ANDIJAN STATE PEDAGOGICAL INSTITUTE

Lecture materials · 2026–2027 academic year

SUBJECT

Information Systems and Digital Technologies

Lecture 6 · Input & Output Devices

Part 2 of 2 · 2 hours

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LECTURE 06 · 2 HOURS · PART 2/2

5

CHAPTER FIVE

Fundamentals of Computers

Output Devices

How a computer turns what it knows back into something a person can see or hear

- Display monitors
- Printers
- Plotters
- Voice · projectors · terminals

WARM-UP

The computer has worked something out. How does it tell you?

Name as many ways as you can in thirty seconds. Then sort them into two piles.

1

Which of your answers leave something behind when the power goes off?

2

Which of them disappear the moment the screen turns off?

3

Is there a device that could belong to both piles?

LEARNING OBJECTIVES

By the end of this lesson you will be able to…

1. **Define** what an output device is and explain the difference between hard copy and soft copy.
2. **List** the five categories of output device and place any named device into one of them.
3. **Compare** CRT, LCD and TFT monitors on technology, size, power and picture quality.
4. **Distinguish** impact from non-impact printers, naming the chapter's three impact and two non-impact printers.
5. **Describe** the four types of plotter and say how each one moves the pen and the paper.
6. **Explain** the two voice response systems, the three projector types and the three terminal types.
7. **Compare** today’s display types (LED-backlit LCD, OLED) and read a monitor’s key specifications.
8. **Explain** how LCD, DLP and laser projectors work and choose a projector for a room.

01

What an Output Device Is

The definition · the five categories · and the difference between hard copy and soft copy

- Definition
- Five categories
- Hard copy
- Soft copy

An output device presents information to the user

Output devices receive the processed data — the information — from the CPU and present it to the user in a desired form. They act as an interface between the computer and the user, converting machine-readable information into human-readable form.

That human-readable form may be text, graphics, audio or video — and the five categories of output device follow from it

1

Display monitors

CRT · LCD · TFT

2

Printers

Impact and non-impact

3

Plotters

Drum · flat-bed · ink-jet · electrostatic

4

Voice output systems

Human voice reproduction · speech synthesis

5

Projectors

Ultralight · conference room · fixed installation

THE KEY DISTINCTION

Hard copy and soft copy

PERMANENT

Hard copy

A physical form of output.

- **Printers**
- **Plotters**

The output on a hard copy can be preserved for a long time compared with the output displayed on a display monitor.

TEMPORARY

Soft copy

A temporary form of output. Unlike hard copy, it is not permanent.

- **Display monitors**
- **Voice output systems**
- **Projectors**

Display monitors are the most commonly used soft copy output devices.

Printers and plotters give hard copy. · Display monitors, voice output systems and projectors give soft copy.

CHECK FOR UNDERSTANDING

Hard or soft? · hands up

Hard copy or soft copy — and which category?

1

A printout of your homework.

Output 1

2

A film shown on a white screen at the front of the room.

Output 2

3

An architectural drawing plotted on a large sheet.

Output 3

4

The automated voice you hear when you call a helpline.

Output 4

Answers: 1 — hard copy, printer. 2 — soft copy, projector. 3 — hard copy, plotter. 4 — soft copy, voice output system.

