TRAINING COURSE

ON

SOFTWARE FOR SURFACE WATER DATA MANAGEMENT

UNDER

WORLD BANK FUNDED HYDROLOGY PROJECT

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FUNDAMENTALS OF COMPUTER HARDWARE

BY

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1.0   INTRODUCTION

The development of water resources of the country to meet growing demands of rising population is a challenging task. Hydrological investigations and analysis form an essential component for investigations, planning, design, construction and operation of water resources projects. The developments of system approach, electronic instrumentation and advent of high speed computers have led to significant progress in modelling and simulation of complex hydrologic processes. Computers are used because they are reliable and fast. Computers of different sizes and configurations with their capabilities for rapid processing and objective analysis of data have made it possible to develop data collection, communication and processing systems.

The application of computers for hydrology can be grouped into following categories:

- Ordinary computations. like statistical computations, rainfall runoff modelling by different methods, unit hydrograph studies, reservoir sedimentation studies, design flood and water availability computations.

- Intense computations, like calibration of parametric models, multiple reservoir optimization etc.

- Graphics : Hydrology involves lot of plotting work and graphics can be considered as a task by itself.

- Data Storage and Retrieval : Magnetic media is ideally suited for storage, processing and retrieval of large volumes of hydrological data.

The other applications of computers in an organisation may be for accounting, personnel information system, management information system, office automation like word processing, networking, electronic mail, database management system etc.

1.1   What is a Computer?

A computer is made up of electronic and electro-mechanical devices. To understand what is a computer, it is better to learn what it can do.

Computer transforms data in to information through an information processing cycle made up of input, processing, storage, and output. A Computer can only accept data in computer-readable form. Data in this form can be captured quickly and accurately and are available for further computer-based information processing. While processing data, computer needs detailed instructions to perform arithmetic, text manipulation and logic operations. Problems of higher complexity can be tackled in shorter periods through the use of computers.

A computer has two main components: **Software and Hardware.**

2.0   SOFTWARE

A working machine requires an extensive set of instructions to control its operations. These instructions are collectively known as software. The instructions which control what a computer does in response to command of a user are normally handled in two sets. One set of instructions controls the system under which the computer operates fixing the detailed movement and handling of information. This set is called the operating system. The second set, known as the application software, allows the user to call up instructions which support a given tasks rather than to the operation of the computer.

The programming languages serve as the means by which a programmer communicates with a computer system. Three levels of programming language are in common use : machine language, assembly languages and high-level languages.

As most programs are not coded in machine language, they are translated into machine language by systems software. The initial version of a program is called the source code and the translated version is called the object code. With assembly languages, an assembler performs the translation. With high-level languages, compilers or interpreters perform the translation. A compiler translates a program all at once. An interpreter translates a program one statement at a time and then executes it prior to translating the next statement.

Assembly languages which were developed to reduce the errors of machine language programs, are a more readable form of machine language programs. High-level languages have more powerful commands that are 'problem-oriented' rather than 'machine-oriented'. However, programmers lose some control over the manner in which processing occurs as they make use of each higher level of programming language.

Every programming language is designed to achieve certain goals. These goals represent the design features of the language. The design features are particularly useful in comparing the strengths and weaknesses of different programming languages. The four most popular high level languages used for programming are FORTRAN, BASIC, C and PASCAL. FORTRAN is primarily used for scientific and engineering problem solving. BASIC is a general-purpose programming language that is very easy to learn and C is a very powerful, but also more complex general purpose programming language. PASCAL is a general purpose programming language that offers very sophisticated control and data structures.

