Disk defragmentation.

Fragmentation. As data is stored on a newly formatted disk the data is written to unused contiguous sectors (ie, those sectors which follow one another). If data is erased then the deleted sectors may leave "holes" of free space among used sectors. Over time, after many inserts and deletes, these free sectors may be scattered across the disk so that there may be very little contiguous free space. This phenomenon is called "disk fragmentation". If a file, such as a document file say, is written to the disk the read-write heads will have to move about as they access the fragmented free space. This slows down the writing process and will also slow down any subsequent reads. Therefore, performance suffers. When this happens it may be possible to use a special disk defragmenter program to re-organise the data on the disk so as to eliminate the fragmentation.

Summary

a. Auxiliary storage is used, as its name suggests, to supplement main storage.
b. The descriptions have concentrated on the physical features rather than uses, which
C. will be discussed later in the text.
d. The main auxiliary storage media are in *magnetic* form.
i. Magnetic disk unit - magnetic disk.
ii. Magnetic diskette unit - magnetic diskette (floppy disk).
iii. Optical disk unit - optical disk. iv. Magnetic tape unit - magnetic tape.

The comparative performance of backing storage media and devices is shown

Devices and Media.	Typical Access Time.	Typical Storage Capacities.	Typical i transfer Rates.	Types of Storage SASt or DAS1.	Where used as primary medium.
1. Floppy disk (diskette)	260ms	180 K bytes to 1.25 M bytes	24,000 bps - 50,000 bps (bytes per second)	DAS	Small micro computer based systems - oth erwise as a back up medium for hard disk
2. Magnetic disk	20 - 60 ms	60 Mbytes - 5 Gbytes	312,000 bps - 2,000,000 bps	DAS	Minicomputers and
3. Optical disk	looms	55 Mbytes - 10 Gbytes	200,000 bps	DAS	Minicomputers and mainframes - for archiving or on-line back up
4. Magnetic tape (reel-to-reel)	A search is required.	40 Mbytes - 160 Mbytes	160,000 bps - 1.250.000 bps	SAS	Minicomputers and mainframes - mostly as a back-up medium
5. Magnetic tape cartridge	A search is required.	50 Mbytes - 10 Gbytes	160,000 bps - 2.6 Mbps	i	Microcompute and minicomputers.
6. Magnetic tape cassette	A search is required.	Up to 145,000 bytes.	10 bps - 33,000 bps	SAS	Small micro computer systems.

Fig. 7.13. **Comparative performance of backing storage media and devices.**

 Points to note
a. Note the terms "on-line" and "off-line". "On-line" means being accessible to and under the control of the processor. Conversely, "off-line" means *not* accessible to or under the control of the processor. Thus, *fixed* magnetic disks *are permanently* "on-line"; a magnetic tape reel or an exchangeable magnetic disk pack is "on-line" when placed in its respective units, but "off-line" when stored away from the computer, terminals, *wherever* their physical location, are said to be "on-line" when directly linked to the processor.
b. On exchangeable disks, the read-write heads serving each *surface will* be positioned over the *same relative track* on *each surface* because the arms on which they are fixed move simultaneously.
c. The "jukebox" was introduced in this segment as an option used with CDs but jukeboxes are available for a variety of disk devices.
d. The term *"cartridge" is* ambiguous unless prefixed by *"tape"* or *"disk".*
e. The devices and media have been separated for ease of explanation. It should be noted, however, that in the case of the *fixed* disk the media are permanently fixed to the device, and therefore they cannot be separated. f.
Backing storage is also called **auxiliary storage.**
g. Input, output and storage devices are referred to collectively as peripheral devices.

All these devices are "keyboard devices", which merely means that their primary means of entering data to the computer is via a keyboard. The keyboards resemble the QWERTY typewriter keyboard, but usually have several additional keys, which are used for other purposes depending upon the type of device.

Terminals

By far the most common form of **terminal** is the VDU which was introduced in 4.36. Terminals have a keyboard for input and a display screen or printer to show both what is typed in and what is output by the computer. Terminals which have a printer instead of a screen are called "terminal typewriters". They are now rather outdated and rare, so the name "terminal" is now normally synonymous with VDU and is often used instead. There are many different types of VDU terminals in use today. Only the more common features and variants will be described.

