PIN is entered using the keypad. They are similar to the contactless system except for two points:-

- * The customer has to key in their PIN to make a transaction
- * These cards don't make use of Radio Frequency technology.

Chip & PIN readers are used where payments are made using cards such as supermarkets, restaurants...

Advantages:-

- More secure system than contactless payments
- More robust system than magnetic stripe cards

Disadvantages:-

- Fraud, need to be careful to ensure PINs are not read by somebody else while typing it in.

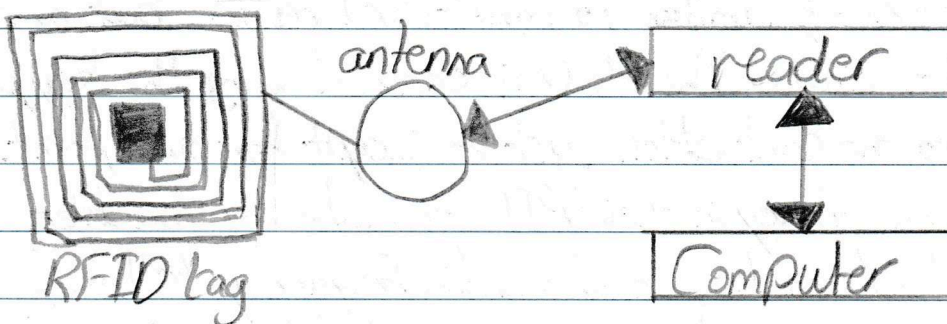
* Radio Frequency Identification (RFID) Readers:-

Readers use radio waves to read and capture information stored on a tag. In some applications, the tag can be read from a distance. The RFID tag is made up of two components:-

- Microchip that stores & processes information.
- Antenna which is used to receive & transmit data / Info

The tags can be Passive (use the reader's radio wave energy to relay back the info) or battery-powered (use a small embedded battery to power the RFID)

Uses of RFID ⇒ livestock tracking, Retail, Admission Passes & libraries.



Advantages:-

- The tags can be read from a distance.
- Very robust & reliable technology
- Very fast read-rate
- Bidirectional data transfer
- Bulk detection is possible

Disadvantages:-

- Tag collision (when the signals from two or more tags overlap)
- Easy to jam or interrupt as it uses radio waves
- Easy to hack the data/signal
- More expensive than a barcode system

* **OPTical Mark Recognition / Reader (OMR)** ⇒ device which can read marks written in pen or pencil on a form. It is used to read questionnaires, multiple-choice examination papers, voting papers

Advantages:-

- Very fast way of inputting the results of a survey
- They are more accurate because there is no typing
- They are more accurate than OCR methods.

Disadvantages:-

- The forms need to be carefully designed to make sure the shading is correctly positioned.
- There can be problems if they have not been filled in correctly

* Optical Character Recognition / Reader (OCR) $\Rightarrow$ device that converts the text on hard copy documents into an electronic form that can be used in various application packages.

Uses $\Rightarrow$ processing of passports & identity cards, converting hard documents into electronic form which can be stored on a computer, automatic number plate recognition systems in car parks, digitizing historic newspapers & rare books.

Advantages:-

- Much faster data entry system
- Number of data entry errors reduced

Disadvantages:-

- The system will have difficulty reading some handwriting
- Not very accurate technique

* Comparison of OCR and OMR * Important

OCR	OMR
• Possible for customers to extend their answers to questions • Can read handwriting but it has to be clear & neat. • Used for converting printed documents to an editable electronic format • Requires a complex recognition system • Fewer 'how to fill in' instructions • There are still problems recognizing all types of handwriting (inaccuracy)	• Information obtained is limited to the choices offered in each question • Detecting where marks have been made on a page • It is ideal for multiple-choice exam papers • This method requires complex and expensive forms to be completed • Requires more 'how to fill in' instructions easier & faster to complete. • More accurate method for reading data

* **Barcode Readers** $\Rightarrow$ used to read information in the form of a bar code either using built-in readers or handheld scanners

Uses	Advantages	Disadvantages
• Supermarkets & shops • Libraries • Used as a safety function to ensure that electrical equipment is checked on a regular basis	• Faster than keying in data • Can help improve safety • Allow automatic stock control • Tried & trusted technology	• Relatively expensive • Barcodes can be swapped around on items • Can be more easily damaged than RFID tags or magnetic stripes

* **Quick Response (QR) code readers** $\Rightarrow$ QR code consists of a block of small square (light & dark) known as pixels, can hold more information than barcodes (up to 4296 characters).

The three large squares at the corners function as a form of alignment and the remaining small corner square to ensure the correct size & correct angle of the camera shot.