02

Display Monitors

The most commonly used soft copy device — in three technologies

- CRT
- LCD
- TFT
- Head to head

FIG. 5.1

CRT monitor — an electron beam on a phosphor screen



Fig. 5.1 (a) A CRT monitor

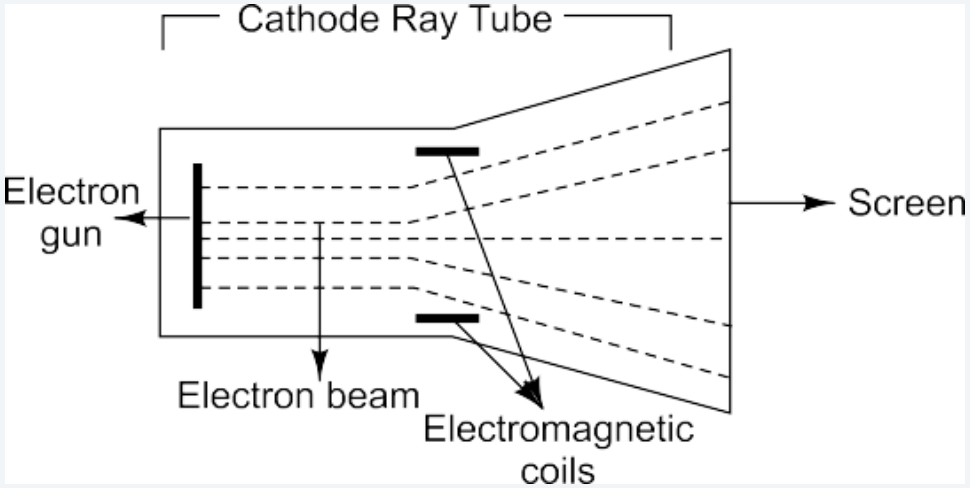


Fig. 5.1 (b) The internal components of a CRT

What is inside

An empty glass tube with a phosphor coated fluorescent screen and a source of electrons known as the electron gun. The tube containing the screen and the electron gun is the CRT.

Three components to name

- **Electron gun**
- **Phosphor coated screen**
- **Electromagnetic coils**

1. Current flowing through the CRT heats it, and the electron gun emits a beam of electrons.
2. The beam hits the screen, which is made of small dots known as pixels, and the phosphor coating emits light.
3. Electromagnetic coils in the glass tube deflect the beam so that it scans across the screen.
4. The scan produces an image, and the varying light intensity lets the human eye see it.

Why designers liked it — and why it disappeared

Many graphic designers preferred CRT monitors, and the chapter says why: the contrast ratio and the colour depth.

ADVANTAGES

- A high contrast ratio
- A high colour depth — which is why many graphic designers preferred them
- A change in resolution does not affect the clarity of the picture

DISADVANTAGES

- Very bulky, and occupies a lot of space on the desk
- Consumes a lot of power
- Produces a large amount of heat

Keep that third advantage in mind — it is exactly the thing the LCD monitor on the next slide cannot do.

FIG. 5.2

LCD monitor — light bent by liquid crystals



Fig. 5.2 An LCD monitor

An LCD monitor uses liquid crystals technology to display the images. The liquid crystals are the molecules of the liquid filled in the LCD.

THE MOLECULES	They flow easily in different directions and can bend a beam of light. They uphold their directions and stay in the same position relative to each other.
EACH PIXEL	Contains a number of liquid molecules layered between two transparent electrodes and crossed polarising filters.
HOW AN IMAGE FORMS	As light falls on the molecules they bend it towards a polarising filter, which absorbs the light — making the polariser appear dark for the display of images.
ADVANTAGES	Small in size and light in weight, so it occupies less space on the desk. Power consumption is very low, because liquid molecules need less power to bend light.

Three disadvantages: a fixed resolution, so images blur when the resolution is changed · reduced clarity when images move fast or change rapidly · weaker colour quality than a CRT monitor.

FIG. 5.3

TFT monitor — an LCD with a transistor per pixel



Fig. 5.3 A TFT monitor

A TFT monitor is similar to an LCD monitor, with one difference: it uses thin film transistor technology alongside liquid crystal technology to improve the quality of the image.

THE DIFFERENCE	An LCD monitor uses only the liquid crystal technology. A TFT monitor adds thin film transistors.
PER PIXEL	For each pixel on the screen a small transistor switch and a capacitor are used, and each pixel is controlled separately.
CHARGING	A row scan driver turns on the transistor switch to charge the capacitors of all the pixels in a particular row.
HOLDING	The transistor switches off as soon as the capacitors are charged. The capacitor then maintains the same voltage until the row scan driver switches the transistor on again.

The one sentence to remember: TFT = liquid crystal technology + thin film transistor technology, giving better image quality than an LCD.

HEAD TO HEAD

The three monitors compared

	CRT	LCD	TFT
Technology	Cathode ray tube: an electron gun, a phosphor coated screen and electromagnetic coils	Liquid crystals that bend light towards a polarising filter	Liquid crystal technology plus thin film transistor technology
Size and weight	Very bulky; occupies a lot of space on the desk	Small in size and light in weight; occupies less space	Similar to LCD *
Power	Consumes a lot of power and produces a large amount of heat	Very low — liquid molecules need less power to bend light	Similar to LCD *
Changing resolution	Clarity of the picture is not affected	Fixed resolution — images become blurred when it is changed	The chapter does not say
Picture quality	High contrast ratio and colour depth; preferred by many graphic designers	Weaker colour quality than CRT; clarity drops when images move fast	Better than LCD, because each pixel is controlled separately

* *The chapter says only that a TFT monitor is similar to an LCD monitor except for one difference — it adds thin film transistor technology to improve the image quality.*

MONITORS TODAY

Beyond CRT, LCD and TFT: displays you meet today

1 LED-backlit LCD

The usual “LED monitor”: an LCD (TFT) panel lit from behind by LEDs. Thin, bright, cheap.