Features of **the** VDU **Terminal.**

a. It is a dual-purpose device with a keyboard for data input and a cathode ray tube screen for output. The latter is similar to a TV screen. The screen is normally housed along with the device's electronic components in a cabinet similar to that used for a PC's monitor.

b. The keyboard resembles the QWERTY typewriter keyboard, but usually has several

 additional keys, which are used to control and edit the display.

c. Characters are displayed on the screen in a manner that resembles printed text. A typical full screen display is 24 rows by 80 columns (ie, 1920 characters).

d. The display can normally be generated in two different modes:

 i. Scrolling mode in which lines appear at the bottom and move up the screen rather like credits on a movie screen.

 ii. Paging mode in which one complete screen-full is replaced by another, rather like a slide projector display.

e. Most VDUs have features that allow particular parts of the display to be highlighted or contrasted, eg,
 i. Inverse (Reverse) video, ie, black on white instead of white on black. ii. Blinking displays.
 iii. Two levels of brightness.
 iv. Colour - on the more expensive models.

f. **Cursor** controls. A cursor is a small character-size symbol displayed on the screen, which can be moved about the screen both vertically and horizontally by means of special keys on the keyboard. During data input, the display may resemble a blank form. In this case data may be entered by first moving the cursor to a space on the "form" and then typing in the data. Further keys may allow the data to be edited or corrected.

g. Inbuilt microprocessors. The numerous internal functions of almost all modern VDUs are controlled by inbuilt microprocessors. The more expensive models are often called intelligent terminals.

How it works. When a key is pressed on the keyboard the character's code (in ASCII, say) is generated and transmitted to the computer along the lead connecting the terminal to the computer. Normally the character code received by the computer is immediately "echoed" back out to the terminal by the computer. When a character code is received by the terminal

it is interpreted by the control circuitry and the appropriate character symbol is displayed on the screen, or printed depending upon the type of terminal. In what follows the basic operation of a VDU is covered in more detail.

For the more basic VDU models the character codes are stored in a memory array inside the VDU with each location in memory corresponding to one of the 24 x 80 character positions on the screen (Fig 8.1). The VDU is able to interpret control characters affecting the text format. Each character in the character set has its display symbol defined in terms of a grid of bits. These predetermined patterns are normally held in a special symbol table in ROM. Common grid sizes are 8 x 14 and 9 x 16. The character array is scanned by circuitry in the VDU and the character map generator

refers to the ROM to produce the appropriate bit-map image for each character to he displayed on the screen. Often the device is able also to interpret sequences of control characters (often beginning with the ASCII control character) which may alter display - characteristics such as reverse video or colour. This kind of VDU is only able to form images on the screen by constructing them from character symbols by means of the character map generator. It is therefore called a character terminal. The superior alternative is a graphics **terminal** which has high quality displays that can be used for line drawings, draughtsmen's drawings, etc. In a Raster Scan Display, which is just one of many types of display technology, the character codes received from the computer are interpreted by the terminal's map generator which then loads the appropriate hit pattern into special memory (video RAM) acting as a bit-map for the whole screen

C
R
E
DISPLA
Y
ROM
CHARACTER
SYMBOL

t   CHARACTER
SCREEN

CHARACTER
KEYBOA CODE
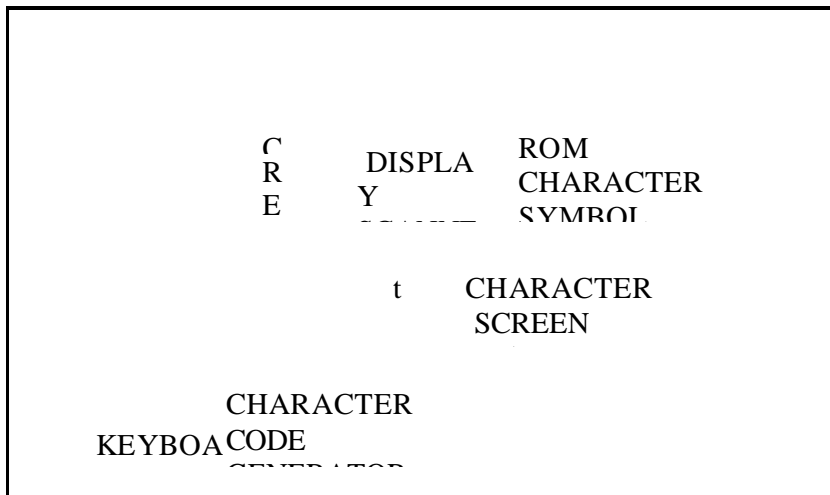
Workstations

A typical workstation looks similar to a PC because it is a desktop computer with screen and keyboard attached. However, it is different in a number of respects as will be seen from the following list of essential features.