Uses	Advantages	Disadvantages
• Advertising to contain data such as address, phone • Contain links to apps • Wi-Fi authentication - can be used to store Wi-Fi • Can be used to deliver augmented reality • Used to establish virtual online stores	• Hold more info than barcodes • Fewer errors - built-in error-checking systems • Easier to read using cameras & smartphones • Easy to transmit QR codes either as text messages/images • Possible to encrypt QR codes - greater protection	• More than one QR format is available • Because there are a large number of free apps to generate QR codes, malicious codes can be transmitted "attagging"

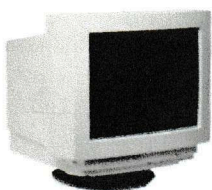
[3] Output Devices $\Rightarrow$ any hardware device that takes the output data from a computer & puts it into a human-readable format or uses it to control another device.

- capable of receiving data from another device to generate an output but cannot send data to another device
- needed by a computer to share the results with a human
- less complex than input devices because they only have to turn computer signals into an output

*** Monitors:** There are two types of monitors, **CRT monitor** - Cathode ray tube - **TFT screens** - Thin Film Technology -

$\rightarrow$ **CRT monitors:** the least expensive type of monitor, they come in various sizes, make use of an electron gun firing against a phosphor screen. The picture is made up of tiny dots which are colored red, green or blue, the intensity of each colored dot makes up the vast range of colors interpreted by the eye.

Uses	Advantages	Disadvantages
• Only used in specialist areas such as CAD • They are used with light-pens	• Screen can be clearly seen at a wider range of viewing angles • Allow the use of light-pens	• Heavy, have a very large footprint on a desk • They run very hot and can cause fires • They consume more power than LCD monitors • They can flicker which lead to headaches & eye problems.



→ **LCD screens**:- made up of tiny liquid crystals. These crystals make up an array of pixels which are affected by changes in applied electric fields

→ **LED screens**:- made up of tiny light-emitting diodes (LEDs). Each LED is either red, green or blue in color. By varying the electric current sent to each LED, its brightness can be controlled, producing range of colors

Note ⇒ Many monitors and TV screens are advertised as LED when in fact- they are LCD screens which are backlit using LEDs.

Uses	Advantages	Disadvantages
• Used in most modern computers • Offer touch-screen input • Used in mobile phones, tablets, laptops --	• Low power consumption • Light-weight devices • Don't suffer from screen image burn-in • Very sharp image resolution • Screens can be made in large variation of sizes • Don't suffer from a flickering image • Produce low electromagnetic fields	• Color & contrast from various viewing angles can be inconsistent • Motion blur • Lower contrast than CRT • Can have weak or stuck pixels • LCD panel may not be uniformly illuminated by the back light.



* Touch Screen:- can work as both input & output device.

Uses	Advantages	Disadvantages
• Smartphones & Tablets	• Faster data entry	• Limited number of options available
• ATMs at banks	• Very easy method for choosing options	• They are not very accurate & the interface is not fast
• Ticket Collection machines	• User-Friendly method no need for training	• The screen can get very dirty
• Information kiosks	• Option to expand the size of the display	• Security risk

* Multimedia Projectors:- receive signals (digital or analogue) usually from a computer, TV or DVD and the image is magnified & projected onto a large screen.

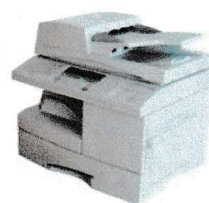
Uses	Advantages	Disadvantages
• Training presentations	• Enables many people to see a presentation	• Images can sometimes be fuzzy
• Advertising presentations	• Avoids the need for several networked computers	• Expensive to buy
• Home cinema systems		• Can be difficult to set them up.

* Printers : Very Important

→ Laser printers : produce very high-quality hard copy. The print rate per page is very quick (if a large number of pages are being printed). They rely on large buffer memories.

Uses ⇒

- They are used where low noise is required
- Fast, high-quality and high-volume printing.



