THE COMPUTER CHARACTERISTICS

Computers are electronic machines that process information. They are capable of communicating with the user, of doing five kinds of arithmetic operations, and of making three kinds of decisions. However, they are incapable of thinking. They accept data and instructions as input, and after processing the information, they output the results.

When talking about computers, both hardware and software need to be considered. The former refers to the actual machinery, whereas the latter refers to the programs that control and coordinate the activities of the hardware.

Computers are machines designed to process electronically specially prepared pieces of information, which are termed data. Handling or manipulating the information that has been given to the computer, in such ways as doing calculations, adding information or making comparisons is called processing. Computers are made up of millions of electronic devices capable of storing data or moving them at enormous speeds, through complex circuits with different functions.

All computers have several characteristics in common, regardless of make or design. Information, in the form of instructions and data, is given to the machine, after which the machine acts on it, and a result is then returned. The information presented to the machine is the input; the internal operations, the processing; and the result, the output. These three basic concepts of input, processing, and output occur in almost every áspect of human life whether at work or at play.

The centrepiece is called either the computer, the processor, or, usually, the central processing unit (CPU). The term "computer" includes those parts of hardware in which calculations and other data manipulations are performed and the high-speed internal memory in which data and calculations are stored during actual execution of programs. When data or programs need to be saved for long periods of time, they are stored on various secondary memory devices or storage devices.

Computers have often been thought of as extremely large adding machines, but this is a very narrow view of their functions. Although a computer can only respond to a certain number of instructions it is not a single-purpose machine since these instructions can be combined in an infinite number of sequences. Therefore, a computer has no known limit on the kinds of things it can do; its versatility is limited only by the imagination of those using it.

In the late 1950s and early 1960s computers were very expensive to own and run. Moreover, their size and reliability were such that a large number of support personnel were needed to keep the equipment operating. This has all changed now that computing power has become portable, more compact, and cheaper.

In only a very short period of time, computers have greatly changed the way in which many kinds of work are performed. Computers can remove many of the routine and boring tasks from our lives, thereby leaving us with more time for interesting, creative work. It goes without saying that computers have created whole new areas of work that did not exist before their development.

COMPUTER CAPABILITIES AND LIMITATIONS

Like all machines, a computer needs to be directed and controlled in order to perform a task successfully. Until such time as a program is prepared and stored in the computer's memory, the computer 'knows ábsolutely nothing, not even how to accept or reject data. Even the most sophisticated computer, no matter how capable it is, must be told what to do. Until the capabilities and the limitations of a computer are recognised, its usefulness cannot be thoroughly understood.

In the first place, it should be recognised that computers are capable of doing repetitive operations. A computer can perform similar operations thousands of times, without becoming bored, tired, or even careless.

Secondly, computers can process information at extremely rapid rates.

Thirdly, computers may be programmed to whatever level of accuracy is specified by the programmer. These machines are very accurate and reliable especially when the number of operations they can perform every second is considered. Because they are man-made machines, they sometimes malfunction or break down and have to be repaired. However, in most instances when the computer fails, it is due to human error and is not the fault of the computer at all.

In the fourth place, general-purpose computers can be programmed to solve various types of problems because of their flexibility. One of the most important reasons why computers are so widely used today is that almost every big problem can be solved by solving a number of little problems – one after another.

Finally, a computer, unlike a human being, has no intuition. A person may suddenly find the answer to a problem without working out too many of the details, but a computer can only proceed as it has been programmed to.

THE CENTRAL PROCESSING UNIT

It is common practice in computer science for the words "computer" and "processor" to be used interchangeably. More precisely, "computer" refers to the central processing unit (CPU) together with an internal memory. The internal memory or main storage, control and processing components make up the heart of the computer system. Manufacturers design the CPU to control and carry out basic instructions for their particular computer.

The CPU coordinates all the activities of the various components of the computer. It determines which operations should be carried out and in what order. The CPU can also retrieve information from memory and can store the results of manipulations back into the memory unit for later reference.

In digital computers the CPU can be divided into two functional units called the control unit (CU) and the arithmetic-logical unit (ALU). These two units are made up of electronic circuits with millions of switches that can be in one of two states, either on or off.

The function of the control unit within the central processor is to transmit coordinating control signals and commands. The control unit is that portion of the computer that directs the sequence or step-by-step operations of the system, selects instructions and data from memory, interprets the program instructions, and controls the flow between main storage and the arithmetic-logical unit.

The arithmetic-logical unit, on the other hand, is that portion of the computer in which the actual arithmetic operations, namely, addition, subtraction, multiplication, division and exponentation, called for in the instructions are performed. It also performs some kinds of logical operations such as comparing or selecting information. All the operations of the ALU are under the direction of the control unit.

Programs and the data on which the control unit and the ALU operate, must be in internal memory in order to be processed. Thus, if located on secondary memory devices such as disks, programs and data are first loaded into internal memory.

Main storage and the CPU are connected to a console.

HARDWARE AND SOFTWARE

In order to use computers effectively to solve problems in our environment, computer systems are devised. A "system" implies a good mixture of integrated parts working together to form a useful whole. Computer systems may be discussed in two parts.

The first part is hardware – the physical, electronic, and electromechanical devices that are thought of and recognised as 'computers'. The second part is software – the programs that control and coordinate the activities of the computer hardware and that direct the processing of data.

The basic components of computer hardware are joined together in a computer system. The centrepiece is called either the computer, the processor, or usually the central processing unit (CPU). The term "computer" usually refers to those parts

of the hardware in which calculations and other data manipulations are performed, and to the internal memory in which data and instructions are stored during the actual execution of programs. The various peripherals, which include input and/or output devices, various secondary memory devices, and so on, are attached to the CPU.

Computer software can be divided into two very broad categories – systems software and applications software. The former is often simply referred to as 'systems'. These, when brought into internal memory, direct the computer to perform tasks. The latter may be provided along with the hardware by a systems supplier as part of a computer product designed to answer a specific need in certain areas.

The success or failure of any computer system depends on the skill with which the hardware and software components are selected and

blended. A poorly chosen system can be a monstrosity incapable of performing the tasks for which it was originally acquired.

STEPS IN PROBLEM SOLVING

Can a computer solve problems? Definitely not. It is a machine that carries out the procedures which the programmer gives it. It is the programmer then who solves the problems. There are a few steps that one has to follow in problem solving:

Step 1. The programmer must define the problem clearly. This means that he or she has to determine, in a general way how to solve the problem. Some problems are easy, while others take months of study. The programmer should always start by asking: 'Do I understand the problem?'

Step 2. The programmer must formulate an algorithm, which is a straightforward sequence of steps of instructions used to solve the problem. Constructing an algorithm is the most important part of problem solving and is usually time-consuming. An algorithm can be described by a flowchart or a block diagram.