3.0 HARDWARE

The block diagram of a computer system is shown in Fig.1. The commonly used term for computer devices is hardware. The four categories of hardware components are central processing unit, memory, input devices, output devices. Hardware is useless without software. Hardware and software used together make up computer system.
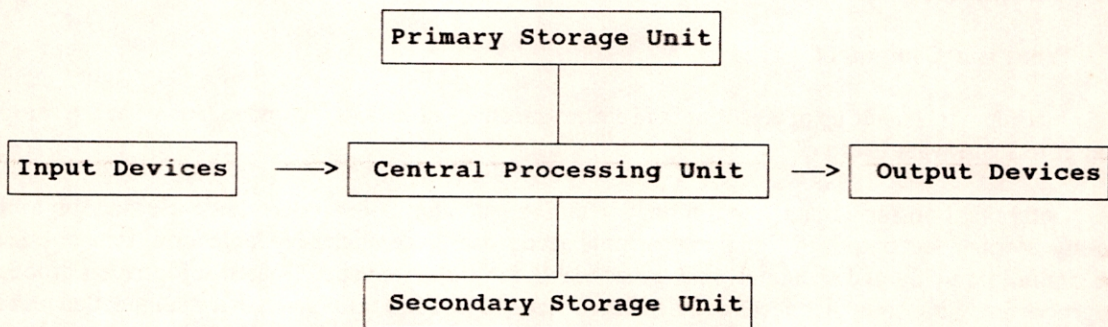
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                    ┌─────────────────────┐
                    │ Primary Storage Unit│
                    └──────────┬──────────┘
                               │
┌───────────────┐    ┌─────────┴─────────────┐    ┌────────────────┐
│ Input Devices │ ─> │Central Processing Unit│ ─> │ Output Devices │
└───────────────┘    └─────────┬─────────────┘    └────────────────┘
                               │
                    ┌──────────┴───────────┐
                    │Secondary Storage Unit│
                    └──────────────────────┘
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Fig.1   Block Diagram of a Computer

3.1 Central Processing Unit

The most important hardware component of a computer system is the central processing unit (CPU). It is a microprocessor, which performs the arithmetic, logic and control functions of the computer. It directs and coordinates all the processing. It controls the transfer of data and performs basic operations. The operations performed by the CPU are controlled by instructions in the form of a computer program.

A CPU that has been implemented on a single silicon chip is called a microprocessor. Microprocessor chips use many different internal designs, and the chips vary in appearance and capability. One of the specific ways in which they vary is in dataword length. This refers to the number of bits of data that can be retrieved from memory each machine cycle. To take the advantage of the higher processing capabilities of CPU , a cache was introduced to act as a bridge between the microprocessor and the slower RAM.

In 1981, IBM entered in the market of microcomputer, with its IBM PC. This computer was based on INTEL's next generation of microprocessor chip, named 8088, which could manipulate 16 bit of information at once. This CPU has a 16-bit internal architecture but communication with external devices is in 8-bit mode. Over the next several years, there are two major families in microcomputer industry. One family following the IBM PC standard, is based on INTEL 8088 chip and its successors, the INTEL 80286, 80386, 80486 and the PENTIUM chips. The other major group is the APPLE family, based on the MOS 6502 chip (APPLE II) and MOTORLA 68000 chip (MACINTOSH).

3.2   Memory

The memory of a computer is of two types: **primary memory and secondary memory.**

3.2.1   Primary Memory

All computers have an internal memory that functions as a working space for holding programs and data. Every part of this internal memory is equally accessible to the CPU. Primary memory chips are designed as RAM or ROM. RAM stands for Random Access Memory, which means that instructions or data can be read from this memory or written into it. Thus, RAM is sometimes referred to as read/write memory. The types of RAM chips, most commonly used today, are volatile, meaning that the memory contents will be lost when the electrical power is turned off.

ROM, or Read Only Memory, can only be used to read permanently loaded instructions or data. Software stored in ROM hardware is called firmware. ROM uses storage technology that is nonvolatile, and thus is not affected by loss of power. Erasable Programmable ROM or EPROM chips have been developed in which ultraviolet light can be used to erase the information stored on the chip. EEPROM or Electrically Erasable Programmable ROM chips can be used in situations where selected bytes of information need to be changed electronically.

The capacity of the memory is measured in bytes, one byte being composed of 8 bits of binary code. Depending on their power PCs have a RAM capacity between 640 kilo bytes (1 KB = 1024 bytes) and 64 Mega bytes (1MB = 1024 X 1024 bytes).

Primary memory provides temporary storage for data and programs. It is cleared when the computer is switched off or reset. It is relatively expensive and cannot be used to permanently store data and programs. For this purpose, secondary storage devices are used.