2 OLED

Each pixel makes its own light — true black, very thin, even flexible. Phones and premium TVs.

3 QLED

An LED-lit LCD with a quantum-dot layer for brighter, richer colour.

4 Plasma

Tiny gas cells glowing like neon lamps. Big TVs in the 2000s; no longer made.

5 Touchscreen

A display with a touch layer: both output and input (phones, ATMs, kiosks).

6 E-ink

Reflects room light like paper and uses power only when the page changes. E-readers.

Most “LED monitors” are LCD/TFT panels with LED backlights — so the chapter’s LCD and TFT ideas still apply.

MONITORS TODAY

Reading a monitor’s specifications

1 Screen size

Measured diagonally in inches: 24″ is common for an office desk.

2 Resolution

Pixels across × down: Full HD 1920×1080, QHD 2560×1440, 4K 3840×2160.

3 Refresh rate

Pictures per second, in hertz: 60 Hz for office work, 144 Hz or more for games.

4 Response time

How fast a pixel changes colour, in ms. Lower means less blur in motion.

5 Panel type

IPS: best colour and viewing angles. VA: deep contrast. TN: fast and cheap.

6 Connections

HDMI, DisplayPort or USB-C connect the monitor to the computer.

Example: “27″ IPS, 2560×1440, 144 Hz, 1 ms, HDMI + DisplayPort” — you can now read every part of it.

CHECK FOR UNDERSTANDING

Which monitor? · call it out

Which display monitor is being described?

1

It contains an electron gun and electromagnetic coils.

Clue 1

2

Its images blur when you change the resolution.

Clue 2

3

It uses a transistor switch and a capacitor for every single pixel.

Clue 3

4

It is bulky, hot and power-hungry — but graphic designers liked it.

Clue 4

Answers: 1 — CRT. 2 — LCD. 3 — TFT. 4 — CRT. Follow-up: which two monitors share the liquid crystal technology? (LCD and TFT.)

03

Printers

Hard copy on paper — with or without a mechanical contact

- What a printer is
- Impact printers
- Non-impact printers
- Head to head

The most widely used output device

A printer is computer hardware that generates the hard copy of the information processed by a computer system. The hard copy can be a paper or any other physical printing medium — and it can be preserved for a long time compared with output shown on a display monitor.

How you get a hard copy

1 Connect

The printer is connected to a computer with the help of a cable.

2 Command

The user gives the print command through the user interface of the computer.

3 Hard copy

The printer generates the hard copy, which can be preserved for a long time.

Printers differ on four features

- **Colour**
- **Resolution**
- **Memory**
- **Speed**

Some printers are fast, others slow; some print in many colours, others in a single colour only.

On the basis of their working principles, printers fall into two major categories

- **Impact printers**
- **Non-impact printers**

THE SPLIT THAT ORGANISES EVERYTHING

Impact and non-impact printers

MECHANICAL CONTACT

Impact printers

There is a mechanical contact between the print head and the paper.

The print head resembles a hammer and transfers the ink to the paper in the form of the required characters. An impact printer contains an individual print head for each character: the print head strikes the ink ribbon, the ribbon strikes the paper, and an impression of that character is left behind.

- **Dot matrix**
- **Daisy wheel**
- **Drum**

NO MECHANICAL CONTACT

Non-impact printers

There is no mechanical contact between the print head and the paper.

These printers spray ink on the paper with the help of a nozzle. They do not produce much noise and are fast compared with impact printers — and the reason for the lower noise is the absence of mechanical moving parts.

- **Ink-jet**
- **Laser**

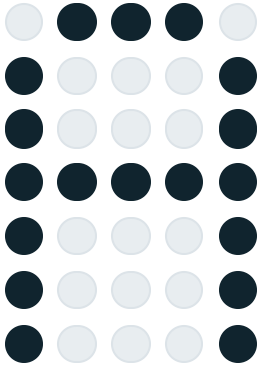
Three impact printers, two non-impact printers — learn which is which, because the chapter tests it repeatedly.

