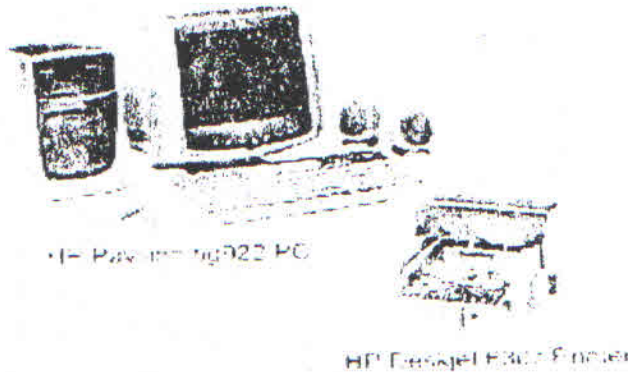


CHAP 1 HOW COMPUTERS WORK

1.1. Overview

This chapter will discuss the basics of Information Technology as they relate to the computer engineer. So in this chapter student will learn several of the vocabulary words important to the technician.

A computer system as shown in Figure 1 consists of hardware and software components.



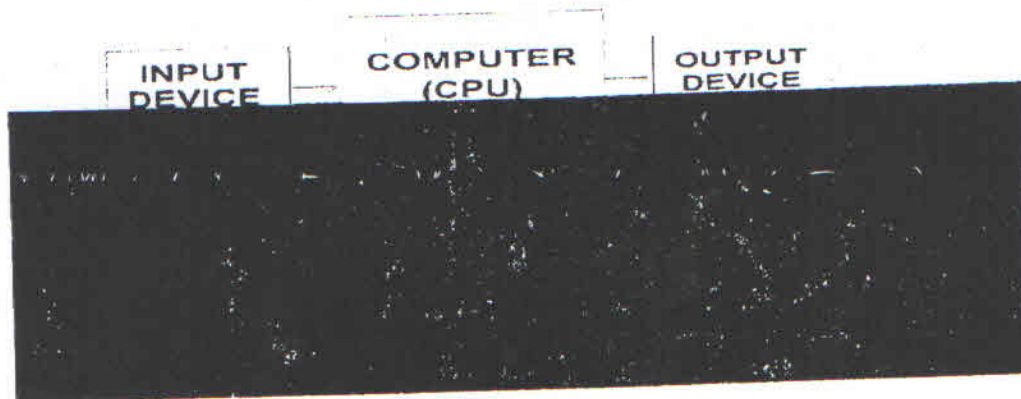
Hardware is the physical equipment such as the case, floppy disk drives, keyboards, monitors, cables, speakers, and printers. The term software describes the programs that are used to operate the computer system. Computer software, also called programs, instructs the computer on how to operate. These operations may include identifying, accessing, and processing information. Essentially, a program is a sequence of instructions that describe how data is to be processed. Programs vary widely, depending on the type of information that is to be accessed or generated. For example, the instructions involved in balancing a checkbook are very different from those required to simulate a virtual reality world on the Internet.

balance sheet

1.2. Computer System

As mentioned in the previous point, the operating system (OS) is the software that controls functionality and provides lower-level routines for application programs. Most operating systems provide functions to read and write data to files. An operating system translates requests for operations on files into operations that the disk controller can carry out. **The operating system helps the computer perform four basic operations, which include input-process-output-storage (see Figure down):**

Chapter 1 Input, Process, Output, and Storage



- The input operation recognizes input from the keyboard or mouse.
- The processing operation manipulates data according to the user's instructions.
- The output operation sends output to the video screen or printer.
- The storage operation keeps track of files for use later. Examples of storage devices include floppy disks and hard drives.

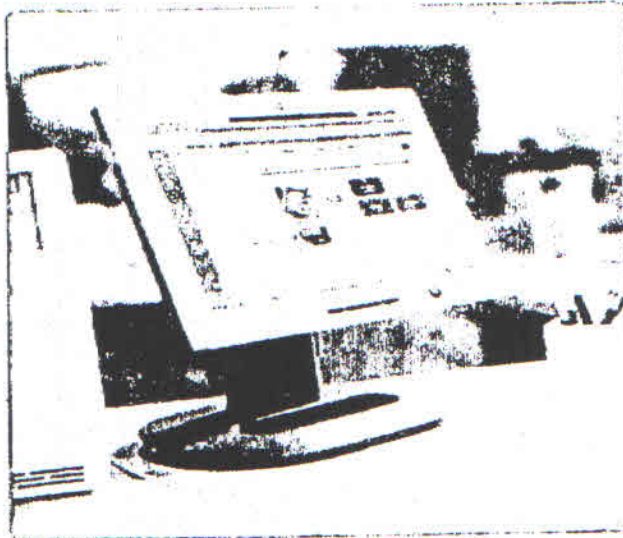
The most common way to input data into a computer is from the keyboard as shown in Figure down.



Opening a web page, an e-mail file, or a file that came from a network server are also ways to input data. After the data has been input, the computer can process or crunch the data. While a file is open and the text is being reformatted, the computer is processing data.

Processing data usually results in some kind of output, such as a word processor file or a spreadsheet. The most common way to output data is to send it to the computer monitor, as shown in following Figure,

Output Device



HP I1520
15" flat panel monitor

or to a printer. Today, most computers have a connection to the Internet, making it common to output the data to the Internet via e-mail or as a web page.