Step 3. The programmer must translate the algorithm or flowchart into a computer program. To do so, he or she writes detailed instructions for the computer, using one of the many computer languages available following the exact sequence of the flowchart algorithm. The program is usually written on coding sheets, which have a specific format drawn on them.

Step 4. The program is entered into the computer at a terminal with a visual display unit.

Step 5. The program must then be tested. To do so, the computer operator presses the 'read' button. This transfers the information to the memory of the computer. Alternatively, the program must be read from disk. If the programmer is using a terminal to enter the instructions it is possible, with the aid of a few commands, to store the program in the memory of the computer and get a printout.

THE WORLD OF PERSONAL COMPUTING

Personal computing is a partnership between the person and the computer.

Believe it or not, a personal computer is easier to operate than a car. It's even easier to operate than a telephone, which comes with no instructions at all. Suddenly, personal computers invaded our world. It's not surprising that it takes most of us a while to get comfortable with a technology that so recently arrived on the scene.

The purpose of this book is to introduce the intelligent, competent adult to the exciting world of personal computing in order to be able to use a PC for your business, for your employer, or at home, and is comfortable for you.

THE THREE SIDES OF A COMPUTER SYSTEM

An IBM-compatible computer consists of three pieces of hardware-a keyboard, a box containing the actual computer ("the system unit"), and a thing that looks like a TV but can't get any channels. Those are most obvious parts of the PC. But for a computer to be more than just a collection of boxes it needs two other things.

The second element of a computer system is the software, the instructions or "programs" that tell it what to do.

The third useful element is a community which refers to the human community that has arisen around the PC and that is as valuable to the PC owner as the other two components.

The existence of this community is one of the things that makes the PC a landmark in the history of microcomputers and personal computing. The first landmark was a hardware development, the introduction of the first microcomputer, the Altair, in 1975. As the Altair and other early microcomputers began to catch on, hobbyists developed games, languages, and other programs for them. But microcomputers weren't of much practical use until another major landmark, a software development, took place in 1979; the introduction of VisiCalc, the world's first electronic spreadsheet. Suddenly business people and professionals could do their old tasks faster and better, and do things that were previously impossible, merely by investing a few thousand dollars in hardware, a few hundred dollars in software, and a few dozen hours in deciphering the documentation.

In 1981 IBM rocked the world by announcing the IBM PC.

America, and soon the world had to take the micro seriously. Very quickly the PC showed its true power. Although it had a memory capacity several times greater than its predecessors, the power to store millions of items of information, and to search files and "crunch numbers" with extreme speed (like having the world's fastest file clerks and bookkeepers on your staff), the ultimate measure of the PC's power was – and continues to be – the range of tasks it can perform.

Programmers created new programs or modified existing ones for the PC.

The same thing happened in the hardware arena. Scores of manufacturers had introduced hardware enhancements such as plug-in circuit boards that gave the PC more memory, more functions, and more flexibility than Big Blue – as IBM is sometimes called – had dreamed of.

Thus the IBM PC is really a three dimensional computer system consisting of hardware, software and community.

After the IBM PC had been on the market for about two years, IBM introduced a more powerful version, which is called the XT (for extended Technology). The major difference between the two machines was that the XT came with a hard disk in addition to a floppy-disk drive. The XT's hard disk could store almost as much information as 30 floppy disks and ran about ten times as fast.

In 1984 IBM introduced the AT (for Advanced Technology). The company made a number of changes but the most significant one is that instead of the AT being built around an Intel 8088 microprocessor chip (like the PC and XT) IBM used the faster and more powerful Intel 80286 chip.

In 1986 the still more advanced Intel 80386 microprocessor found a home in the PC family. The PC family has a long and dynamic life.

THE SYSTEM UNIT

The system unit is the heart of the computer. It contains the central processing unit (CPU), the part that actually manipulates your numbers, words, or other information. In large computer systems the CPU is made up of a number of separate components. In personal computers, however, the entire CPU resides on a single integrated chip, called a microprocessor.

It is because of this chip that personal computers are also called microcomputers.

The system unit also contains memory components, which store data, and port, the inlets and outlets through which data pass on the way to or from the outside world (input and output). One of the input ports is connected to the keyboard, and one of the output ports is connected to the video display monitor. In this sense, the computer's operation is very much like a bank: all processing and storage functions are handled behind the scenes, while tellers, and automatic teller machines function as input and output devices.

Let's begin the tour by examining the system unit. The computer's one or two floppy-disk drives are located in front of the power supply, and power to operate the disk drives comes from the cables.

If you are standing in front of the open unit, looking down at it you'll see the metal enclosure in the back right comer which contains the power supply. The power supply converts power from the wall to power the computer can use. Just to the cord's right is an outlet that can supply power to a monochrome monitor and to it's left are louvers for the cooling fan. On most PC's the on-off switch is on the right side of the power supply. The computer's one or two floppy-disk drives are located in front of the power supply in the lower right corner of the unit.

Lying flat on the left half of the system unit is the system board. This is the computer. It is a printed circuit board that holds the microprocessor chip (the central processing chip, or CPU) that makes the whole PC work, and a number of memory chips that give the CPU something to work on.

The microprocessor in most PCs is the Intel, although some use an Intel or other chip. The memory is laid out in rows of nine chips each; eight of the chips are needed for storage of data, and the ninth is used to verify that data.

The system board for IBM PCs has eight slots (actually large sockets) It is sometimes referred to as the motherboard.

The plug-in boards serve several purposes, the first of which is to hold additional memory. A second use of plug-in board is to hold the circuitry that controls various components of the system. The third purpose of plug-in board is to link the PC to various input and output (I/O) devices. This is done by means of the ports mentioned previously. Most printers

require that data be sent to them through a parallel port, but some require that the computer have a serial port, sometimes called the asynchronous port. Not all the boards are the same size.

THE MONITOR

Every computer must have an input device for receiving instructions and data, a CPU (central processing unit), which processes the data according to the instructions, and an output device, which returns the processed material to the user. If we think of the system unit, which contains the CPU, as the heart of the computer, the input and output devices are its connections to the outside world.

The PC's basic output device is the video display monitor.

The PC can also send output to other devices, including a printer, a modem, and, for more limited purposes, a speaker.

While the incredible power of personal computers sometimes makes us think they can do anything, even computers involve compromises. The monitor requires such a compromise. Monitor screens can display extremely steady, highly detailed images, providing easy to read text. They can also display colourful, rapidly changing images, providing fast – moving animation. But a single monitor cannot optimise both.

The imagine a video screen is transitory; if not continually recreated, or refreshed, it will disappear. For the highest quality flicker-free display, it is desirable that the image not begin to fade before it is refreshed.