3.2.2   Secondary Memory

Secondary memory uses magnetic recording techniques that retain the data when the power to the computer is turned off. The most popular secondary storage devices are magnetic tape and magnetic disk, both of which can store data in a physically compact form. Compared to tape, much faster access time is possible with magnetic disks. The storage capacity of a disk depends on the number of tracks per surface, the bit density, and the number of recording surfaces. The speed with which data can be found and retrieved depends on access time. Access time is the amount of time it takes from the point of requesting data until the data are retrieved. The disks may take the form of either a fixed (hard) disk fitted inside the computer, or flexible (floppy) diskettes.

Floppy disk drives record data in serial bit streams on the coated surface of thin plastic diskette. The diskette is made of a flexible Mylar plastic coated with a thin layer of metallic oxide particles. Data is recorded

on the surface of the diskette in a set of concentric circles called tracks and the data on each track is further divided into equal size pieces called sectors. Magnetic read/write heads retrieve and record the information on the surface of the diskette. The diskettes are available in various sizes and capacities. The most common are 5.25" diskettes with 360 KB or 1.2 MB capacity and 3.5" diskettes with 720 KB or 1.44 MB capacity. They are removable.

The large storage capacities are provided by hard disks. They are commonly of Winchester type. They are rigid aluminum platters coated with a magnetic oxide. The read/write heads float a few micron inches above the spinning magnetic surface. Most hard disks currently available are hermetically sealed to prevent dust particles from entering in the disk mechanism. Since the space between the disk surface and the read/write heads is very small, these particles may cause the head to crash onto the disk resulting in permanent damage to the disk and the data stored on it. They come in a variety of sizes and the significantly different storage capacities and can be further categorized in terms of being fixed or removable. Now-a-days hard disks of very high storage capacity are available and at reasonable prices and disks of capacity of 1 GB are very common.

Now a days CD-ROM or a Compact Disk Read Only Memory is becoming more popular because of its speed and high storage capacity. A CD-ROM is a plastic disk, made up of many layers, used to store information. They are the optical disks and instead of disk heads, use laser beam to read data. These have very large storage capacities (more than 500 MB). The limitation of using CD-ROM is that it is a Read Only Memory.

Magnetic tapes are thin plastic tapes coated with magnetic material. They come in three forms reel-to-reel, cartridge, and cassette. All magnetic tapes work in a similar fashion, very much like audio cassettes. The storage capacity of a tape is determined by the number of bits per inch that can be recorded, the length of the tape and the blocking factor. Now a days DATs or Digital Audio Tapes are replacing magnetic tapes because of their compact size and large storage capacity, say of the order of 4 GB.

Most data and programs are stored on secondary storage.

3.3   Input & Output Devices

Input and output (I/O) devices move data into and out of the computer's processor. The most common input device is a keyboard. Other input devices are mouse, light pen, touch screen, digitizer, optical code reader, scanner, voice recognition devices. A mouse is an input device that moves the cursor to the display screen as the mouse is moved across the fat surface, such as desk. The mouse is equipped with buttons that is pressed to make the selection. Light pen and touch screen allows computer users to point at images on the display screen make choice that control the computer, using either photocell pen or simply their own fingers. A digitizer pad is a flat plate equipped with an electronic stylus which can be used to enter graphical information with great precision and perform a variety of graphics and drafting functions, such as that done in computer aided design. Optical character reader scans pages of printed text, convert each character to its corresponding digital signal and sends this information to the computer for manipulation and/or storage. Scanners are similar to optical character reader with the exception that instead of recognising individual characters, they read the image pixel by pixel, thus enabling them to copy pictures as well as text. Voice recognition devices use a microphone/ telephone and special interface which identify voice pattern and convert the spoken words into the corresponding preprogrammed commands.

The computer can manifest its output in a variety of forms : visual, printed, graphical and electronic. The terminal displays the text and graphics generated by the computer. The terminals known as monitors are of two categories : monochrome monitors and colour monitors. They can also be classified as text only monitors and text and graphics monitors.