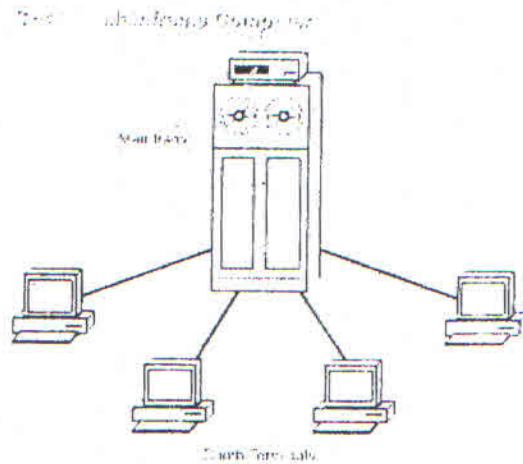
Data storage is probably the most important of the four basic computer functions. The most common way to store a file is to save it to a hard drive. Hard drives can be thought of as very large file cabinets. An operating system will find a place on the hard drive, save the file, and remember its location.

1.3. Computer types

There are two types of computers detailed in this section. The mainframe, which has provided computing power for major corporations for more than 40 years and the personal computer which has had more impact on people and business than any other single device in history.

A. Mainframes

Mainframes are powerful machines that allow companies to automate manual tasks, shorten the time to market for new products, run financial models that enhanced profitability, and so on. The mainframe model consists of centralized computers, usually housed in secure climate controlled computer rooms. End users interfaced with the computers via dumb terminals. These dumb terminals are low cost devices that usually consist of a monitor, keyboard, and a communication port to communicate with the mainframe. Initially, terminals were hard wired directly to communication ports on the mainframe and the communications were asynchronous. An illustration of a mainframe computer is shown in **Figure below**.



Note: Asynchronous means "without respect to time". In terms of data transmission, asynchronous means that no clock or timing source is needed to keep both the sender and the receiver synchronized. Without the benefit of a clock, the sender must signal the start and stop of each character so that the receiver knows when to expect data.

A mainframe environment depends on a single computer or group of computers that can be centrally managed and maintained. This configuration has the additional advantage of being more secure. It is secure not only because of the physical security of the computer room, but also because of the end users lack of ability (not total inability) to introduce viruses into the system. The cost of virus protection and eradication today is costing companies hundreds of millions of U.S. dollars annually. *The disadvantage is that because of its mainframe system, the mainframe system is likely to be used.*

At its peak in the late 70s and early 80s, the mainframe (and later the minicomputer which was a smaller and less expensive line of mainframes) market was dominated by IBM and Digital Equipment Corporation. These high-powered machines, however, came with high price tags. The cost of entry into the mainframe market was typically **several hundred thousand to several million US dollars**. The minicomputer began to bring similar capabilities at a lower price, but the minicomputer configurations were often over ten thousand U.S. dollars as well.

Mainframes continue to play a large role in corporate computing. It is estimated that there are still 24 million dumb terminals in use worldwide. In addition, 15 million PCs are currently deployed to function primarily as mainframe terminal emulators. These dumb terminals are American Standard Code for Information Interchange (ASCII) character based devices and are often referred to as green screens because many display green characters.

The term "mainframe" used to refer to the cabinet that housed the CPU; today it refers to a large computer system. The list below shows the advantages and disadvantages of mainframes.

There are several advantages of mainframes:

- Scalability, the ability to add more users as the need arises
- Centralized management
- Centralized backup
- Low cost desktop devices (dumb terminals)
- High level of security

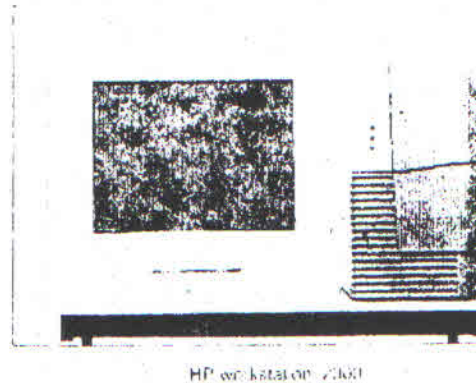
There are several disadvantages of mainframes:

- Character-based applications
- Lack of vendor operating system standards and interoperability in multivendor environments
- Expensive, with a high cost for set up, maintenance, and initial equipment
- Potential single point of failure (non-fault tolerant configurations)
- Timesharing systems, which means that there is a potential for a bottleneck

B. PCs

A personal computer (PC) is a standalone device, meaning that it is independent of all other computers as shown in Figure 2.

FIGURE 2 Personal Computer



With the advent of the PC, the graphical user interface (GUI) gained wide introduction to users.

GUI, (pronounced goo-ee) employs a graphics display to represent procedures and programs that can be executed by the computer. An example is the Windows desktop. These programs routinely use small pictures, called icons, to represent different programs. The advantage of using a GUI is that the user does not have to remember complicated commands to execute a program. The GUIs first appeared in Xerox and Apple computers. Along with GUI, thousands of Windows based applications were also introduced.

As PC technology has improved, the power of the PC has risen to the point that it can perform enterprise level functions. The advantages and disadvantages are listed below.

There are several **advantages** of PC computing:

- Standardized hardware
- Standardized, highly interoperable operating systems
- GUI interface
- Low cost devices (when compared to mainframes), low cost of entry
- Distributed computing
- User flexibility
- High productivity applications

There are several **disadvantages** of PC computing:

- Desktop computers cost, on average, five times as much as dumb terminals, according to some industry estimates
- No centralized backup
- No centralized management

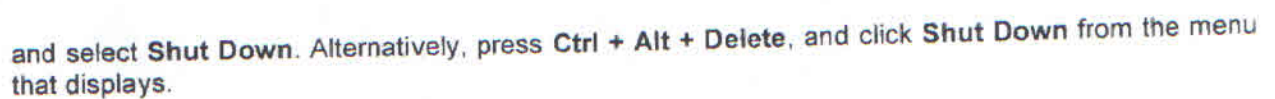
1.4. Starting, shutting down, and restarting a computer

Turning on the PC

The monitor will also have a power switch in most cases. Usually this is in the front or lower right portion of the display case. (Switches can be push-on/off, or rocker switches.) They are manufactured to withstand thousands of on/off cycles, typically outlasting the PC itself.