THE KEYBOARD

Information can be sent to the computer from files stored on a disk, from a modem, or from a pointing device such as a mouse. But just as the monitor is the computer basic output device, the keyboard is the basic input device.

The keyboard is probably the most individual aspect of a computer. Although the-screen may be just as personal, since you look at it all the time, its qualities – colour, sharpness, flicker, and so on – can be evaluated objectively. Contact with the keyboard, on the other hand, is tactile, which is more intimate and more subjective.

There are three "standard" keyboard designs for the PC family. Each was initiated by IBM. They differ in the number of keys, in the arrangement of some of these keys, and in certain other features. All current IBM personal computers now use a 101-key keyboard.

THE PRINTER

Although the system unit, the keyboard, and a monitor are all the computer needs to get its job done, you probably need at least one more piece of hardware: a printer. We usually want the end result of the computer's activity to be printed out on paper – we want hard copy, not just electronic copy.

All printers do basically the same thing: they transform electronic information from the computer into letters, numbers, and symbols, on paper. But they don't all do this in the same way.

Letter-quality printers use a print wheel and provide high-quality printing and a wide range of interchangeable typefaces, but are relatively slow and expensive. Dot matrix printers, which use a number of tiny wires in various combinations to create characters are considerably faster and less expensive than letter-quality printers, but their output is generally of lower quality.

Laser printers. Whereas letter-quality and dot matrix printers strike a ribbon to deposit ink on the paper, laser printers use a technology similar to that of photocopy machine to deposit minuscule dots. Most laser printers deliver a resolution of 300 dots per inch (dpi). This results in extremely sharp and detailed images, and text that almost equals that of letter-quality printer.

The Hewlett-Packard LaserJet printer has brought quality printing to the desktops of thousands of offices throughout the world. With its Resolution Enhancement technology, the HP LaserJet printer has established itself as the industry standard. You can scale typefaces, create and manipulate graphics and print complex documents faster than ever before. At last ability to mix graphics and text on a page is an investment. That is why all HP LaserJet printers are compatible with every software package on a market, as well as any existing HP LaserJet printer.

Laser printers produce characters and images by printing a series of extremely small dots. In conventional laser printing these dots are all the same size, and the borders of images look as steps. Resolution Enhancement technology improves its quality by means of HP LaserJet Toner Imaging System, processing the characters one step later. This toner cartridge gives you more accurate reproduction of the scanned images.

THE DOCUMENTATION

The components covered so far are the major hardware items in a typical PC installation: the three essentials (system unit, monitor, and keyboard) plus a printer. But there is one essential component we haven't examined – the manuals, or if you prefer computer jargon, the documentation. The IBM manuals are thorough, but they are great once you understand them but awfully confusing to newcomers. If you continue to refer to manuals from time to time many points that didn't make sense the first time will eventually become clear. Gradually you'll become not only computer literate, but computer competent-and-perhaps even more important – computer comfortable.

STORAGE

Memory gives you a temporary area to do your work, the CPU processes it and the monitor displays it, but if you can't save your work, it will all disappear the moment you turn the power off. The first IBM PC's offered two forms of long term storage: standard cassette tape recorders and low capacity floppy disks. Floppy disk capacity has increased significantly and fast high capacity hard disks have become common place. Optical storage (as contrasted to the magnetic technology used by disks) is coming into increasing use for certain applications.

When we talk about storage we're actually talking about two things: a medium (such as floppy disk) and a mechanism (such as a disk drive that reads and writes information to and from the floppy disk). Most storage methods involve removable media. Hard disks on the other hand, use fixed media – the platters on which the data are stored are sealed inside the drive mechanism. Hard disks provide two important advantages over floppy disks: greater storage capacity and increased speed. Data transfer rates for hard disk drives are much greater than their floppy counterparts. Hard disk drives read and write data ten to twenty times faster than a floppy one.

The two characteristics considered when selecting a hard disk are capacity and speed. Three other forms of storage devices deserve mention: removable disk cartridges, tapes and optical disks. Tape drives are useful for backups archival copies of everything stored on your hard disk. Programs and data can be backed up to floppy disks. The content of the larger hard disk can be copied to a given tape drive in minutes with very little effort.

A few manufacturers offer drives that use floppy disks encased in plastic cartridges. Like hard drives these units have a higher capacity than floppy drives storing 100 to 250 Mb of data on a single disk. But like floppies they are removable and interchangeable. A common use of removable hard drives is to provide a convenient backup system. Optical disks hold massive amounts of data and permit almost instantaneous access.

Their drawback is that once stored data cannot be erased to make room for additional data. One form of optical storage, CD ROMs, is used to distribute large databases.

CD-ROM

As early as 1980, when the first audio compact-disc appeared, its producers promised that the users of personal computers would also get the capability to store information with a volume of 640 megabytes. It became simply impossible to resist the sound-text-image combination and CD-ROM conquered the world.

And though attention was largely focused on CD-ROM attractiveness for multi-media market large-scale software companies acknowledged that CD-ROM could also carry software information. Even more popular programs come on these bristling discs.

For software producers a compact disc worth less than a dollar is equivalent to a whole dozen of floppy discs and half a kilo of technical specifications. The users get a simplified process of program installation, technical specifications in the shape of multi-media and large volume disc memory such as types, graphic illustrations and photo illustrations.

For the ultimate user a compact disc offers new possibilities in the method of purchasing software. Ever more often producers bring out compact-discs with the full working versions of programs, types and graphics to which the user gets access upon paying for the password on opening one or another product contained on the disc.

A compact-disc can only be used with a special disc player which is why the growing popularity of compact-discs has led to the mass production of disc player for playing the discs. Many persona] computers are usually sold with a rich collection of CD ROM programs.

Even portable computers are now equipped with compact-disc conductors, whereas such firms as Panasonic, Toshiba. Peacock and Sony have put on the market laptops with integrated CD-ROM disc conductors.

The successor to the CD ROM is DVD. DVD stands for Digital Versatile Disk. In fact it looks like a CD-ROM. You can even play CD-ROMs and audio compact discs in a DVD drive. The difference is that a DVD holds many times more information than a CD-ROM, which means that a single disk can store a two-hour movie, with a quality level unmatched by consumer videotapes. A personal computer equipped with a DVD drive can play a movie, either on its own screen or on a connected television set. A laptop computer equipped with a DVD drive can play a movie on your lap – even on an airplane.

INPUT DEVICES

A computer has four major functional elements: input, processing, storage and output. While the keyboard is the most common input device for PCs, it is not the only one. With a keyboard you move the cursor with the arrow key or, in some programs, with a combination of other keys. You tell the computer what to do by either typing commands or pressing keys to make choices from a list of menu. A mouse is a small rounded box that is connected to your computer by a wire. Moving it over your desktop moves the cursor, and clicking one or more buttons on the mouse enters commands or menu choices. A mouse is almost essential for many graphics programs and can be useful in any program requiring extensive cursor manipulation, including word processing and spreadsheets providing the program is set up to work with a mouse.