Dot matrix printer — characters made of dots



Fig. 5.5 A dot matrix printer

Fig. 5.4 Matrix characters



Each dot is made by a metal pin, brought forward by a small electromagnet. A small plate guides the pins to the ribbon.

A character is printed by the back and forth movement of a print head against a ribbon drenched in ink. The characters are formed out of a matrix containing dots.

Speed of printing	Capable of printing a complete line of characters at a time.
Durability	Very durable — it does not wear out quickly. But the circular channels on the guide plate get damaged by frequent striking, which makes printed characters hazy.
Carbon copies	Capable of producing carbon copies, and it takes continuous paper, so single sheets need not be fed again and again.
Cost	Cheap to use — the cost of printing per page is very low, and the ink ribbon stays preserved for future use even after long periods of disuse.

Still in the shops, still in the factories

ADVANTAGES

- Very durable — does not wear out quickly
- Produces carbon copies
- Takes continuous paper, so sheets need not be fed one at a time
- Cheap: very low cost per page, and the ink ribbon does not dry quickly

DISADVANTAGES

- Produces a lot of noise while printing
- Low printing speed and low printing quality
- Supports limited colours
- Needs a lot of maintenance — damaged pins cause improper text

Where they are still used

Best suited for fields where the content of the printed data is more important than the quality of printing. Although dot matrix printers are not commonly used at homes, they are still widely used in business and industry, because they are cheap and can produce carbon copies.

The noise is not a fault — it is the definition. A dot matrix printer is an impact printer, so something physically strikes the paper every time a character is formed.

Daisy wheel printer — a disk of petals



Fig. 5.6 A daisy wheel printer



Fig. 5.7 The disk of a daisy wheel printer

An impact printer that produces printouts of good quality characters. It contains a metal or plastic disk on which the characters reside on the outer edge of the petals.

How it prints one character

1. The disk rotates until the petal carrying the character to be printed faces the paper.
2. A hammer, acting as the print head, strikes the disk.
3. The disk hits the ink-soaked ribbon.
4. The ribbon leaves an impression of the character on the paper.

Its only advantage: printing characters in different fonts.

Disadvantages: they print text only and not graphics, they are very noisy and very slow, and they print approximately 10 to 75 characters per second.

Drum printer — characters engraved on a cylinder

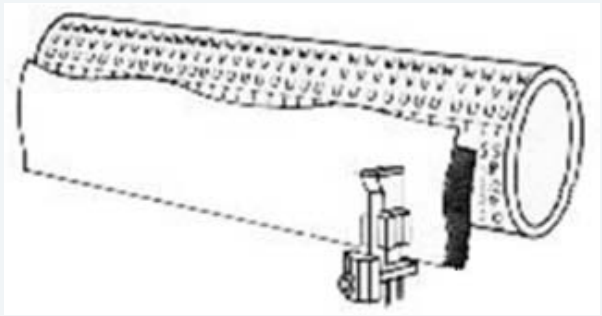


Fig. 5.8 The internal components of a drum printer

An impact printer in which the characters are engraved on a cylindrical drum, which is rotated around the print head hammer. The paper and the ink ribbon lie between the hammer and the drum.

HOW IT PRINTS	The hammer strikes the paper and forces it to hit the ribbon. The ribbon in turn hits the character on the drum, and the impression of the character is formed on the paper.
ADVANTAGES	Low cost, and higher speed than other impact printers.
ALSO	It requires no feeding of paper again and again.
DISADVANTAGES	Poor quality of printing, and large noise production.

Note the order of the strike: hammer → paper → ribbon → drum. In the daisy wheel printer the hammer strikes the disk first, and the disk then hits the ribbon.

CHECK FOR UNDERSTANDING

Which impact printer? · write it down

Which of the three impact printers is being described?

1

Characters sit on the outer edge of the petals of a disk.

Clue 1

2

Metal pins pushed by small electromagnets form a matrix of dots.

Clue 2

3

The characters are engraved on a cylinder that rotates around the hammer.

Clue 3

4

It prints about 10 to 75 characters per second and cannot print graphics.