Hardcopy output of computer generated information can be obtained using a printer or a plotter. Several types of printers are available; they are suited for different kinds of work, such as printing letters of type written quality, quickly printing rough drafts, intermixing graphics and text, producing documents of typeset quality or

printing colour graphics. The two most widely used types of printers are letter quality and dot matrix printers. However, laser printers and inkjet printers are quickly gaining in popularity.

Letter quality printers uses a daisy wheel or a thimble letter head to produce fully formed characters like those of a typewriter. Dot matrix printers form the character by printing a patter of dots corresponding to the shape of the desired character. They are faster and more flexible than the letter quality printers. Their print is not as sharply defined as the letter quality printer.

Laser printers use a beam of laser light to electrostatically etch characters on a photoconductive drum, which is identical to the print drum used in photocopiers. The laser beam scans across the drum discharging rows of dots, at a very high density to form the characters and images of the entire page. Laser printers have the advantage of excellent quality of print, very high speed and quiet operation. Inkjet printers squirt tiny droplets of ink on to the paper to form the characters. They use a printhead mounted on a cartridge which moves across the page to create the image. They are best suited for printing colour graphics and other multicolour images.

Plotters are output devices which permit the production of high quality drawing and text using pens.

4.0   PERSONAL COMPUTER (PC)

The introduction of PCs and the exponential growth of chip technology has remarkably increased the data processing and computational speed. The PC is a versatile tool used in many areas of hydrology by improving management of water resources through automatic data collection devices, use of simulation and optimization for planning and use of real time forecasting techniques for operation of projects. The PC family of computers are a powerful tool, not only for mathematical computation but also for information processing.

Before the advent of PC, earlier systems required more space. The room in which they were housed required temperature and humidity control, beside being dust free. Only limited persons were allowed to enter in computer room. The users had to give information on punch cards or on magnetic tapes to computer center for processing. Against this, PCs occupy less space and can work in normal room environment. Hence PCs are becoming popular and are user friendly.

A PC essentially consists three units:

- Central Processing Unit, typically housed in a rectangular box.
- Video Display Unit (VDU) or display screen
- Keyboard

The keyboard provides the facility to enter commands or information to the computer and the screen to display the response to these commands.

IBM has introduced a series of computers since the introduction of the IBM PC in 1981. They had an immediate impact on the microcomputer industry. Most of the other computer manufacturers recognized the significance of the emerging IBM standard and began to produce "IBM compatible" computers.

The features of major IBM type PCs are as follows :

IBM PC   :   It was the first PC in the market and used 8088 microprocessor with 4.77 MHz speed. Later the speed was improved to 8 MHz. It was base on the floppy drives of 360 KB capacity.

IBM PC/XT: This was an improvement over the IBM PC. Its main difference was the support for a hard disk.

IBM PC/AT: Here AT stands for Advanced Technology. This was the improvement over PC/XT and used

80286 microprocessor. The speed was 8 MHz and 16 MHz. In 1985, INTEL introduced 80386, a 32 bit microprocessor. This significantly enhanced the microprocessors capability to retrieve and store data to RAM. PC 80386's speed varies from 16 to 33 MHz.

The 80386SX can be considered a hybrid 80386 microprocessor. Although it has all the processing capabilities of the 32-bit PC 80386, the former microprocessor was designed to use 16-bit data bus of a 80286. This bus reduction significantly reduced the cost. The PC 80386SX supports 16 and 20 MHz speed. The key difference between a 16 MHz 80286 and 16 MHz 80386SX is the ability of the later to support a true 32-bit operating system.

80486 was the next member of INTEL's fimily. Although similar to the 80386 in its use of a 32 bit bus, the 80486 incorporates a number of functions onto one chip that formerly required seperate chips. Unlike other microprocessors, the 80486 included a on-chip numeric processor and an internal cache.

The latest member of this family is the 80586 microprocessor commonly known as PENTIUM.

5.0   MULTI-MEDIA PC

The word media means the medium that carries our communication to the outside world and renders it in a distributable format, interpretable by all members of the society. "Multimedia" then would logically mean a multifaceted use of various media, be it text, voice, music (sound), images (both still and moving pictures and video) and the ability to use them all together. With the popularity of the PCs the multimedia revolution brings the power of effective communication in the entirety of every individual. The limitation is only individual's imagination and creativity.