     a. It is larger and more powerful than a typical PC. For example, many popular workstations use 32-bit microprocessors whereas PCs are typically 16-bit microcomputers.

     b. It is fully connected into a computer network as another computer on the network in its own right and not just running a terminal emulator.

     c. It has high-resolution graphics on bit-mapped screens as a standard feature. So it incorporates the capabilities of the graphics terminal described earlier.

     d. It has a multi-tasking operating system which means that it is able to run multiple

applications at the same time. This is a feature not found in most PCs.

8.15 Uses. Workstations are normally used by professionals for particular kinds of work such as Finance (dealer rooms), Science and Research, and Computer Aided Design. They are also very popular for programming.

8.16 Examples of workstations are the Digital VAXSTATIONs and the SUN SPARCstations.

8.13

Output Devices

Introduction
Printers

The following devices and media will be described:
a. Printers - Single sheet or continuous stationery. b. Microform recorder - Microfilm or Microfiche.
c. Graph Plotters - Single sheet or continuous stationery. d. Actuators.

Print Speeds tend to be expressed in terms of **cps** (characters per second), **fpm (lines** per minute) or ppm (pages per minute). Printers may be classified as: a. Low speed (10 cps to approx. 300 Ipm) - usually character printers.

  b. High speed (Typically 300 Ipm - 3000 1pm) - usually line printers or page
   printers.

Basic methods of producing print.

  a. Impact or non-impact printing. Impact printers *hit* inked ribbons against paper whereas non-impact printers use other methods of printer, eg, thermal or electrostatic. Most impact printers are noisy.

  b. Shaped character or dot-matrix printing. The difference is explained in Fig. 9.1. A dot matrix can also be used to produce a whole picture or **image** (9.2c) similar in principle, but superior in quality, to the minute pattern of dots in a newspaper picture.

Low-speed printers

Dot matrix impact character printers. These were once the most popular and widely-used low-speed printers. They remain popular for general use where print quality is not critical and are widespread for special purposes. For example, small versions of these printers are often used in conjunction with computerised tills in shops and service stations, especially for dealing with purchases by credit card. They are often loosely referred to as **"dot matrix printers".**

Features

  a. As with all character printers the device mimics the action of a typewriter by printing single characters at a time in lines across the stationery. The print is produced by a small **"print head"** that moves to and fro across the page stopping momentarily in each character position to strike a print ribbon against the stationery with an array of wires.

   b. According to the number of wires in the print head, the character matrix may be

    7 x 5, x 7, 9 x 7, 9 x 9 or even 24 x 24. The more dots the better the image. c. Line widths are typically 80, 120, 132, or 160 characters across. d. Speeds are typically from 30 cps to 200 cps.

    e. Multiple print copies may be produced by the use of carboned paper (eg. 4-6 copies using NCR (No Carbon Required) paper).

    f. Some higher quality versions can produce NLQ(Near Letter Quality), have inbuilt alternative character sets plus features for producing graphs, pictures, and colour

Inkjet printers. The original models of these printers were character matrix printers and had only limited success. Modern inkjet printers can act as character printers or page printers producing high print quality relatively quietly and have therefore replaced dot matrix printers for most low speed printing office use.

HP   **DeskJet**   850
Picture courtesy of Hewlett Packard

Features.
a. These are non-impact page printers often having inbuilt sets of scaleable fonts.
b. They operate by firing very tiny ink droplets onto the paper by using an "electrostatic field". By this means a medium quality bit-mapped image can be produced at a resolution of about 300-600dpi. Those using oil-based inks tend to produce higher quality print than those using water based inks.
c. They are very quiet but of low speed (4-6ppm). Their lower speed is reflected in the price.
d. Some models print colour images (typically at 2ppm), by means of multiple print heads each firing droplets of a different colour.
e. Some can print on plain paper, glossy paper and transparencies.

