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Getting to Know the Computer: II*

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With the commercial jet shortly graduating to supersonic speeds of 1,500 or even 2,000 m.p.h. we are assured of a further shrinkage of our non-sanforised world. This process of shrinking continues to accelerate and is being facilitated by the use of EDP (the computer). The time is not far off when passports will have to be tailored to "computident" (computerized identification); when all the books in a library will be reduced to tape and be accessed easily enough; when the income-tax department automatically send out a cheque to a tax-payer---a refund on account of an over payment.... Since knowledge can mean power let us try to learn something more about this machine because it will be increasingly involved with the problems of man in providing the means for producing better solutions in time. So many right answers are obtained too late, particularly when conditions change. We must, therefore, be able to modify our premises and original plans to keep pace with altered circumstances. How many of us are aware that the present irrigation system in West Pakistan built up over a 100 years is gong to be completely changed within the next 15 years or one-seventh of the time it took to develop the system in the first place? This is but one of many examples showing the increased pace of change which is affecting our daily lives. There is no reason why the means to effectively utilize the power of the computer cannot be developed. "the only obstacle is human inertia on the negative side and the extent of imagination of man on the other or positive side".

In a previous a previous article on "How to Control Red Tape" the author brought out the difficulties that arise out of impatience resulting in inadequate preparation by "plugging" in a computer into an undisciplined system, that streamlining using the Systems & Procedures approach, provides optimization of resources (human and otherwise) expended for both an O&M (Work Study) and EDP (computer) effort. "At this stage the Systems & Procedures approach should have achieved standardization and eliminated unnecessary

1. Functions
2. Forms/Reports/Records
3. Data on retained Forms/Reports/Records
4. Controls

and have consolidated a number of forms, in addition to smoothening out the cyclical peaks and troughs of work.

In an earlier article the various steps required in problem-solving with particular attention to the degree of detail required where use of the computer may be indicated was clearly brought out. Readers may remember Mr. Shaikh's travel itinerary!

This article proceeds a step further. It attempts to familiarize the reader with how the computer gets about it. There are already a number of computers in the country and more

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are expected in the future. That most of them are not being utilized to their maximum is only indicative of the difficulties which lie in the work **preparatory** to their use. It is in the interest of Pakistan to justify the investment in the hardware. This, of course, means emphasis on the software.

Overall benefit

From times immemorial labour-saving devices have brought about increased productivity. Though, it is true, that there has been local hardship whenever such devices were introduced. However, an examination of the balance sheet shows that there has always been an overall economic benefit. And that is what matters, increased productivity is the key to progress. It follows, therefore, if we are to cushion the isolated inconveniences that new technology must bring in its train, we must think ahead. "We must plan rationally the introduction and use of these management tools". There is no reason why such planning cannot be done properly. All it involves is having a clear understanding of the capabilities and limitations of this fast expanding information technology. With a sound appreciation as the base, the results of applicative effort cannot be but good. The implications of each step that we may take can be worked out well in advance.

But, what is this machine that causes us to keep flitting from large and important issues (the bird's eye view) to the detailed which appear deceptively unimportant? It is well that we be informed about it. Better the devil you know than the devil you don't, more so when this product of the human brain has come to stay, and how!

Two kinds of computers

There are two kinds of computers

1. Analog.
2. Digital

The analog computer as its name implies works on analogies, eg a water supply organization may wish to know how much water they are selling per day. It can be done by filling a large tank whose volume is known and then emptying it, not a very practical proposition! It is also possible to determine the quantity sold by measuring variations in the pressure of water (the analogue of varying water demand) continuously. A very small differential pressure set up can do this. Thus we have eliminated the huge tank. In much the same fashion changes in temperature, voltage, etc. can be used for purposes of measurement and control. The slide rule of the engineer is also an analog computer, it is a scalar representation of numbers, on the logarithmic pattern. We can multiply and divide (and do other things also) very large numbers on a piece of wood or plastic just a few inches long.

Control of Processes

Most of the applications of this type of computer are in control of processes such as in petroleum refineries, paper making machines or even in the centralized control of electric power distribution in a grid or network.

We are, however, more concerned with the digital. This computer reacts to changes of discrete integral numbers as opposed to the analog which measures continuously. The digital operates on the simplest scale we know, ie the binary. Now, this is not complicated at all, for we are quite familiar with both the half-penny/penny and takka/anna scales. We are also familiar with the 225 square feet equal to one marla and twenty marlas equal to one kanal and 9.68 kanals (Lahori variety) equaling one acre and 640 acres equaling one square mile. If we look closely we find we carry one marla once we total more than 225 square feet and less than 450. We carry one kanal when the marlas exceed 20 but are less than 40..... And so on. In the half-penny/penny and takka/anna scale we carry one penny or anna when we have two half-pennies or two takkas.