It all started with the enterprising efforts of a few imaginative people, for whom computer did not only mean serious number crunching, complicated databases, MIS and low resolution games but a multifaceted tool into which, through clever programming, they could breath the life of CD quality stereo sound, colourful animation and electrifying images. It is often interactive. It needs a large memory, so a CD is used for storage.
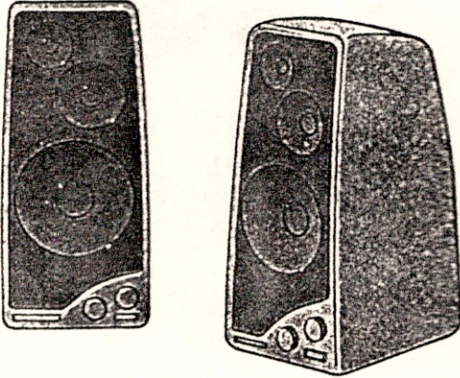
A multimedia upgrade consists of a CD-ROM drive and a sound blaster card and often include head phone, speaker, a microphone and multimedia CDs. A typical multimedia system is shown in Fig.2 and Fig.3.
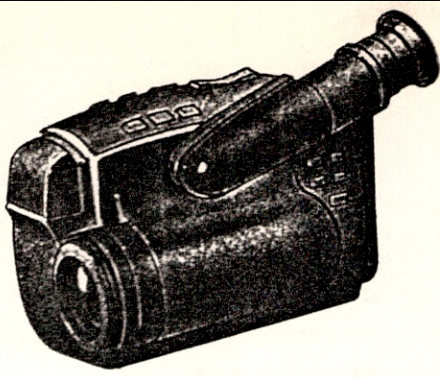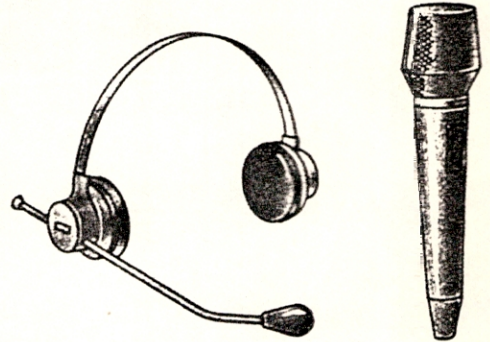
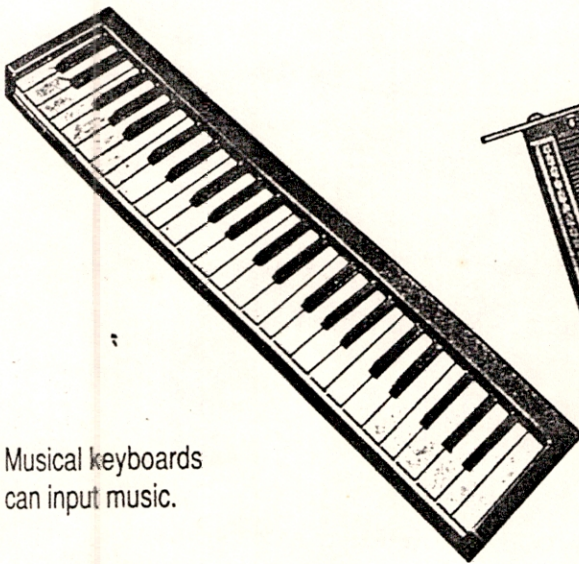Video cameras record moving pictures on videotape.
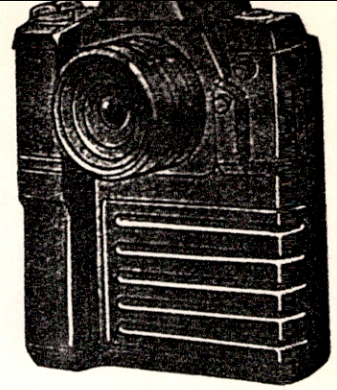
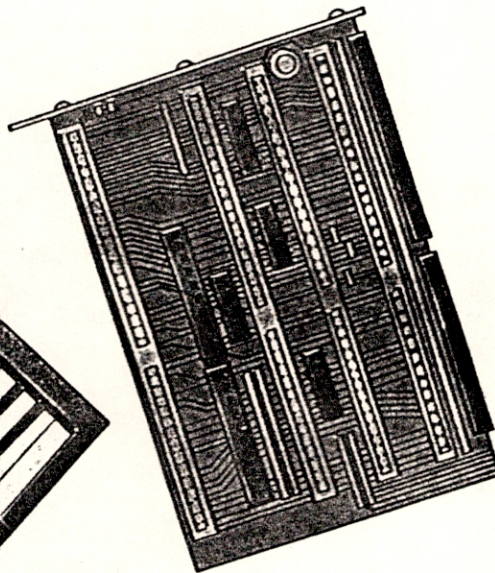Special cameras take photographs in digital form.