Shutting Down a Computer

Figure 1. The relationship between the number of species and the number of genera in the family *Chrysomelidae*.



Do not turn the computer off until a message displays indicating that it is safe to do so. Important data that is stored in memory while the system is running needs to be written to the hard disk before turning off the computer. Newer computers will automatically turn off power when the shutdown process is complete.

Note: It is extremely important not to power off the computer with the power switch. Most operating systems like Macintosh and Windows have a specific method for turning the system off. In Windows, choose the **Shut down** button from the **Start** menu. On a Macintosh, choose the **Shut down** button from the **Special** menu.

Restarting the PC

Restarting a PC that has already been powered up is referred to as a warm boot. This can be achieved by pressing the reset button on the front panel. Alternatively, press **Ctrl + Alt + Delete**, and click **Restart** from the menu that displays. The concepts of warm boot and cold boot are discussed more thoroughly in Chapter 2, "How Computers Work".

1.5. Measurement-related terminology

When working in the computer industry, it is important to understand the terms that are used. Whether reading the specifications about a computer system, or talking with another computer technician, there is a rather large dictionary of terms that should be known. The technician needs to know the following terminology:

- **bit** – A bit is the smallest unit of data in a computer. A bit can take the value of either one or zero, and it is the binary format in which data is processed by computers.
- **byte** – A byte is a unit of measure that is used to describe the size of a data file, the amount of space on a disk or other storage medium, or the amount of data being sent over a network. One byte consists of eight bits of data.
- **nibble** – A nibble is half a byte or four bits.
- **kilobyte (KB)** – A kilobyte is 1024 (or approximately 1000) bytes.
- **kilobytes per second (kBps)** – A measurement of the amount of data transferred over a connection. For example, a network connection. kBps is a data transfer rate of approximately 1,000 bytes per second.
- **kilobit (Kb)** – A kilobit is 1024 (or approximately 1000) bits.
- **kilobits per second (kbps)** – kbps is a measurement of the amount of data transferred over a connection. For example, a network connection. kbps is a data transfer rate of approximately 1,000 bits per second.
- **megabyte (MB)** – A megabyte is 1,048,576 bytes (or approximately 1,000,000 bytes).
- **megabytes per second (MBps)** – A common measurement of the amount of data transferred over a connection. For example, a network connection. MBps is a data transfer rate of approximately 1,000,000 (10^6) bytes per second.
- **megabits per second (Mbps)** – A common measurement of the amount of data transferred over a connection. For example, a network connection. Mbps is a data transfer rate of approximately 1,000,000 (10^6) bits per second.

Note: A common error is confusing KB with Kb and MB with Mb. Note that a capital B indicates bytes while a lower case b indicates bits. Similarly, multipliers greater than one are capitalized and multipliers less than one are lower case. For example, $M=1,000,000$ and $m=0.001$. Remember to do the proper calculations when comparing transmission speeds that are measured in KB with those measured in Kb. For example, modem software usually shows the connection speed in kilobits per second (for example, 45 kbps). However, popular browsers display file-download speeds in kilobytes per second, meaning with a 45-kbps connection, the download speed would be a maximum of 5.76-kBps.

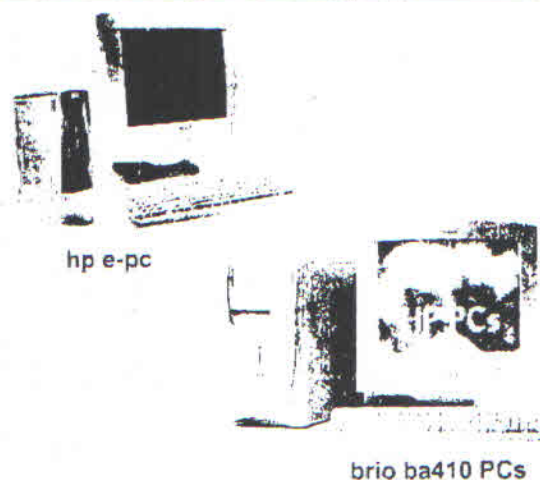
CHAP 2. HARDWARE COMPONENTS

The hardware that makes up the computer (the components of the desktop computer) is explained in detail and illustrations are included.

2.1. Computer Cases

The computer case and the power supply are two very important parts that help determine the performance of the system. The type of motherboard used is usually determined by the type of case and power supply. (The power supply is usually included in the computer case.) Computer cases and power supplies are detailed in this section.

The type of case is the first decision when building a computer. The case is made up of the metal chassis (or frame), and a cover, usually constructed of metal or hard plastic. The case is the housing unit for the internal components and protects against dust and damage. The case usually comes with the power supply needed to power the computer and the installed components. Computer cases are either desktop or tower models as shown in **first Figures 1 and second 2.**



- The desktop model sits on a desk horizontally. The monitor can be set on top. This choice can be a space saver.
- The tower model stands upright in a vertical position that allows easy placement on the floor. Mini-tower, mid-tower, and full tower cases are available.

note of desk The choice of a desktop case or tower is a matter of personal preference. However, it is important to consider the workspace before choosing a case.