This binary scale is a very convenient scale as far as the electronics of the computer are concerned, because it means all we have to do is to count up to 2 and carry 1. Now, one and two can be represented by on and off or zero and one. This can also be expressed as open/closed or true/false. These two "positions" can be converted into the presence or absence of light or magnetism or electricity. This presence or absence can be made to actuate the electronic circuitry and so it is with this as the basis that the computer operates.

Scales

Reverting to scales for a moment, in the decimal scale we add up to 10 and carry one---in our daily life. If we could relate the decimal scale, ie 0,1,2,3,4,5,6,7,8, and 9 to the binary we could, in that event communicate with the computer in an on/off fashion. The table below shows the correspondence, (1 is on and 0 is off):

Decimal Counting	Equivalent Binary Counting
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000

It is quite clear from the above that by use of the on/off principle we can express any ordinary number such as 256 or 13.... In binary. This means we can communicate meaningfully with the computer as far as numerals are concerned.

But, what about the letters of the alphabet from A to Z, and a comma, a fullstop, a multiplication or division sign and so on? If we glance at the decimal/binary table shown above, we can see the decimal numbers 2, 4, 8 and 16 are expressed in binary as 10, 100, 1000 and 10000. It follows: 32 would be 100000 and 111111 would be 32 plus 16 plus 7 plus 4 plus 2 plus 1 or 63, this gives us a count of 64 (0 to 63 inclusive). It should, therefore, be possible to express the 10 digits 0, 1,2,3,4,5,6,7,8, and 9; 26 letters of the alphabet A,B,C.....X,Y,Z; the punctuation and arithmetic signs and yet have some of the count of 64 to spare. Since we can give each letter of the alphabet a number, we can communicate alphabetic characters to the computer. The same goes for punctuation and arithmetic signs.

What happens is, that the input to the computer in the form of on/off signals are fed, in on paper or cards with a hole or no-hole (on/off) in them. When a hole presents itself to the computer it permits the flow of electricity and we have the "on" position and 'vice versa'. Later, if any output is required the line-printer, similar to the familiar telex or teletype machine converts the on/off symbols back into numerals, alphabetic characteristics, punctuation marks or arithmetic signs.

A Binary digiT is called a "bit". There are hundreds or other terms that have come into existence, in common with any professional activity, in the past few years. To list them all would require a dictionary, however here are a few: byte, random, access, program NAND, NOR, nanosecond, floating point, binary coded decimal, compiler, processor, object language program, on-line, real-time, leap-frog test, crippled leap-frog test. MIMO (muck in, muck out), tape mark, ALGOL and of course GIGO and so on.

5 basic elements

The normal way of "inputting" data to a computer is though punched cards, punched paper-tape or magnetic tape (same as used on tape recorders). The computer unit consists of five basic elements:

1 Input Unit
2 Output Unit
3 Arithmetic Unit

4 Storage Unit
5 Control Unit

Characteristics

The storage unit can store any data fed into it in its internal memory. This is what makes it so different from an ordinary desk calculator. In addition to the internal memory we can store data in external auxiliary units. This may be in the form of magnetic tape, discs (similar to long-playing records) or drums, it could also be in the form of more punched cards or paper-tape too.

Let us get an idea of the speed with which the computer can deal with and process data, this means looking at each of the 5 units comprising the computer hardware system.

Input

Considering the punched card which normally has 80 columns in it: there are card readers which can read 300,600 or more per minute. If we require one card to record the issue of a single item of inventory or the amount of overtime for a particular worker..... The card reader could at 600 per minute go through 36000 in one hour.

Once the data are in the computer things happen ever so much more quickly. The transfer rate within might be the equivalent of 600 cards second or even speedier. This indicates that we would have very many punching (and lets not forget, verifying) operators of looking after the voracious appetite of the monster.

It is also possible to use other means of input to the computer such as punched paper-tape, recognition optically or even magnetically.