Daisywheel printers. This was once a popular type of low-speed printer that was favoured over dot matrix printers but is now far less common because it has been superseded by superior inkjet printers.
Features.

a. An impact shaped-character printer.
b. These printers are fitted with *exchangeable* print heads called daisywheels. To print each character the wheel is rotated and the appropriate spoke is struck against an inked ribbon.
c. Speeds are typically 45 cps.
d. They are similar to dot matrix printers in terms of page size and multiple-copy printing.

9.11 Other low-speed printers. There are many other lox-speed printers too numerous to mention. One worth a mention is the Thermal printer which is a non-impact

character matrix printer which prints onto special paper using a heated print head. It is very quiet and this gives it a big advantage for some applications.

Actuators

Computers are frequently used to control the operation of all manner of devices, appliances, mechanisms and processes. Any computer output device which is used to communicate some required action to a machine may be called an Actuator. For example a microcomputer operating a washing machine would use actuators to operate the motors and pumps. In a chemical plant controlled by computer actuators would operate valves, pumps, etc.

Other devices

It is becoming increasingly common for small loudspeakers to be fitted in desktop computers. Although this facility is often used for computer games there are a number of serious uses. One general use is as a means of providing messages to the user, the simplest form of which is a warning "bleep" sound when something is wrong. However, loudspeakers really come into their own when used in conjunction with digitised sound (2.33). For example, by means of special software a desktop computer may be turned into a sound synthesiser unit which can be hooked up to an audio system.

Summary

The *features* of the *main* hardware units and media for the output of data from the computer have been covered. They are:
   a. Printers - Single sheet or continuous stationery.
   b. Microform recorder - Microfilm or Microfiche,
   c. Graph Plotters - Single beet or continuous stationery.
   d. Actuators.

Week Four Lecture Note

Data Capture and Data Entry

Introduction

These days *the majority of computer end-users input data to the computer :via keyboards on PCs, workstations or terminals.* However, for many medium and large scale commercial and industrial applications involving large volumes of data the use of keyboards is not practical or economical. Instead, specialist methods, devices and media are used and these are the subject of this segment. The segment begins by examining the problems of data entry. It goes on to consider the stages involved and the alternatives available. It then examines the factors that influence the choice of methods, devices and media for data input. Finally, the segment examines the overall controls that are needed over data as it is entered into the computer for

processing.

The selection of the best method of data entry is often the biggest single problem faced by those designing commercial or industrial computer systems, because of the high costs involved and numerous practical considerations.

The best methods of data entry may still not give satisfactory facilities if the necessary controls over their use are not in place.

Problems of data entry

The data to he processed by the computer must be presented in a machine-sensible form (ie, the language of the particular input device). Therein lies the basic problem since much data *originates* in a form that is *fear* from machine sensible. Thus a painful error-prone process of transcription must be undergone before the data is suitable for input to the computer.

The process of data collection involves getting the original data to the "processing centre", transcribing it, sometimes converting it from one medium to another, and finally getting it into the computer. This process involves a great many people, machines and much expense.

A number of advances have been made in recent years towards automating the data collection process so as to bypass or reduce the problems. This segment considers a variety of methods, including many that are of primary importance in commercial computing. Specialist methods used for industrial computer applications will be covered in later segments.

Data can originate in many forms, but the computer can only accept it in a **machine sensible form.** The process involved in getting the data from its point of origin to the computer in a form suitable for processing is called **Data Collection.**

Before dealing with the individual stages of data collection it should be noted that data collection *starts* at the source of the raw data and *ends* when valid data is within the computer in a form ready for processing.

Many of the problems of data entry can be avoided if the data can be obtained in a computer-sensible form at the point of origin. This is known as data capture. This segment will describe several methods of **data capture.** The capture of data does not necessarily mean its immediate input to the computer. The captured data may be stored in some intermediate form for later entry into the main computer in the required form. If data is input directly into the computer at its point of origin the data entry is said to be on-line. If, in addition, the method of direct input is a terminal or workstation the method of input is known as **Direct Data Entry (DDE).** The term **Data Entry** used in the segment title usually means not only the process of physical input by a device but also **any** methods directly associated with the input.
Stages in data collection

The process of data collection may involve any number of the following stages according to the methods used.