Hardware components are installed in the bays of the case. The bays are placeholders for the drives so they are neatly organized. Devices may be easily interchanged from bay to bay if necessary. Drive bays are 5.25 inches or 3.5 inches wide and some are normally left unfilled in a new computer. This allows the machine to be upgraded with a ZIP drive, tape back up, or a CD-ROM burner.

2.2. Power Supplies

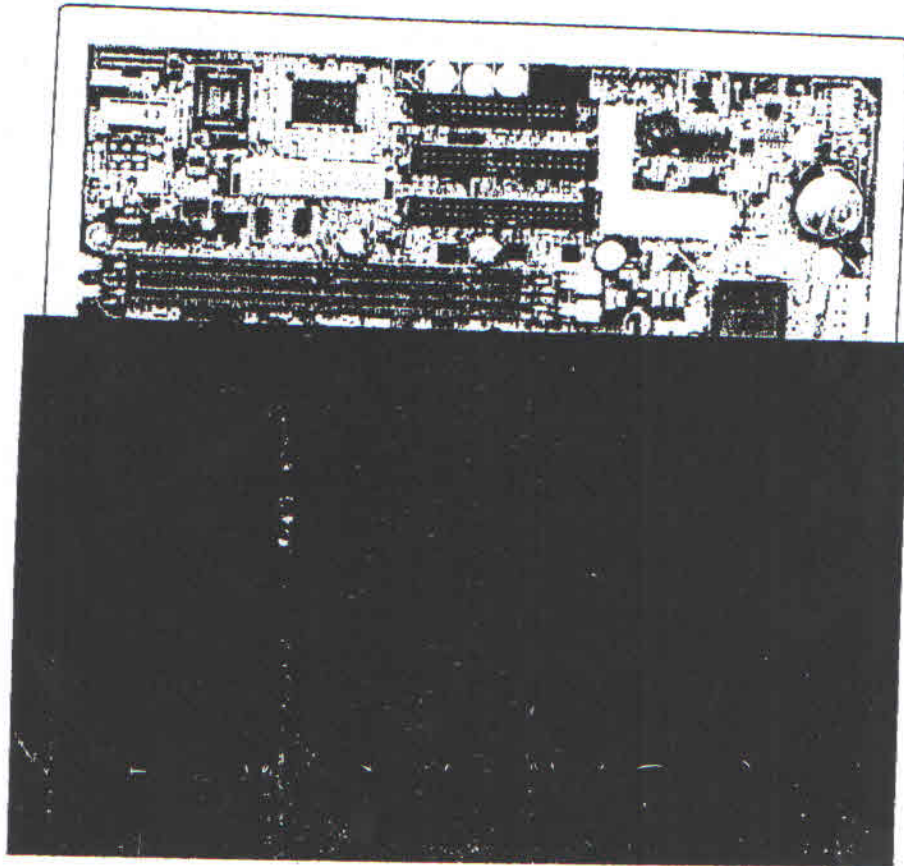
As shown in **Figure 3**, a power supply provides the needed voltage to power the various electronic circuits that make up the PC. It receives the external AC power.

The power supply is contained in a metal box. Within this box, a transformer converts the voltage that is supplied from standard outlets into voltages that the computer parts need to operate.

This section discusses the subject of motherboard technology. Knowledge of the motherboard, also called the system board or main board, is crucial because it is the nerve center of the computer system. Everything else in the system plugs into it, is controlled by it, or depends on it to communicate with other devices on the system. The system board is the largest of the printed circuit boards and every system has one. It generally houses the CPU, the controller circuitry, the bus, RAM, expansion slots for additional boards, and ports for external devices. In addition, it contains the Complementary Metal-Oxide Semiconductor (CMOS) (pronounced C moss), other Read Only memory (ROM), BIOS chips, and support chips providing varied functionality. If the computer is a desktop type, the system board is generally located at the bottom of the computer case. If the computer is a tower-configuration case, the system board is mounted vertically along one side. All components relating to the system unit connect directly to the system board. External devices such as the mouse, keyboard, or monitor would not be able to communicate with the system unit without the system board.

Printed circuit boards are constructed from sheets of fiberglass. They are covered with sockets and various electronic parts, including different kinds of chips. A chip is made up of a very small circuit board etched on a square of silicon, a material with the same chemical structure as common sand. Chips vary in size, but many are roughly the size of a postage stamp. A chip is also referred to as a semiconductor or integrated circuit. The individual wires and hand-soldered connectors used in older system boards are replaced today by aluminum or copper traces printed on circuit boards. This improvement has significantly saved the amount of time spent on building a PC and has reduced the cost, both for the manufacturer and the consumer. **Figure 1** shows the components of an ATX motherboard and how they fit together.

ATX Motherboard



2.4. The CPU

The CPU is one of the most important elements of the personal computer. On the motherboard, the CPU is contained on a single integrated circuit called the microprocessor. The computer will not run without a CPU. Often referred to as the brains of a computer, the CPU contains two basic components:

- A control unit instructs the rest of the computer system on how to follow a program instructions. It directs the movement of data to and from processor memory. The control unit temporarily holds data, instructions, and processed information in its arithmetic/logic unit. In addition, it directs control signals between the CPU and external devices such as hard disks, main memory, I/O ports, and so on.
- The Arithmetic/Logic Unit (ALU) performs both arithmetic and logical operations. Arithmetic operations are fundamental math operations like addition, subtraction, multiplication, and division. Logical operations such as the AND, OR, and XOR are used to make comparisons and decisions, and these determine how a program is executed.