Clue 4

Answers: 1 — the daisy wheel printer. 2 — the dot matrix printer. 3 — the drum printer. 4 — the daisy wheel printer. Follow-up: which of the three can produce carbon copies?

Ink-jet printer — droplets through a nozzle



Fig. 5.9 An ink-jet printer

A non-impact printer that produces an image by spraying small droplets of ink on the paper with the help of a nozzle.

SHAPING THE CHARACTER	A magnetised plate guides the sprayed ink to form the particular shape of a character or a symbol on the paper.
RESOLUTION	300 dots per inch, producing high quality printouts such as graphics and images.
ADVANTAGES	Cheaper and portable compared with the other non-impact printers.
DISADVANTAGES	Slow speed · it requires a special ink suitable for inexpensive papers · and the printouts take some time to dry.

Exam point: the chapter gives the ink-jet resolution as 300 dots per inch. Learn the figure.

Laser printer — a charged drum and dry toner



Fig. 5.10 A laser printer

Laser printers print both black and coloured text — but colour laser printers are very costly, so single colour ones are generally used.

A non-impact printer that produces images with the help of a laser beam. It works on the same technology as the one used in a copier machine.

1. The laser beam electrically charges the drum, which is coated with selenium.
2. The entire document to be printed is transferred to the drum.
3. The charged drum rolls into the dry powder ink known as toner.
4. The toner sticks to the charged images on the drum.
5. The toner is transferred to the paper with the help of heat and pressure.
6. The electrical charges and the remaining toner are automatically removed from the drum.

High speed · high resolution · high quality printing in various fonts · and no noise at all.

Three printers for publishers and print shops

Although most applications use ink-jet or laser printers, there are some high quality printers primarily used by publishers and print shops to create high quality colour images.

1

Photo printers

2

Thermal-wax printers

3

Dye-sublimation printers

The chapter says only one more thing about all three: these printers are very slow and expensive.

HEAD TO HEAD

The five printers compared

Printer	Kind	How it prints	Good	Not so good
Dot matrix	Impact	Metal pins pushed by electromagnets strike a ribbon to form a matrix of dots	Durable · carbon copies · continuous paper · very cheap per page	Noisy · low speed · low quality · limited colours · high maintenance
Daisy wheel	Impact	A hammer strikes a petal of a disk, which hits the ink-soaked ribbon	Good quality characters · different fonts	Text only, no graphics · very noisy · very slow, 10 to 75 characters per second
Drum	Impact	A hammer strikes the paper against the ribbon and the character engraved on a rotating drum	Low cost · higher speed than other impact printers · no repeated paper feeding	Poor printing quality · large noise production
Ink-jet	Non-impact	Small droplets of ink sprayed through a nozzle, guided by a magnetised plate	300 dpi · high quality graphics and images · cheaper and portable	Slow speed · needs special ink · printouts take time to dry
Laser	Non-impact	A laser charges a selenium drum, which picks up toner and transfers it by heat and pressure	High speed · high resolution · various fonts · no noise	Colour laser printers are very costly

CHECK FOR UNDERSTANDING

Impact or non-impact? · write I or N

Impact or non-impact — and can you name the printer?

1

It sprays droplets of ink through a nozzle at 300 dots per inch.

Printer 1

2

A hammer forces the paper against a ribbon and an engraved drum.

Printer 2

3

It charges a selenium drum and fuses toner onto the paper with heat.

Printer 3

4

Pins strike a ribbon to build each character out of dots.

Printer 4

Answers: 1 — non-impact, ink-jet. 2 — impact, drum. 3 — non-impact, laser. 4 — impact, dot matrix. Follow-up: why are non-impact printers quieter?

04

Plotters

High quality graphics drawn with pens — and the four ways of moving them

- What a plotter is
- Drum & flat-bed
- Ink-jet & electrostatic
- Head to head

PLOTTERS

Drawing with pens instead of printing with ink

A plotter is a device used to print high quality graphics and images. It uses one or more pens to produce a high quality drawing: the pens change their positions and draw continuous lines to produce an image.

Why plotters appeared

They were used as a substitute for coloured printers when printers were very expensive and could not draw bigger images such as graphs. Plotters provided cheap and efficient drawing — but they required a separate pen for each colour, which affected their speed.