Another approach to avoiding the tedious task of typing is the scanner which scans a page of text and inputs the characters directly in the computer. Closely related to scanners are digitizers which scan a photo or other image and convert the visual information into digital form that can be stored in the computer and reconstructed on the monitor or printer. Today both devices can be practical additions to your system if you need the services they offer. Voice input still has a long way to go and is only practical in very specialised situations. Other input devices that you may want to consider include bar code readers, light pens, joysticks and trackballs.

OUTPUT DEVICES

APC can provide output in the form of signals that can control other devices, such as lights, appliances and alarm systems. It can also provide voice output. The most-used output device is actually the monitor. We usually want the results of our labours in a more permanent form and most often on paper. This means some form of printer or plotter. Printers and plotters. In choosing a computer system most of the thought usually goes into the computer itself and the software that will run on it. Yet in some ways the printer is the most critical part of the whole system. It is the face you present to the world and it is also a potential bottleneck. For your PC to fulfil its potential its printer should receive the proper consideration, connection, control and care. Dot matrix printers are fast, inexpensive and provide hard copy that in most cases looks like it came off a computer. A letter-quality printer uses a daisy wheel to print fully formed characters. For strictly personal use thermal printers are the least expensive of all.

Most of dot matrix printers can generate graphics, though slowly and with only moderate detail. Plotters have the advantage of actually drawing lines not just assembling tiny dots. However, plotters have only limited text printing capability. An increasingly popular alternative to all of these is the laser printer. For desktop publishing it's essential that text comes closer to a true letter-quality printer, line-based graphics (graphs, charts, drawings) come closer to plotter quality; while for pictures involving shading and other complexities a laser printer surpasses anything else in its class. Laser printers are very fast and very quiet, they are also

more expensive than the other options, take up more space and draw more power.

MODEMS

A modem is a device that translates computer signals into frequencies that can be sent over telephone lines. "Modem" is a contraction of the words "modulator" and "demodulator", the technical terms for the signal translation process.

The two main considerations in choosing a modem are transmission speed and whether to buy an internal or an external modem.

A modem's speed rate is simply the rate (measured in bits per second) at which it can send data. Modems that operate at 300 bits per second (bps) can transmit approximately 30 characters per second (cps), while 1,200 – bps modems can transmit 120 cps and 2,400 – bps modems 240 cps. The faster modems can switch to a lower speed when desirable. 33,600 and 56,000 bps modems are gaining increasing acceptance in the business world. However, whereas, regular phone lines usually suffice for transmissions up to 33,600 bps, special dedicated phone lines are usually required for reliable transmission at speeds above that.

Modems come in two configurations: external and internal. An external modem is enclosed in a separate case and draws its power from either a wall outlet or batteries. External modems take up desk space and must be connected to the computers serial port by a cable. If your computer already has a serial port, an external modem has the advantage of not using up a slot. External modems have one feature lacking in internal modems: status lights which provide visual feedback concerning the connection and data flow.

An internal modem is contained on a plug-in board and draws its power directly from the computer. Internal modems have the advantage of being out of sight and out of the way-no boxes and no extra cables. They also cost a little less than the external variety.

All modems require communications software in order to function. Many modems include a program in the purchase price.

A number of separate programs are also available. You should verify that communications programs will operate properly with the modem you have a plan to purchase.

SOFTWARE (WORD)

Word processing is the closest thing to a universal computer application. We all write, and anyone who writes can benefit from a word processor.

The problem with writing is that words often look different on the page than in your imagination. But with a word processor everything you write is tentative. Your words await your approval; if you don't like what you see, revision is easy. When you are satisfied you can save the work on a disk and print it on paper, you can revise and, reprint and still finish in time.

With a word processor editing is easy. Word processor allows you to take a word, a sentence, or a block of text and move it elsewhere in your text. The word processing program keeps track of where you are and automatically moves to the next line when the cursor reaches the right margin. Perhaps the most amazing thing about word processing is their global search and replace capability. If you discover, for example, that in your report on packing alternative you neglected to capitalise a word the computer can do it for you. To locate a particular point in something you wrote, you no longer have to scan every page; just use the search function. A word processor, like many other types of programs, involve trade-offs; it is difficult to maximise both power and ease of use in the same product.

INFORMATION

Word processing programs manipulate words. Spreadsheets and accounting programs manipulate numbers. Filing programs and database management systems (DBMs) manipulate information.

Seventy-five years ago sociologist Max Weber noticed that office management was based upon written documents – the files. That is even true today: in the information age the control of information equals power.

Filing programs handle lists of information, from stamp collection to personal records. They can search, retrieve, recognise, and print reports or labels. Most are easy to learn and easy to use. For home use and some business uses they are ideal, but filing programs cannot relate one list to another or follow complex instructions. They manage files one at a time.

Database Management systems on the other hand can keep track of several files at once and follow complex instructions.

GRAPHICS

If your PC has configuration of a monochrome monitor it can display detailed letters and numbers but cannot generate true graphics. However you do have access to character graphics which can generate bar charts, boxes, borders, and the like. For true graphics, however, you must have either a colour monitor and adapter or other monochrome graphics adapter board that provides full graphics capability on a monochrome screen, whether black and white, green, or amber.

You will also need some way to tell the computer what you want to do. This is where graphics programs come in. The most common use of graphics on PC is to provide a visual representation of business data in the form of charts or graphs. A number of programs offer this capability. Some are stand – alone programs – you provide the information (designing shapes, lines, etc.), and they provide the picture. Other are add – on programs – they tie into your database, spreadsheet or statistic program, obtain the information from it, and generate a visual display such as a bar graph or a pie chart.

A second way of using PS's graphics capability is to produce

pictures for various purposes. There are two basic ways to generate pictures and diagrams with a personal computer clip art, and freehand drawing and designing software. Programs such as The Printing Press offer hundreds and even thousands of pictures, and allow the user to vary their size, location on the page and other characteristics.

More complex but also more flexible than clip art, this category of graphics program lets you create any picture you want rather than being limited to those provided by the program. One type, often called paint programs, permit onscreen freehand drawing. Another, CAD (computer-aided design) is for more format designs, such as architectural and engineering drawings. Both types usually require that the computer be equipped with a mouse or other pointing device, since drawing smooth curves and other keys would be too difficult.

DIGITIZERS

One method of reducing the cost of developing pictures on the screen is to "digitize" a printed illustration. Digitizers can read an image from a sheet of paper and convert it into a picture for display on the screen. The quality of the displayed picture depends on the paper original, but also on the resolution (that is the number of dots per inch) that the digitizer supports. A digitizer can produce good pictures on the screen with levels of grey scaling to give depth. It is then possible to edit these pictures using a special software package to improve the quality or add colour. The use of digitizers is increasing rapidly and it is possible to attach these very economically to certain printers.