Advantages ⇒

- Printing is fast where large number of copies are required
- They can handle very large print jobs
- The quality is high
- Toner cartridges last for a long time

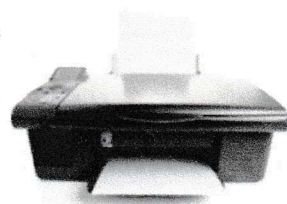
Disadvantages ⇒

- Only fast if several copies are being made
- Color laser printers tend to be expensive to run
- They produce ozone & volatile organic compounds

→ Inkjet printers : used to produce good-quality hard copies. Don't have large buffer memories so printing is done a bit at a time

Uses ⇒

- Used where low-output volumes are required
- Where high-quality printing is required for single pages
- 3D inkjet printers are now being used to produce prototypes



Advantages ⇒

- High-quality output
- Cheaper to buy than laser printers
- Very lightweight
- Don't produce ozone & volatile organic compounds

Disadvantages ⇒

- Slow output if several copies are needed
- Cannot do large print jobs
- Printing can smudge if the user is not careful
- Can be expensive if used a lot

→ **Dot Matrix printers** : impact printer where a print head presses against an inked ribbon. They tend to be slow, noisy and the output is not that good compared to inkjet & laser printers

Uses ⇒

- They can be used in noisy or dirty environments
- They are used in applications where multi-part stationery is of value
- Still widely used in till receipts

Advantages ⇒

- They can be used in dust/dirty or moist environments
- Carbon copies or multi-part outputs can be produced
- Very cheap to run & maintain
- Easy to use if continuous stationery is required



Disadvantages ⇒

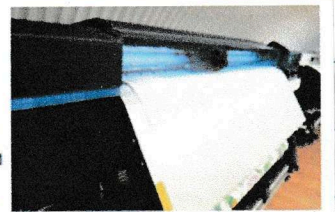
- Very noisy - not good in an office environment -
- Cost more than an inkjet printer to buy initially
- Very slow, poor-quality printing

* **Graph plotters**:- Instead of toner or ink cartridges, plotters use a pen, pencil or marker pen to draw multiple continuous lines rather than a series of dots like a printer.

The size of the paper can be anything from A4 up to several metres. They produce vector graphic drawings

Uses ⇒

- Producing architectural drawings
- Producing engineering drawings
- Drawing animation characters (cartoon)



Advantages ⇒

- Very high-quality output
- Able to produce large, monochrome & color drawings to a high accuracy
- Able to print on a variety of materials

Disadvantages ⇒

- Very slow at printing
- Expensive equipment to purchase initially, although running costs are low once purchased
- Have a very large physical footprint

* 3D printers :- primarily used in CAD applications. They are based on inkjet & laser printer technology & can produce solid objects. The solid object is built up layer by layer using materials such as powdered resin, powdered metal, paper or ceramic.

The Features of 3D printing ⇒

- They range from the size of a microwave up to the size of a small car
- 3D printers use additive manufacturing (object is built up layer by layer)
- Direct 3D printing uses inkjet technology, a print head can move left to right & up to down to build layers
- Binder 3D printing uses two passes for each of the layers, the first pass sprays dry powder then on the second pass a binder (a type of glue) is sprayed to form a solid layer.
- Newer technologies are using lasers & UV light to harden liquid polymers

Uses ⇒

- Prosthetic limbs can be made
- Making items to allow precision reconstructive surgery
- In aerospace, manufactures are looking at making wings & other aeroplane parts
- Fashion & Art
- Making parts for items no longer in production.

* How to create a solid object using 3D printers??

A design is made using Computer-aided design (CAD) software



The drawing is imported into some special software that prepares it in a 3D printer format



The 3D printer is set up to allow the solid object to be made



The solid object is built up layer by layer. This can take several hours depending on the thickness of the layer, the material & the final size



The object is removed from the printer & is then prepared. In many cases, the object has to be left to 'cure' for a few hours

Advantages ⇒

- The manufacturing of items has become much easier than before
- 3D printers can manufacture items relatively quickly, it allows rapid prototyping.
- The cost of 3D printing is still less when compared to labour costs
- Medical benefits are emerging
- Parts for machinery that are no longer made could be manufactured.

Disadvantages ⇒

- Make counterfeit items or items that infringe others' copyright
- Dangerous or illegal activities may appear because of using new technologies
- Potential for job losses

* Speakers:- output devices that produce sound. When connected to a computer system, digitized sound stored on a file needs to be converted into sound using digital to analogue converter.

Uses	Advantages	Disadvantages
• used in all phones & built-in in the most computers • Outputs sound from multimedia presentations • Helps visually impaired people • Plays downloaded files	• Sounds amplified through speakers can be much louder than the original. • Everyone can hear the output • Can create a good atmosphere • Can help visually impaired people • Very simple technology	• Speakers can be disturb to others • To get high-quality sound, the required speakers can be expensive • Can take up a lot of desk space

* Actuators:- is a mechanical or electromechanical device such as a relay, solenoid or motor

Uses	Advantages	Disadvantages
• Used to control motors, switches, buzzers ... • Allow a computer to control physical devices that require analogue inputs	• Allow remote operation of many devices • They are inexpensive	• They are an additional device in the system that could go wrong • Computer signals need to be converted as the actuators are usually analogue devices