One separate pen for every colour — so the plotter was slow

Then they moved to four colours

Later plotters used four basic colours only. These are the primary colours, which combine in different ratios to form other colours — so the pens no longer had to be changed frequently, and the speed of plotters increased.

Cyan | **Magenta** | **Yellow** | **Black**

Four categories, on the basis of how they work

- **Drum plotters**
- **Flat-bed plotters**
- **Ink-jet plotters**
- **Electrostatic plotters**

Drum and flat-bed — what moves?

Drum plotter



Fig. 5.11 A drum plotter

The pen
Moves vertically, along the Y axis — left or right

The paper
Wrapped on the drum, and moves horizontally, along the X axis — backward or forward

Together
The two movements produce a graph or an image

Flat-bed plotter

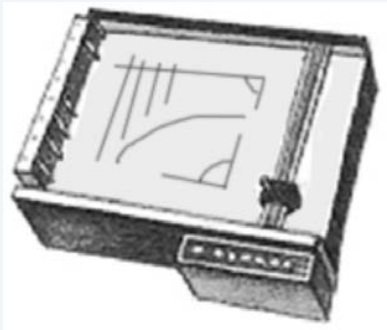


Fig. 5.12 A flat-bed plotter

The paper
Its position is kept constant

The pens
Are moved around in various directions, along both the X and the Y axis

The size limit
The size of the drawing depends on the size of the flat bed on which the paper is adjusted

Drum plotter: both the pen and the paper move. · Flat-bed plotter: only the pens move.

FIGS. 5.13 AND 5.14

Ink-jet and electrostatic plotters

Ink-jet plotter

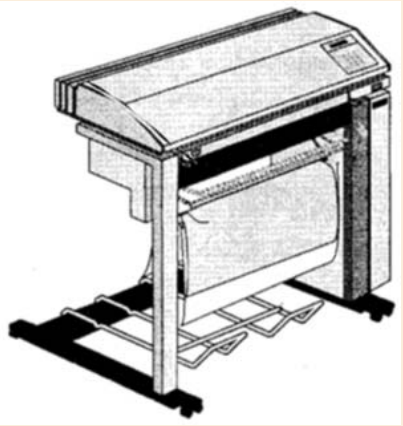


Fig. 5.13 An ink-jet plotter

A line or a solid colour output is drawn by spraying ink droplets on the paper.

High speed, and higher quality output than the other plotters.

The nozzles that spray the ink can get blocked soon, so they require more maintenance than the other plotters.

Electrostatic plotter



Fig. 5.14 An electrostatic plotter

Electrostatic charges are used to draw images and graphs, made of tiny dots on a special paper.

The fastest plotters, producing output of high quality and resolution.

One becomes vulnerable to the chemicals used in the plotters to produce the electrostatic charge.

HEAD TO HEAD

The four plotters compared

Plotter	How it works	Strength	Weakness
Drum	The pen moves along the Y axis; the paper, wrapped on the drum, moves along the X axis	Both movements combine to produce the graph or image	—
Flat-bed	The paper is kept constant and the pens move in various directions, along both X and Y axis	—	The size of the drawing depends on the size of the flat bed
Ink-jet	Sprays ink droplets on the paper to draw a line or a solid colour output	High speed, and higher quality output than the other plotters	The nozzles can get blocked soon, so more maintenance is needed
Electrostatic	Electrostatic charges draw images and graphs made of tiny dots on a special paper	The fastest plotters; high quality and resolution	One becomes vulnerable to the chemicals used to produce the charge

The dashes are deliberate: the chapter states no disadvantage for the drum plotter and no advantage for the flat-bed. Do not invent them in an answer.

CHECK FOR UNDERSTANDING

Which plotter? · call it out

Which of the four plotters is being described?

1

Both the pen and the paper move to produce the image.

Clue 1

2

The paper stays still and only the pens move.

Clue 2

3

It draws by spraying ink droplets, and its nozzles block easily.

Clue 3

4

It is the fastest, and it uses chemicals to produce a charge.

Clue 4

Answers: 1 — the drum plotter. 2 — the flat-bed plotter. 3 — the ink-jet plotter. 4 — the electrostatic plotter. Follow-up: name the four colours a modern plotter uses.

05

Voice, Projectors and Terminals

Output you hear, output projected on a wall — and the device that does both input and output

- Voice output systems
- Speech synthesis
- Three projector types
- Three terminal types

Two ways to make a computer speak

Also known as voice response systems. They record simple messages in human speech form and then combine all these simple messages to form a single message.