It is also possible to purchase video digitizers that can take a photograph of a person or an object and digitize it in colour.

A BRIEF INTRODUCTION TO PROGRAMS

Most business applications of personal computers involve manipulating or commanding words, numbers, or information. For processing words, you would use a word processing program. The most common kind of programs for working with numbers is the electronic spreadsheet, though various kinds of statistical analysis and accounting programs also fall into this applications category. For handling information there are a number of powerful database management systems available, as well as simpler filing programs. The results of these programs are usually printed out on paper, sent to another computer using a modem and a communications program, or stored on a disk.

Two additional kinds of programs are educational programs and utilities. Computer-assisted instruction (CAI) can help you to understand your computer, improve your typing, learn a foreign language, lake full advantage of a complicated program, etc. Utilities are the software equivalent of an administrative assistant or handyman. Some utilities manage the computer's input and hard disk, DOS does not really destroy the data or program in the file.

COMMUNICATIONS

Communications programs allow you to share data between computers. These can be two PCs, or a PC and a mainframe. To transfer data you need a communications program, a telephone, and a modem (which converts the computer's digital signals into analog frequencies the phone lines can handle, then converts them back at the other end).

PROGRAMMING

Any problem is expressed in purely mathematical terms. It contains formulae, equations, calculations. But the problem is for the computer a thing beyond its understanding. The computer cannot handle formulae, equations or calculations. The computer does not know what man asks of it. The programmer is the connecting link between the computer and the problem it has to solve. He has first to visualise then to subdivide any complex problem into a sequence of simple instructions that the computer could cope with.

livery problem, even the simplest one, contains numerous instructions. Naturally, the more complicated is the problem, the longer is the list of instructions. The compilation of programs is a very difficult job requiring high qualification. When the problem is compiled and laid into the computer the latter sets to work. 1 he program in a computer is executed in sequence, cycles, step by step operation after operation.

Each instruction consists of two parts: it tells "what to do" and "where to do it" – the operation and the address part, or simply address.

Without the program the electronic computers, even those capable of millions of operations per second, are at best, items of furniture of institute and factory offices.

The entire line of calculations in the computer, the so-called processing of information is organized by the programs. It's the program that ensures the execution of all operations assigned to the computer.

The programmers prepare whole series of standard programs for the solution of typical problems. The greater the problem file provided for the computer the better it is adapted for work, the easier is its contact with the user, the greater are the facilities for its use.

Program compilation has become a sort of an industry for the mathematical provision of computers. This mathematical provision is a complex of programs compiled in special libraries. They enable the computer to operate efficiently, to carry out the solution of programs.

COMPUTERS DON'T BITE

This brings up two important things you should realize about using a PC, First, there is nothing you can do from the keyboard that can damage the computer. You can change or erase data or programs which is why you'll be using copies and making backups of your disk – but you can't break anything. Punching a wrong key won't cause it to self-destruct, explode, punch you back.

Second, the computer does not know what you are doing. The computer doesn't know anything. Not only aren't computers smart, they aren't even dumb. A computer has no more intelligence than a microwave oven, and can only do what a person – you, the engineer who designed the hardware, or the programmer who wrote the program you are using – has told it to do. What's more, the computer doesn't keep track of what you are doing. Unless you are using a sophisticated accounting program that generates an audit trail there is no way for a computer to monitor your activity, let alone make any judgements about it; so relax, enjoy, and press a few more keys.

DATA PROCESSING

Data processing refers to the operations which are performed on the data either to derive information from them or to order them in files. These operations include functions performed both by programmers and automatic equipment.

The functions of programmers are to prepare, test, and document computer programs. This step encompasses analysing a problem, formulating an algorithm to solve it, translating the algorithm into a high-level language, testing the program, and running it with the data. The functions of the computer, on the other hand are to perform arithmetic and logical operations on the program and data after they have been translated

to machine code, and to make the results of these operations accessible to humans.

Data may be processed in batch or in real time. The former means grouping transactions and processing them as one unit, while the latter refers to processing the data almost simultaneously as it is generated. Another approach to data processing is structuring and organizing the data so as to make them useful and available to more than one, particular user. This is called data base management.

PROGRAMMING LANGUAGES

All programs are written using various programming languages which translate the applications-oriented commands we understand into a code a computer understands. When programmers write a program, it must be converted into a machine language. This conversion is carried out by a compiler or an interpreter.

Programming languages help programmers to communicate with the computer by using a number of rules built, into each language, without having to know the details of the hardware of the particular computer they are using.

High-level languages were developed to make programming more effective. Because of clear connection to English, high-level languages are easier to learn than assembler language or machine code. They are quicker to write, easier to understand, and easier to maintain.

But why have more than one high-level language? Attempt have been mode to produce universal programming languages but the requirements of business and science and engineering fields are quite different, so the language to cover both areas becomes large and complex. No programming language is perfect – far from it – so there are continuous attempts at improvement.

OPERATING SYSTEMS

Computers actually need two kinds of software. The one that gets the most attentions is applications software, programs that let you use the computer to perform a particular job. Examples are spreadsheets, accounting programs, word processors and database management systems.

The other kind is called system software or an operating system. The operating system is often compared to a traffic cop, directing instructions and data to and from the keyboard, screen, disk drives and so on. The operating system is the control program, that decides which job should run on a priority basis, depending on the facilities needed by each one and the importance attached to the job. Some of the operating system remains in part of the computer memory all the time the computer is running, while other parts are loaded from disk storage as they are needed. The purpose of the operating system is to help management make efficient use of the overall system. The operating system is a collection of programs that are combined to carry out a wide variety of functions.

IBM's personal computers use an operating system called PC-DOS (DOS stands for disk operating system). Microsoft retains the right to market its own version, under the name MS-DOS (for Microsoft Disk Operating System). In most respects these two versions, often collectively called simply DOS, are identical.

LOCAL AREA NETWORKS (LANs)

When two or more computers are connected they form a network. The term local area network (LAN) refers to the cables, network cards, and other equipment needed to connect a number of PCs, and printers in a limited geographical space, such as a building. Usually, a network has a central computer (usually a Pentium-11 PC or IBM RISC type computer) designed as a server, on which the software needed to operate and manage the network resides. Centrally stored software, like virus protection, word processing, spreadsheet, and mail programmes, can be shared by all users.

The LAN makes it possible to share data between computers. For instance a single copy of a software program can be installed on one PC and used by all other PCs linked to the network. It is also possible to share equipment, such as printers and scanners. For instance, all the PCs on the network can print their data/results on the same printer without moving any equipment or working on a different PC.