The processor handles most of the operations that are required of the computer by processing instructions and sending signals out, checking for connectivity, and ensuring that operations and hardware are functioning properly. It acts as a messenger to major components such as RAM, the monitor, and disk drives. The microprocessor is connected to the rest of the computer system through three buses, including the data bus, address bus, and control bus (the bus types are discussed in detail later in this chapter). There are many different companies that produce CPUs, including Intel,

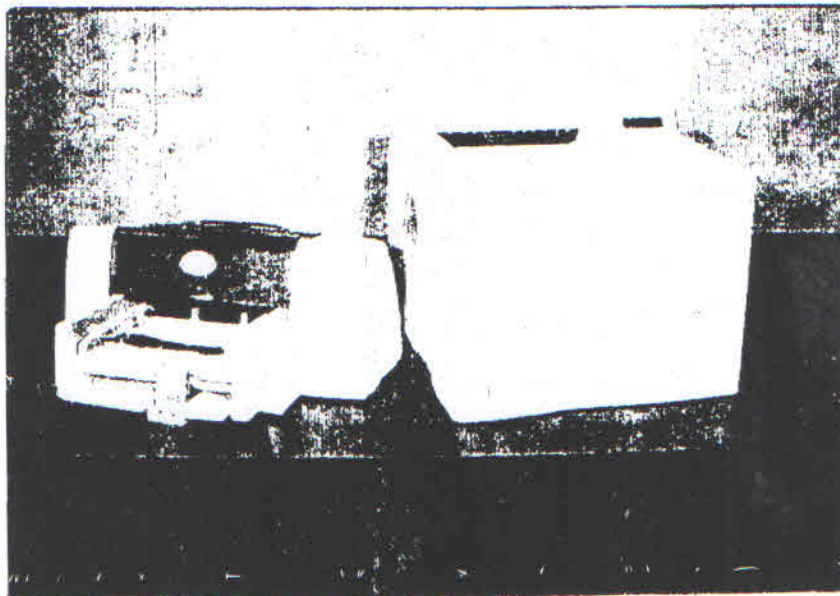
Advanced Micro Devices (AMD), and Cyrix. Intel is credited with making the first modern, silicon-based CPU chip in 1971.

2.5. Printer

Printers are a vital part of modern PC systems. The need for hard copies of computer and online documents is no less important today than when the paperless revolution began several years ago. Today's computer technician must be able to understand the operation of various types of printers in order to install, maintain, and troubleshoot printer problems.

The most popular types of printers in use today are electrophotographic type laser printers and sprayed inkjet printers as shown in **Figure 1**.

Figure 1 LaserJet and Inkjet Printers



Older impact type dot matrix printers are still used in many offices and homes but it is getting difficult to find replacement parts as these units break down.

Printers are connected to personal computers with USB, firewire, serial, parallel, and network cable connections. Wireless types of connections include infrared and radio wave technology.

Printer drivers are software that must be installed on the PC so that the computer can communicate with the printer and coordinate the printing process. Printer drivers vary according to printer type, manufacturer, model, and PC operating system.

In this section, how the various printers work, starting with the dot matrix printer, will be explained.

Buying a Printer

Print quality and resolution

Both inkjet and color laser printers can produce professional quality photos. However, if an inkjet printer is being considered, be aware that all inkjets are not made equal. Not all are capable of professional quality printing. Generally, the higher end the inkjet, the better the quality. As a matter of fact, there are inkjet printers that are specially designed to produce top quality photos, but these units tend to do poorly on printing text. The print quality is a factor of the resolution capabilities of the printer, and it is discussed later in this section.

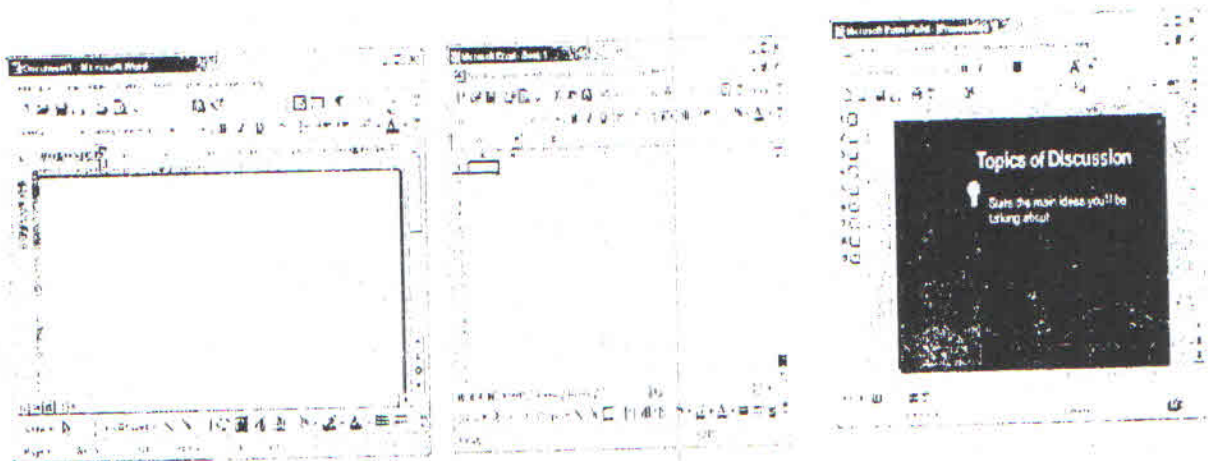
Reliability

Some printers are practically designed to have a short lifespan. In most cases these are throwaways. Some brands of printers are more reliable than others. In general, it makes more economical sense to spend a bit more upfront and have a durable printer. For example, it is more economical to spend U.S. \$900 on a printer that can last for 5 years than U.S. \$250 each year to replace a printer that is worn out or broken. In considering a printer brand, examine the construction. Is the cartridge attached to the print head? Replacing a print head is much more expensive than replacing a print cartridge. Try to determine the ease of replacing parts and their availability.