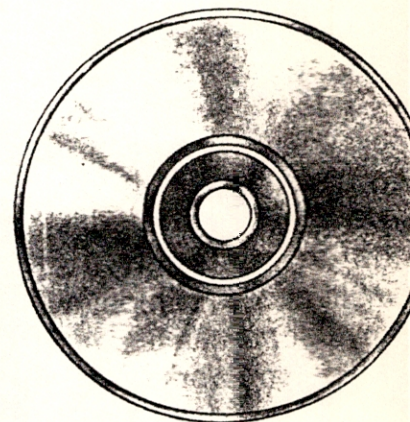Speakers let the user listen to sound.

Microphones let the user record sounds and voices.

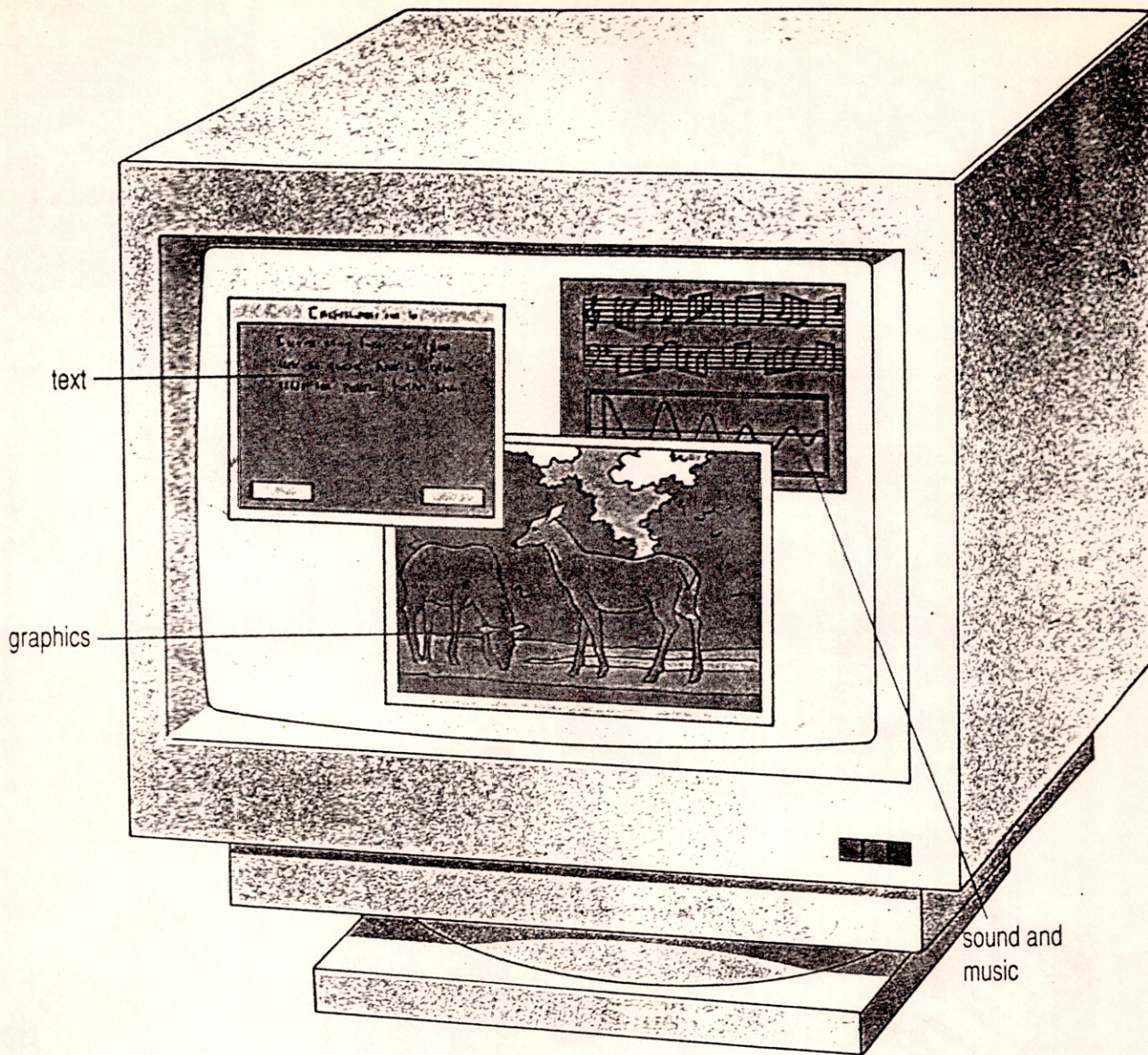

Musical keyboards can input music.

Special circuit boards are needed for video, sound and graphics.

Optical disks are used for memory.

Fig. 2 : Various Inputs for Multi-Media Upgrade

text

graphics

sound and
music

Multimedia software often uses windows to display
information.

Fig. 3 : Typical Multi-Media Upgrade
          Screen

6.0   PERFORMANCE INDICES OF A COMPUTER

Computers differ widely in their computing power and speed. There performance can be measured in
a number of ways, such as the number of instructions that can be processed in a given time period. Other
indicators of computer power are the dataword length and the size of primary memory. A committee known as
System Performance Evaluation Committee (SPEC) has come out with a few performance indices. The index
SPECint92 is a geometric mean of six integer tests written in C language and SPECfp92 is the geometric mean
of 14 tests (five in single precision and nine in double precision). The typical value of these indices for a
Pentium PC may be of the order of one hundred. Some other measures are Linpack DP in mega floating
operations per second (MFLOPS), Linpack SP(in MFLOPS), and Linpack TPP(in MFLOPS). Sometimes an
overall performance index which includes measures of CPU and peripherals is also computed.

7.0 USEFUL HINTS REGARDING USE OF PCs

o   Avoid excessive heat. The PC should be kept at least one foot away from the   wall.

o   Don't move the PC while it's is power ON. Movement of any kind could cause severe damage to the hard disk and could result in it's failure.