Different kinds of networks are available commercially the most popular of which are Novell and Microsoft NT. Each network has a Network Protocol that is chosen to provide file handling and saving, messaging, and various application services.

COMPUTER SCIENCE

Computer science is concerned with information processes, with the information structures and procedures that enter into representation of such processes and with their implementation in information processing systems.

The main objects of study in computer science today are the computer itself and the phenomena surrounding it. Work is focused on the structure and operation of computer systems, on the principles of their design and programming, on effective methods for their use in different classes of information processing tasks and on theoretical characterisation of their properties and limitations. A computer provides the bases for modelling any information processing system. If the task can be represented in the form of a program it can be stored in the computer and the computer can represent and implement any information process. It provides a realistic bases for exploration and study of a great variety of concepts, schemes and techniques of information processing.

EXPERT SYSTEMS

Expert systems are a class of computer programs that can advise, analyse, design, diagnose, explain, explore, forecast, form concepts, identify, interpret, justify, learn, manage, monitor, plan, present, retrieve, schedule, test and tutor. They address problems which normally are thought to require human specialists for their solution. Some of these programs have achieved expert levels of performance on the problems for which they were designed.

Expert systems are usually developed with the help of human experts who solve specific problems and reveal their thought processes as they proceed.

Experts typically solve problems that are unstructured and ill-defined, usually in a setting that involves diagnosis or planning. They cope with the lack of structure by employing heuristics, which are the rules of thumb that people use to solve problems when a lack of time or understanding prevents an analysis of all the parameters involved. Likewise, expert systems employ programmed heuristics to solve problems.

Experts are engaged in several different problem solving activities: identifying the problem, processing data, asking general questions, collecting information, establishing hypothesis, exploring and refining data, and making a decision.

Expert systems, like human experts can have both deep and surface representations of knowledge.

Systems, that use knowledge represented in different forms have been termed multilevel systems.

ARTIFICIAL INTELLIGENCE

Artificial intelligence is a growing branch of computer science that studies ways of making computers behave "intelligently". This includes many ill structured tasks-playing games, understanding natural languages, proving theorems – not solvable by conventional computer methods. Many AI programs solve such problems with varying degrees of success. Although a program that can understand natural language is still a dream, many chess-playing programs can beat expert human players.

More successful AI programs include knowledge-based expert systems applied to a wide spectrum of real-life problems, from airline catering to oil exploration. These programs can use knowledge about a specific domain from a human expert to solve routine problems. For example, expert systems perform comparably to human experts in diagnosing certain infections, finding the structure of chemical compounds, and manipulating mathematical symbols. They offer new ways to tackle problems heretofore difficult to solve using conventional algorithmic approaches.

AI techniques are solving many difficult problems in computer science itself. With automatic programming, AI helps design software and. with automatic configuration of computer systems, hardware as well. AI also helps in the maintenance and fault diagnosis of computer hardware and leads to better user interfaces based on a natural language.

Because of the increased use of AI techniques in computer science, hardware and software engineers must learn about AI's capabilities and limitations.

CAREERS

There is a wide range of jobs available in the field of data processing, the most common of which are programmer (or program developer), system analyst, data processing manager, and support personnel.

The main tasks of a computer programmer are first, to write programs to solve problems; second, to write them on time as they are needed – and third, to write them clearly by fully documenting them so that other programmers can understand them. The kinds of problems that are tackled depend on whether the programmer is working for a computer manufacturer or user. The former needs such programs as compilers, assemblers, executives, operating systems, and utility routines. These programs are intermediaries between the machine and the commercial programs which are written in one of the high-level languages. They are about the system, and therefore programmers who write them are called systems programmers. Manufacturers usually sell this kind of software along with their systems. If the programmer is working for a computer user, however, his or her programs may deal with either scientific or commercial problems.

Specifications for the data processing problems are given to the programmer by the systems analyst. The key to this person's job is communication, because he or she should be able to interact with the people in the department both verbally and in writing. Since one of the analyst's tasks is to analyze problems, outline solutions to them, and then delegate them to programmers to code, he or she must be able to express ideas regarding these problems clearly, thoroughly, and in writing. In addition, the analyst must have conversational ability since the job involves working with other people more often than working alone. The other aspect of this job deals with setting the objectives of a project and then finding the best method of achieving them. This involves constant examination of the system, modification of weaknesses in it, or sometimes even changing it to a completely new system.

The key person in a data processing department is its manager. It is on his or her capacity as a leader as well as on his or her technical knowledge that the success of the department depends. The manager is responsible for communicating with his or her superiors regarding policy-making decisions of the organization, and regarding the services provided by the department. The manager should have the ability to comprehend technical writings related to the field in order to advise his or her superiors of the most recent developments in data processing which have a direct bearing on their problems. He or she should have enough practical data processing experience to ensure that everybody in the department, be it the analysts, the programmers, or the rest of the computer operations staff, are all working towards the same end. The manager should have an active mind, imagination, tact, and the ability to control others. The most important quality, though, is to remain calm and think clearly . at times of crises.

RUSSIAN WINDOWS 98

Microsoft has gone a lot of effort and expense to deliver Windows 98 in Russia on time. So what benefits are there for users?

Though it contains nothing new for anyone using an Apple Macintosh computer, Windows 98 is much better for working in a multilingual environment than previous versions of Windows. For a start, the product now has a Russian-Language interface. The Pan-European (English-language, version of Windows 98 has been available in Russian) the P-an-European edition has full Cyrillic character support, all of the menus and system information is in English. The Russian version of Windows98 is entirely localized. All of the interface is in Russian as well as documentation. For the intuitive features in Windows98 to be of any use someone sitting at a computer of course needs to know what it is telling him.

A major step forward in Windows 98 is that you are able to switch between multiple alphabets and keyboard layouts with ease. In earlier versions of English Windows 3.1 it was not possible to use Russian fonts at all – Russian characters just looked like gibberish on the screen. In later versions you could install Russian fonts but it was still only possible to toggle between only two keyboard layouts (e.g. Russian and International English). If you wanted to use a third character set it was necessary to completely rest your system setting. In Windows 98 if you receive a document written in virtually any alphabet the chances are you will still be

able to read it -even if you do not have the exact font installed that created the document.

Also of great help is that Windows 98 should enable users to better integrate the hodgepodge of Russian and English MS DOS and MS Windows applications they currently use here. Russians can open Russian MS-DOS applications within Windows 98 and share data with any other Window program.

Windows 98 can make working with the Russian language a lot more hassle-free.