CHAP II. COMPUTER SOFTWARES OR PROGRAMS

Let start by reminding that two types of software are operating systems and applications.

As needed, application software accepts input from the user and then manipulates it to achieve a result, known as the output. Applications are programs designed to perform a specific function directly for the user or for another application program. Examples of applications include word processors, database programs, spreadsheets, web browsers, web development tools, and graphic design tools. Computer applications are detailed later in this chapter. Refer to Figures 2, 3, and 4 for examples of common application software.



An operating system (OS) is a program that manages all the other programs in a computer. It also provides the operating environment with the applications that are used to access resources on the computer. Operating systems perform basic tasks like recognizing input from the keyboard or mouse, sending output to the video screen or printer, keeping track of files on the drives, and controlling peripherals such as printers and modems. The Disk Operating System (DOS), Windows 98, Windows 2000, Windows NT, Linux, Mac OS X, DEC VMS, and IBM OS/400 are all examples of operating systems.

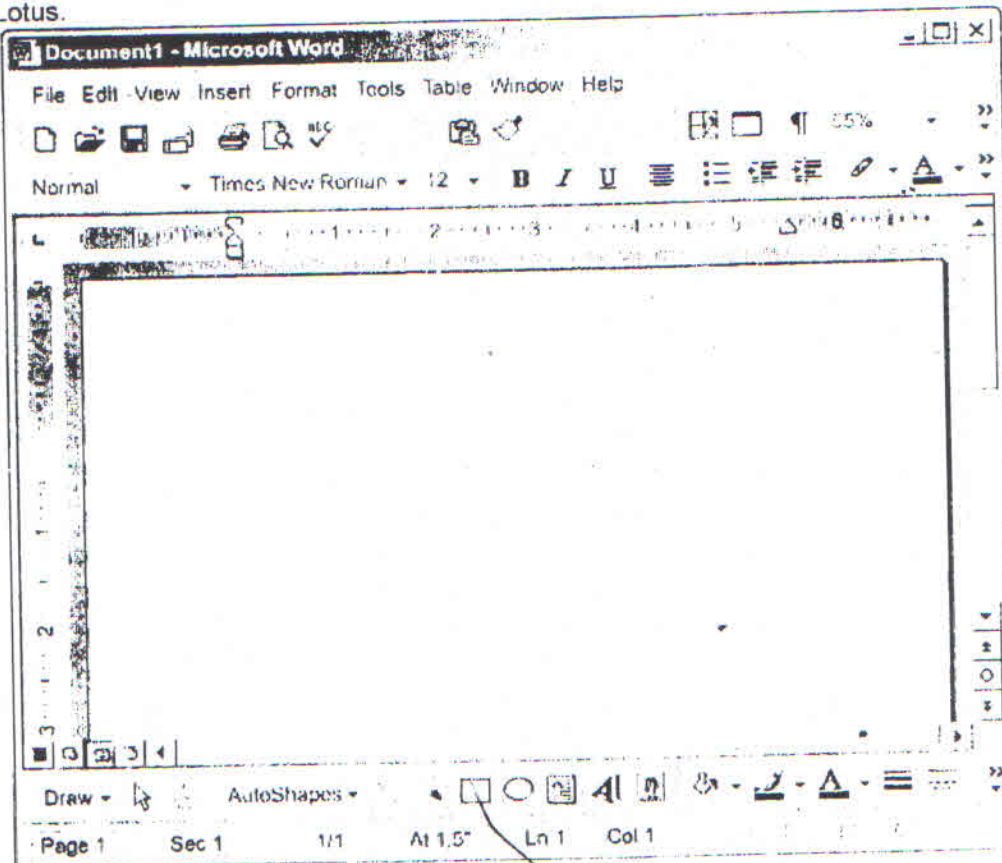
— Operating systems are platform-specific, meaning they are designed for uses with different types of computers. For instance, the Windows operating system (3.1, 95, 98, 2000, XP, or NT) is designed for use with an IBM-compatible personal computer often referred to as a PC. The Mac OS, on the other hand, will only work with Macintosh computers. PC and Macintosh are called platforms. A platform is the computer system on which programs can run.

1.3.1. Overview of Software Applications

i. Word processors

As discussed earlier in this chapter, software applications are the programs that allow the completion of tasks such as writing a report, keeping track of clients, drawing a company logo, displaying web pages, and writing e-mail.

A word processor is an application that creates, edits, stores, and prints documents. **Figure 1** shows Microsoft Word 2000 as an example of a word processor. All word processors can insert or delete text, copy, cut, paste, and define margins. Word processors that only support these features are called text editors. Most word processors support additional features that enable the manipulation and formation of documents in very sophisticated ways. Examples include file management, macros, spell checkers, headers and footers, merge capabilities, advanced layout features, multiple windows, and preview modes. The most popular word processors are Corel WordPerfect, Microsoft Word, and Lotus.