o   Don't shift the PC without parking the hard disk. Use disk parking utilities like Diskpark, Pctools or Shutdown etc. for parking the hard disk.

o   Don't switch the PC ON and OFF frequently. If you switch it OFF wait for at least 30 seconds before turning it ON again. While switching OFF the PC follow the sequence given below:
      - Switch OFF the computer.
      - Switch off the monitor.
      - Switch OFF your CVT.
      - Switch OFF the main power point.

o   PC/AT with printer requires CVT with 1 KVA rating. Please check whether the CVT is adequate or not.

o   Keep the printer and keyboard covered while not in use in order to prevent the dust, which makes the mechanical parts wear very soon.

o   Do not run diagnostic softwares like Disk Manager, QAPLUS etc. unless you are completely familiar with it. It may permanently damage the disk.

o   Do not attempt low level formatting on the hard disk. Specially the PC-AT/386 users should not format their hard disk on their own, as these HDDs do not require it and may become useless once it is done.

o   If any part of the PC/Printer like printer knobs are broken don't throw it away. It may be required by the service engineer to replace it.

o   Avoid using PC during sudden temperature or humidity changes which could lead to condensation on the components. If you change the environment wait a half an hour before the power ON.

o   Avoid keeping a PC on vibrating surfaces, which could loosen connections.

o   Avoid dust, dirt, smoke and humidity (the direct path of a desert cooler). They damage keyboards, floppy drives and other components. Dusty floppy drives can destroy the floppies in seconds.

o   In case of any problem call the service engineer instead of trying to fix it yourself.

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