NOTEBOOKS AND WALLET PCs

Many people who work from both office and home, choose a laptop (or a slightly smaller computer, known as notebook) as their primary computer. These small computers can then be connected to a large monitor and to the corporate network in the office. Notebook computers will continue to get thinner until they are nearly the size of a tablet of paper. Notebooks are among the smallest and most portable real computers today, but soon there will be pocket size computers with colour screens. When you whip one out, no one will say, "Wow! You've got a computer!".

What do you carry on your person now? Probably at least keys, identification, money, and a watch. Quite possibly you also carry credit cards, a checkbook, travellers check, an address book, an appointment book, a notepad, a pager, concerts tickets, a map, a compass, a calculator, an electronic entry card, photographs, and perhaps, a loud whistle to summon help.

You'll be able to keep all these and more in another information appliance we call the wallet PC. It will display messages and schedules and also let you read or sense electronic mail and faxes, monitor weather and stock reports, and play both simple and sophisticated games. At a meeting you might take notes, check your appointments, browse information if you're bored, or choose from among thousands of easy-to-call photos of your kids.

Rather than holding paper currency, the new wallet will store digital money. Today when you hand someone a dollar bill check, gift certificate, the transfer of paper represents a transfer of funds. But money does not have to be expressed on paper. Credit card charges and wired funds are exchanges of digital financial information. Wallet PC will make it easy for everyone to spend and accept digital funds. Your wallet will link into a store's computer to allow money to be transferred without any physical exchange at a cash register. Digital cash will be used in interpersonal transactions too. If your son needs money you might digitally slip five bucks from your wallet PC to his.

WHY THE PC WILL NOT DIE

The PC has given the average user the kind of computing power that 10 years ago was found only in large corporations. Yet people now take this for granted – and want more. They want to do many of the things they can do on their PCs regardless of where they are or what device they are using -whether its a palm-size computer, a cell phone, an Auto PC or a smart television like WebTV. A combination of sophisticated software, powerful microprocessors, wireless technology and high-bandwidth connectivity is starting to make that a reality.

For most people at home and at work, the PC will remain the primary computing tool: you'll still want a big screen and a keyboard to write a letter to your aunt, view complex Web pages, and you'll need plenty of local processing power for graphics, games and so on. But the PC will also work in tandem with other cool devices. You'll be able to share your data-files, schedule, calendar, e-mail, addressbook, etc. across different machines; you won't have to think about it, it will be automatic. If you can effort it – you'll be able to do that on the device you have with you.

Wherever you are, whatever you want to do, you'll have all the information you need. At the same time the PC itself will be getting more powerful, more reliable and simpler to use. Even though the hardware, networks and software will become more complex there will be a simpler user interface that adapts to your needs, with voice recognition and natural language processing.

When the PC is at the center of a home network (probably connected to a broader network that will constantly monitor performance, update software and download device drivers and the like), it will be incredibly easy to administer, automatic in operation and maintenance-free. And the PC will morph in (many new forms such as book-size "tablet PCs", with all the benefits of the universal PC model.

That model will play a vital role in this new world of anytime, anywhere computing. The PCs high-volume, low-cost approach will be adopted by many of the new smart devices, because it offers amazing value to consumers.

PCs gave the world a whole new way to work, play and communicate. The PC-plus era will be just as revolutionary. It will take the

PCs power and make it available almost anywhere, on devices that haven't yet been dreamed of.

A REVOLUTION BEGINS

Personal computers have already altered work habits, but they haven't really changed our lives so much yet. When tomorrow's powerful information machines are connected on the information highway, people, machines, entertainment and information services will all be accessible. You will be able to stay in touch with anyone, anywhere, who wants to stay in touch with you; to browse through any of thousands of libraries, day or night. Your stolen camera will send you a message telling you exactly where it is, even if it is in a different city. You will be able to answer your apartment intercom from your office or answer any mail from your home. Information that today is difficult to retrieve will be easy to find.

All of this information will be readily accessible and completely personal, because you'll be able to explore whatever parts of it interest you in whatever ways and for however long you want. You will watch a program when it. is convenient for you. You will shop, order food, contact fellow hobbyists, or publish information for others to use when and as you want to. Your nightly newscast will start at a time you determine and last exactly as long as you want it to. It will cover subjects selected by. you. You will be able to ask for reports from Tokyo or Boston, request more detail on a news item, and if you prefer, your news will be delivered to you on paper.

Now there is a new horizon and the relevant question is, "What if communicating were almost free?". The idea of interconnecting all homes and offices to a high speed network has ignited the nation's imagination.

All sorts of individuals and companies are betting their futures on building the elements that will make the information highway a reality.

MICROPROCESSORS UPGRADED THE WAY WE LIVE

Computers makers like IBM and Digital wrote their own software for their own machines.

Intel's microprocessor changed all that. First, Intel didn't make computers or software – yet to do anything useful, its new chip needed software. So Bill Gates and his friend saw a chance to start a software company. Second, it was clear that the microprocessor would dramatically change the computer industry, by cutting manufacturing costs and adding new features.

Intel's advertisement for its new chip, "Announcing a new era of integrated electronics", proved very farsighted.

Powered by the microprocessor, the PC has changed the world. It has revolutionized how we collect, store and use information, how we communicate with each other, how we work, learn and play. Just 20 years ago, nobody used a computer unless they were a hobbyist or worked in a corporative computer department. Today's PCs, using sophisticated software and microprocessors containing more than nine million transistors, give even a child access to more computing more than an old mainframe computer.

It's remarkable how we now take all that power for granted. Using a basic home PC, you can balance your household budget, do your taxes, write letters to friends and fax or e-mail them over the Internet, listen to CDs or the radio, watch the news, consult a doctor, play games, book a vacation, view a house, buy a book or a car... the list is endless.

THE UBIQUITOUS CHIP

These days microprocessors are found in all kinds of products – from cell phones to CD players to your new Cadillac, which has more than 60 – but it's their use in the PC that has had the biggest global impact.

We've seen huge gains in productivity as a result of the PC, and enormous strides in education, medicine, recreation and commerce. And thanks' to the PC, people in remote areas can now telecommunicate to work.

A combination of the PC and the Internet is making news and information travel faster and more freely than ever before, helping to open up closed economies and bring democracy to repressive nations – you can't build borders in cyberspace. The microprocessor-powered PC has given people more freedom, and the power to do more with their freedom.

But the really amazing thing is that we are still at the dawn of the digital age. But 20 years from now, microprocessors will probably be more than a million times again as powerful as they are today. And they'll contain up to one billion transistors.

The microprocessor, introduced by Intel in 1971 is an integrated circuit etched on layers of silicon; it organizes the central electronics of a computer on a chip. It's the brains of PCs.

The first microprocessor was the 4004 with 2,300 transistors. In 1978. Intel produced the 8086 chip with 20,000 transistors.

Intel's upcoming 64-bit chip for high-end computer servers, due out next year, will have about 100 million transistors.