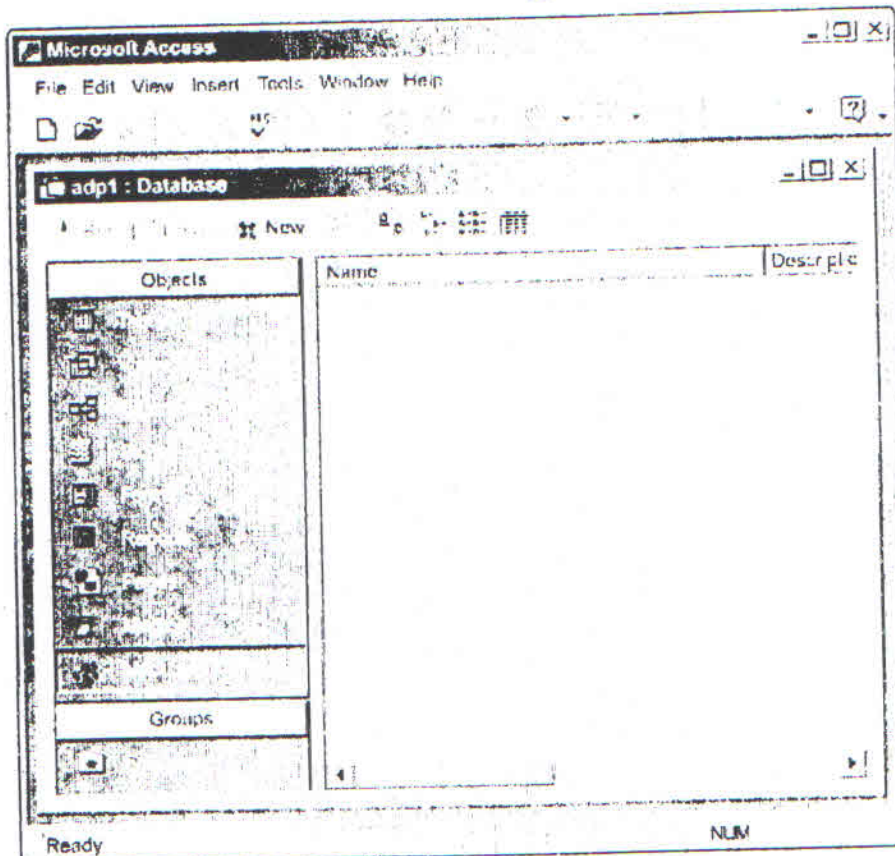
ii. Spreadsheets

In a spreadsheet, numerical data is stored in cells that are arranged on a grid. Cells are referred to by their position in this grid according to the column and row they occupy (such as A3). The data could be a number, text or a calculation. If A3 contained the value 10, and the adjacent cell (B3) contained the calculation $=A3*2.54$ (take the value in A3 and multiply it by 2.54), then the value 25.4 would represent B3. In other words, a value in inches in A3 is converted to centimeters in B3, since 2.54 is the conversion factor.

A range of numerical values can be calculated in this way, and this makes it possible to carry out large and complex calculations. Many spreadsheets have the ability to plot data in the form of graphs, bar charts and pie charts. Microsoft Excel, shown in Figure 1, and Lotus 1-2-3 are both examples of spreadsheet applications.

mark column & row

to mark with points



Flat-File Database

A flat-file database stores the information in a single table. Each column, called a field, contains a particular piece of information such as first name, last name, address, and telephone number. Each row, called a record, contains information for a particular database item, for example John / Smith / 24 Main Street / 286 245 988. An ordinary telephone directory might be stored in this format.