Reproduction of human voice

AND OTHER SOUNDS

The input	Sound is taken in analog form and converted into digital form.
Storage	The converted data is stored permanently on some storage device.
The output	The digital sound may be words, phrases or music. It is sent to the speakers, through which the output is made audible to the users.

Speech synthesis

TEXT TURNED INTO SPEECH

The input	Sound is taken in analog form and converted into speech form.
What it needs	A sound expansion card, a speech synthesiser, and special software to convert written text into speech.
How a word is built	The speech synthesiser combines approximately 50 to 60 basic sounds to produce a single word. Those words then combine to form a speech.

Quality depends on how closely the speech resembles a human voice, and on how easily a user can understand it. · The basic application is in Interactive Voice Response (IVR) systems, used by customer care departments — for example at telecommunication companies.

FIG. 5.15

Projectors — a bigger picture on a white screen



Fig. 5.15 A portable projector

A projector consists of an optic system, a light source, and displays which contain the original images.

A device connected to a computer or a video device, for projecting an image onto a big white screen. The projected images are larger than the original images.

Ultralight portable projectors

Small in size, and therefore referred to as portable projectors.

Conference room projectors

Used for projecting the output at large venues such as business meetings and huge gatherings. Not light weight, but better projection than the ultralight projectors.

Fixed installation projectors

The most expensive projectors. Fixed permanently at the place of presentation, and capable of projecting images in bright light as well.

Once used for showing films; now used on a large scale for presentations in business organisations and for viewing movies at home.

How projectors make the picture: LCD, DLP and laser

	LCD projector	DLP projector	Laser projector
How it works	Light passes through three small LCD panels (red, green, blue), then a prism joins them	A chip of millions of tiny tilting mirrors reflects light through a colour wheel	A laser replaces the lamp as the light source (with DLP or LCD inside)
Strengths	Bright, natural colours; usually cheaper	Sharp, high contrast, small and light	20 000+ hours, instant on/off, very bright
Weaknesses	Visible pixel grid; filters need cleaning	Some people see a “rainbow effect”	Highest price
Typical use	Classrooms and offices	Portable projectors, home cinema, cinemas	Fixed installations, halls, museums

Lamp projectors: the lamp lasts about 3 000–6 000 hours and is expensive to replace; LED and laser light lasts about 20 000 hours.

Choosing a projector for a room

1 Brightness (lumens)

About 3 000 for a classroom with lights on; 5 000+ for a large hall.

2 Native resolution

WXGA 1280×800 for slides; Full HD 1920×1080 for video and fine detail.

3 Contrast ratio

Difference between the brightest white and darkest black; higher is better.

4 Throw distance

Short-throw models make a big picture from 1 m — no shadows of the teacher.

5 Connections

HDMI for laptops, VGA for old PCs, Wi-Fi screen sharing for phones.

6 Light source and noise

Lamp: cheaper, but replace and cool down. Laser/LED: quiet, long life.

CHECK FOR UNDERSTANDING

Identify it · call it out

Which display or projector idea is this?

1

Every pixel makes its own light, so black is truly black.

Clue 1

2

“144 Hz” in a gaming monitor advert.

Clue 2

3

Millions of tiny mirrors tilt to make the picture.

Clue 3

4

The number that tells you if a projector is bright enough for a sunny room.

Clue 4

Answers: 1 — OLED. 2 — refresh rate (pictures per second). 3 — a DLP projector. 4 — brightness in lumens.

TERMINALS

The device that is both input and output

A terminal is a combination of an input device and an output device that helps a computer in receiving as well as transmitting data. A keyboard and a display monitor are the pair that forms a common terminal — and the monitor can be a CRT, an LCD or a TFT.

Terminals are classified on the basis of the data they handle

Intelligent terminal

ALL THE LOGIC

Possesses all the processing power — the logic required to perform operations such as calculations and formatting. It does not require any processor; it performs all the tasks by itself.

Smart terminal

SOME LOGIC

Contains some logic. It needs the help of a processor for complex operations such as performing calculations, but can do simple things on its own — such as making the displayed data appear bold.

Dumb terminal

NO LOGIC AT ALL

Does not contain any logic at all. It only displays the data received from the processor, and it has the slowest speed of the three.