Other microprocessor makers: Motorola, Advanced Micro Devices.

Over the next few years the PC will remain the main computing tool for most people, but it will be joined by all kinds of new microprocessor-powered devices that will make your life even easier. For example, when you are traveling vou'11 be able to call up your itinerary, send an e-mail postcard, book an appointment with your doctor or balance your bank account using a handhold PC that will know what information you need, and when and where you need it. And you will be able to get a map, hotel guide or the news from the Web via new kinds of cell phones.

A REALLY SMART HOUSE

At home, you'll be able to operate your PC by talking to it. It will automatically back up all your information, update its own software and synchronize itself with your TV, cell phone and all devices on your home network. The refrigerator in your kitchen will know how well stocked it is, suggest recipes based on what's available, and order more food from your online grocer. Your TV will double as an interactive shopping mall, letting you buy advertised products or clothes you saw in a sitcom. And if you don't want to watch TV, you will be able to read electronic book that knows your favorite authors and automatically download their latest novels.

Sounds like science fiction? Just a few years ago, it was. But thanks to the microprocessor – and to all the incredible innovations in software* hardware, the Internet and telecommunications – everything that has been described is already possible. And although you can't yet buy all these devices at your local computer shop, the incredible speed at which technology is advancing means that it won't be lone before they are as commonplace as the PC.

THE BEGINNING OF THE INFORMATION AGE

Information has become increasingly important to us. The information revolution is just beginning. When the cost of "communication becomes low enough and is combined with other advances in technology, "information highway" will no longer be just a phrase for executives and politicians. To understand why information is going to be so central, it's important to know how technology is changing the ways we handle information.

The most fundamental difference we'll see in future information is that almost all of it will be digital. Whole printed libraries are already being scanned and stored as electronic data on disks and CD-ROMs. Newspapers and magazines are now often completely composed in electronic form and printed on paper as a convenience for distribution. The electronic information is stored permanently – or for as long as anyone wants it – in computer databases: giant banks of journalistic data accessible through on-line services. Photographs, films, and videos are all being converted into digital information and distill it into quadrillions of packets of data.

Once digital information is stored, anyone with access and a personal computer can instantaneously recall, compare, and refashion it.

What characterizes this period in history is the completely new ways in which information can be changed and manipulated and the increasing speeds at which we can handle it. The computer's abilities to provide low-cost, high-speed processing and transmission of digital data will transform the conventional communication devices in homes and offices.

It's convenient to be able to convert everything into digital representation but the number of bits can build up quite quickly. Too many bits of information can overflow the computers memory or take a long time to transmit between computers. That is why a computer's capacity to compress digital data, store or transmit it, then expand it back into its

original form is so useful. At some point not far in the future, a single wire running into each home will be able to deliver all of a household's digital data. The wire will either be fiber. which is what long-distance telephone calls are carried on now, or coaxial cable, which currently brings us cable television signals. If the bits are interpreted as voice calls, the phone will ring. If there are video images they will arrive as written text and pictures on a computer screen.

WATCH FOR A DIGITAL BOOM

Multimedia enhances the way people work, learn, play, and most importantly, communicate. It is really not such a new medium, but rather old individual media that have come to life together in new formats on new devices and for new personal uses. There are many lessons that the print world, story telling, music and film production can offer about how to make multimedia work as a unified interactive experience.

You are probably involved with multimedia in some way. Many of you may just be getting started in developing multimedia as an extension to your existing work, such as a desktop publishing, software development, or consulting. Others – vendors, distributors, and information providers in publishing, music, art, and education – are on the periphery of the multimedia industry.

Something extraordinary is happening on a global scale. Five mega-industries-personal computing, consumer electronics, publishing, entertainment, and telecommunications – are converging. Rarely before has the world seen a merging of different disciplines like this one. For the first time, they will use a common format. In the near future information for each one of these industries will be available in digital formats, stored in bits and bytes. Almost everything we see on TV, read in print, view at the theatre, and receive over wires or airwaves will be easily accessible and available anywhere, at any time. We are looking at a digital boom!

One of the great challenges with this array of digital information is to provide interfaces and searching mechanisms that allow people sift this information. Multimedia represents intuitive and realistic ways for people to sort through this digital web – to represent this "content" to consumers who are not programmers or "digital scientists". It also represents ways for people to customize their interaction with the digital world so that the information they receive through their senses makes the most sense to them – be it aural, visual, tactile, kinetic, or a combination of these. Think of multimedial as an enhancement to the way people communicate.

EVERYONE, ANYTIME, ANYWHERE

The next step for technology is universal access. Amazingly, it's been more than 20 years since the concept of "convergence" entered the hightech lexicon.

For most of that time convergence has meant two things: the coming together of the computer, consumer electronics, and telecommunications industries and the merging of gadgets such as the PC, TV, and telephone.

But as the 21st century approaches, sophisticated digital technologies and the promise of exploding bandwidth are combining to create a third kind of convergence – one that will change our lives more dramatically than anything we've seen so far. It will deliver the power of the information age into the hands of everyone, anytime, everywhere.

We live in an age where voice, data, and video are just bits, ones and zeros to be pushed down the broadest pipe. Bits don't care how they get where they are going – only that they arrive in the right order and at the right moment. The ubiquity " of bits is already empowering the kind of hybridization that most people watched for consumer electronics these past two decades – multifunctional devices such as modern PCs, WebTV, cable modems, and smart phones.

But this is only the start. Combine digital technology with advanced software, smaller and more powerful microprocessors, and exponential growth in fiber and wireless bandwidth, and you get something far more useful – seamless universal connectivity. This turns convergence on its head. It means that although computer, telecommunications, and consumer electronic technologies will come together, the next generation of smart devices mostly won't.

Universal connectivity will bring together all the information and services you need and make them available to you regardless of where you are, what you are doing, or the kind of device you are using. Call it "virtual" convergence – everything you want is one place, but that place is wherever you want it to be, not just at home or in the office.

The result is that there'll be a proliferation of smart, connected devices, from palm-sized and tablet PCs to Web-enabled phones and AutoPCs. Your files, schedule, addressbook will automatically be replicated onto each of these devices, because everything that can think will link.

A lot still needs to be done to make this a reality. First, in the same way that people must speak the same language, if they are to understand each other and collaborate, smart devices also need to speak a common language to communicate effectively. The best way to achieve this is b\ using existing open Internet standarts. Second, a massive amount of investment is still required if high-speed broadband communications are to be widely available throughout the country.

To make all this happen, we'll see more deals, alliances, and joint ventures involving computing consumer electronics, telecommunications, the Internet, and cable companies. But two things are certain: ubiquitous wireless and high bandwidth data networks are going to get built, and the various smart devices to provide access to these networks will soon be on the market. Together, they will make the potential of virtual convergence a reality.