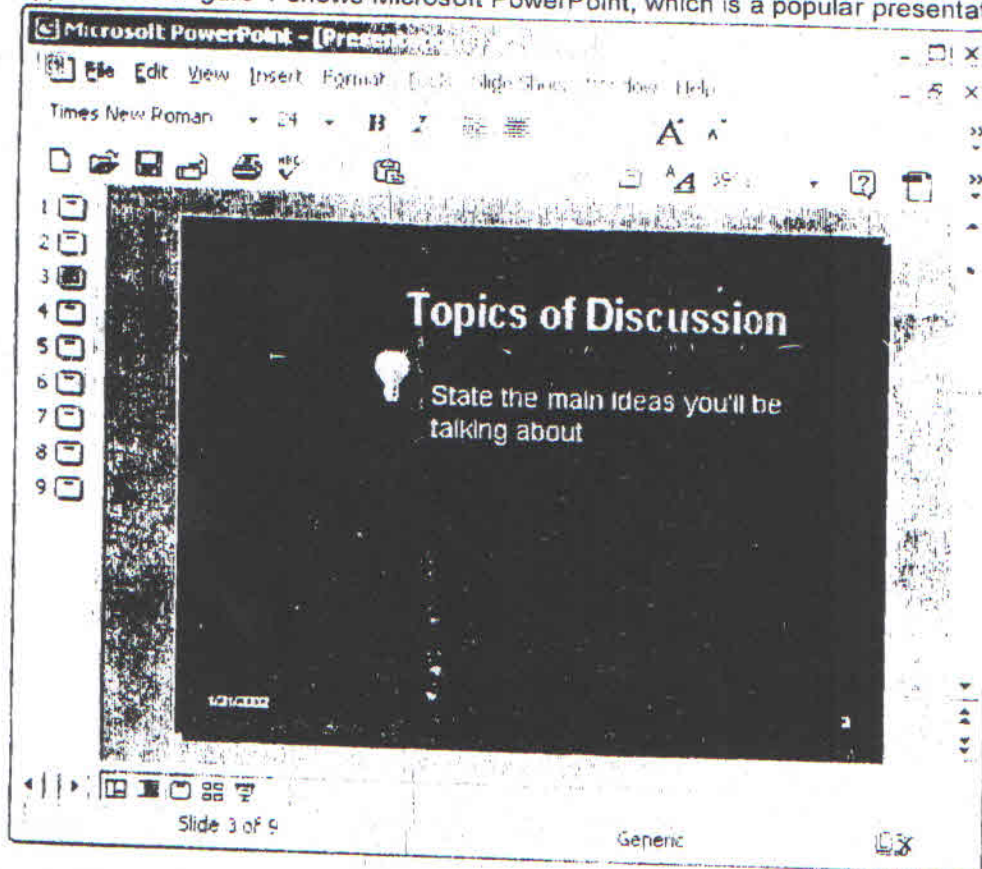
Relational Database

Relational databases are a collection of flat-file databases (or tables) linked through some particular relationship. For example, a bank would use a relational database to store information about its clients. There would be a table containing the names and addresses of clients, a table with detailed information about each bank account, a table with the amount in each account, a table with passwords, and so on. A unique identifier called a key, which forms the relationship between records in different tables, links the information in these tables. For example, when taking money out of a cash machine, the bankcard details and the password number are checked in a security table. Then the account balance table will be checked to make sure there are sufficient funds available, and the transaction is stored in an account transaction table.

Relational databases are the best way to store large amounts of inter-related data. Their advantage when compared with flat-file databases is their ability to handle multiple relationships with a minimum of duplication of data. For example, each bank account will have many transactions (a one-to-many relationship). To do this in a single flat-file database would make it overwhelmingly large and inefficient. Flat-file databases are two dimensional, while relational databases have three or more dimensions.

iv. Presentation applications

Presentation applications, also known as business graphics, permit the organizing, design, and delivery of presentations in the form of slide shows and reports. Bar charts, pie charts, graphics, and other types of images can be created based on data that is imported from spreadsheet applications. Figure 1 shows Microsoft PowerPoint, which is a popular presentation application.



v. Web browser and e-mail

A web browser is an application that is used to locate and display pages from the World Wide Web (WWW). The two most common browsers are Netscape Navigator (see Figure 1) and Microsoft Internet Explorer (see Figure 2). These are graphical browsers, which means that they can display graphics as well as text. In addition, most modern browsers can present multimedia information, including sound and video, though they require plug-ins for some formats.

Note: A plug-in is an auxiliary program that works with a major software package to enhance its capability. An example of a plug-in would be a filter that adds special effects in an imaging program such as Photoshop. Plug-ins are added to Web browsers to enable them to support new types of content (audio, video, and so on). Although the term is widely used for software, it could also be used to refer to a plug-in module for hardware.

E-Mail

Electronic mail (e-mail) is the exchange of computer-stored messages by network communication. Both Netscape and Microsoft include an e-mail utility with their web browsers.

1.3.2. Basic concepts of operating systems

This point will discuss the basics of the operating system. It is the program in charge of running the computer. The components and functions of the operating system are detailed and terminology important to the technician is explained. The emphasis is on the Microsoft Windows 9x. to explain the Windows Operating System. The student will gain an understanding of how the Windows file structure and management system works, and the steps in Windows installation.

A. Components of an operating system

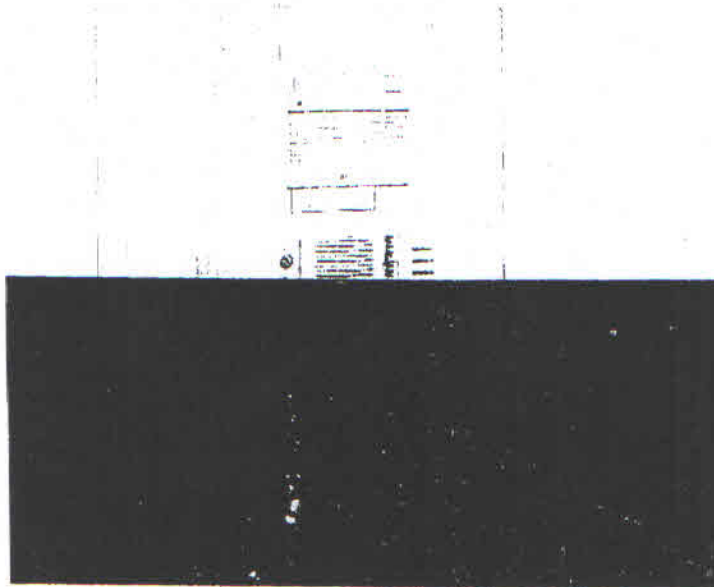
An operating system is a software program that controls thousands of operations, provides an interface between the user and the computer, and runs applications. Basically, the operating system is in charge of running the computer. Today, most computer systems are sold with an operating system already installed. Computers that are designed for individual users (called Personal Computers or PCs) have operating systems that are designed for individuals running small jobs. An operating system is designed to control the operations of programs such as Web browsers, word processors, and e-mail programs.

Test Tip: Know the definition of an operating system as it relates to a PC.

With the development of processor technology, computers have become capable of executing more and more instructions per second. These advances have made it possible to run operating systems that are capable of running many complex tasks simultaneously. When a computer needs to accommodate concurrent users and multiple jobs, Information Technology (IT) professionals usually turn to faster computers that have more robust operating systems.

* Computers that are capable of handling concurrent users and multiple jobs are often called network servers or simply "servers" as shown in Figure 1.

Network Diagram



Servers have operating systems installed called Network Operating Systems (NOS). A fast computer with a NOS installed may run a large company or a large Internet site, which involves keeping track of many users and many programs as illustrated in Figure 2.

Network Diagram