CHECK FOR UNDERSTANDING

True or false · hands up

True or false? Decide before I reveal.

1

A terminal is only an output device.

Statement 1

2

A dumb terminal has the slowest speed of the three terminal types.

Statement 2

3

The speech synthesiser combines about 50 to 60 basic sounds to produce a single word.

Statement 3

4

Fixed installation projectors are the cheapest kind.

Statement 4

Answers: 1 — FALSE, a terminal combines an input device and an output device. 2 — TRUE. 3 — TRUE. 4 — FALSE, they are the most expensive.

REAL-WORLD CONNECTIONS

The chapter's device, and where you meet it today

Device from this chapter	What the chapter says	Where you meet it today
TFT monitor	Liquid crystal technology plus a transistor and capacitor for every pixel	*Nearly every laptop screen and computer monitor now sold*
Dot matrix printer	Noisy and low quality, but cheap and able to produce carbon copies	*Multi-part invoices, bank passbooks and bus tickets*
Laser printer	A laser charges a selenium drum, which picks up toner fused by heat	*The office printer down the corridor*
Ink-jet printer	Droplets sprayed through a nozzle at 300 dpi; the print takes time to dry	*Most home printers*
Plotter	Pens drawing continuous lines for large graphs and drawings	*Wide-format printing of architectural and engineering drawings*
Voice output system	Simple recorded messages combined into one message; used in IVR	*“Press one for account information” when you call a helpline*
Dumb terminal	No logic at all; only displays data received from the processor	*Airline check-in and warehouse screens driven by a central server*

OPTIONAL CLARIFICATION — NOT EXAMINABLE

Where the textbook and modern sources differ

For all tests and exercises, use the chapter as written. The notes below are background only, so that nobody is confused by another source.

CRT monitors

The chapter presents CRT as a current option preferred by many graphic designers. CRT monitors are no longer manufactured for general sale.

→ ***Answer as the chapter does.***

Ink-jet resolution

The chapter gives 300 dots per inch. Home ink-jet printers today are usually rated far higher.

→ ***Answer 300 dpi, as the chapter does.***

TFT and LCD

The chapter treats TFT as a separate category from LCD. Most sources today call a TFT screen a kind of LCD — which matches the chapter's own description of it.

→ ***Keep the chapter's three categories.***

Speakers

The key-terms list defines speakers as output devices, but the body of the chapter covers them only as part of the voice output system.

→ ***Voice output systems, in this chapter.***

A printing slip

The printers section says “all computers cannot produce multicoloured printouts” where the sense requires “all printers”.

→ ***Read it as printers.***

Terminals

The chapter places terminals in the output chapter although a terminal is both input and output. That is the chapter's choice, and its own definition says so plainly.

→ ***Define it as a combination of both.***

REVIEW

Eight questions before we finish

1. Name the five categories of output device.
2. Which devices give hard copy, and which give soft copy?
3. Name the three types of display monitor.
4. Name the three impact printers and the two non-impact printers.
5. What resolution does the chapter give for an ink-jet printer?
6. In which plotter do both the pen and the paper move?
7. Which projector type is the most expensive?
8. Name the three types of terminal, from most logic to none.

REVIEW

Answers

1 **Monitors, printers, plotters, voice output systems, projectors**
The five categories the chapter uses.

2 **Hard copy: printers and plotters**
Soft copy: display monitors, voice output systems and projectors.

3 **CRT, LCD and TFT**
CRT uses an electron beam; LCD and TFT use liquid crystals.

4 **Impact: dot matrix, daisy wheel, drum**
Non-impact: ink-jet and laser.

5 **300 dots per inch**
It produces high quality printouts such as graphics and images.

6 **The drum plotter**
The pen moves along Y; the paper on the drum moves along X.

7 **Fixed installation projectors**
Permanently fixed, and able to project in bright light.

8 **Intelligent, smart, dumb**
All the logic, some logic, no logic at all.

EXIT TICKET

Answer these three before you leave

Write your answers on a slip of paper with your name and hand it in at the door.

1

In one sentence each, define hard copy and soft copy, and give one device for each.

Tests objective 1

2

Name the three impact printers and say what they all have in common.

Tests objective 4

3

Give one difference between a drum plotter and a flat-bed plotter.

Tests objective 5

Next: five interactive activities — output device functions, how it works, printer specs, which device, and the final knowledge challenge.