Output

We have line-printers which can work up to speeds of 1100 or 1300 lines per minute. In one hour that means 72000 lines. If we have 30 lines per sheet of paper it amounts to 2400 sheets per hour. Even this is slow compared to what is going on within the computer itself which could be equivalent to 1100 or 1300 lines per second. We can readily see that it is possible to produce very quickly large quantities of paper-work. Hence, the necessity to ensure that what is produced is good. And this can only be good if the input is good. The input can only be good if the System and Procedures of the organizations are good. In turn they can only be good if top management are prepared to examine their tradition-bound, paper-ridden way of doing things objectively. "This necessitates the use of the scientific method, for after all what is science if it is not.... The acceptance of what works and the rejection of what does not (and) that needs more courage than we think" ('Commonsense of Science'---Bronowski). So much of what we believed is what we have wanted to believe. Hence there is an easy way out and that is to accept as experts those who confirm our prior thoughts and benefits!

The Arithmetic Unit

This is made up of registers (numbered pigeon-holes) each of which can store a set of bits. It is possible through a pre-set body of instruction---the program---to add pigeon-hole X to Y, then transfer the sum to Z, then to compare pigeon-hole Z with A and if Z is greater than A to print out the contents of Z unchanged. This becomes somewhat meaningful if we were to say that X and Y represent the ordinary and overtime yearly wages of a worker. Z is the figure 6000. We know if X plus Y exceeds 6000 income tax must be deducted. In this can the yearly sum is less than 6000 so we just print it out.

The arithmetic unit can be made to add, subtract, multiply, divide, extract roots, detect equality, less than, greater than, inequality, etc. Of course all this happens in millionths of a second. So we see that in addition to normal arithmetic the computer is in a position to make logical deductions based on the results of the arithmetic.

We talk of logical operations, this is of tremendous importance in making the computer such a useful tool. Boolean (after George Boole) algebra is made use of as the basis for such operations. This is binary system of algebra and as the word binary indicates is immediately applicable to the digital computer facilitating logical analysis.

There are several logical functions such as AND, OR, NOT, NAND (AND-NOT), NOR (OR-NOT).... It is of interest to look at one of them, say: OR, how could it be used? Let us go back to the worker who has earned both ordinary time and overtime in the course of the year. It is possible he may have a colleague who has been absent the whole year (at least let us presume so!). The computer could be made to use their names should not be printed out, but if there is any worker who had earned no ordinary time and no overtime his name should be printed out (of course this is a gross over simplification and we are ignoring the fact that if there is no ordinary time there should be no over-time, but then the time-keeper may have made an error, so let us catch him out!). Basically, what we have said is that if "A" (ordinary time) and "B" (over-time) are present singly or together the response must be positive. If it is not so then the response must be absent, we could construction a truth table representing the above, in the following fashion:

INPUT "A"	PLUS	INPUT "B"	EQUALS	OUTPUT
0	PLUS	0	EQUALS	0
0	PLUS	1	EQUALS	1
1	PLUS	0	EQUALS	1
1	PLUS	1	EQUALS	1

A variety of logical functions can be synthesized which are of so much assistance to the computer systems designer.

It is this facility which makes possible the speedy and accurate scanning of piles and piles of amorphous data converting it into something meaningful. The following would, perhaps amplify this: an organization has thousands of items of stock or personnel, it

wishes to isolate certain items or individuals based on certain defined requirements, eg for inventory, the computer should print out all stock items which have not moved more than 5 per cent of the total value in the past one year, where the total valuation exceeds Rs. 50,000. Further that even if certain stock X, Y & Z which are being used for a particular job at less than 5 per cent per annum, which we know is going to last for 2 -1/2 years and we have deliberately stock-piled, it is not required to print out X, Y, or Z....

On the personnel front there may be a request for a particular type of steno say female, married, not less than 35 or more than 40, experience in a job-order industry not to be less than 3 years, and to have a knowledge of any three of the following four languages.... and so forth. If a large number of records have to be scanned the computer can do so quickly enough as may be required in a labour exchange.

Storage Unit

Very much like our manual filing system. This device retains information for later use. The information can be retained in the form of:

1. The working data and analysis which are a part of the processes inflicted on the data by the present sequence of operations---the program. This is akin to our rough working when doing arithmetic manually.
2. The program itself which governs the running of the computer, so as to how it is going to deal with in-coming data.

There is, therefore, an internal store, ie within the machine itself. This is called the Immediate Access Store (IAS). No serial delays exist here, because the going to and the extraction of data are all done electronically. We do not have to go to a magnetic tape, disc or drum to obtain that we are looking for. Hence we can see, in addition to internal storage we can have a host of peripheral storage devices. The descending order of speed is as follows:

1. I.A.S.
2. Magnetic drums and discs
3. Magnetic Tapes
4. Punched cards and paper tape.

Progress is so quick in the computer field that we are almost entering the fourth generation (presently we are in the third generation). A new method for storage---called thin film memories are already on the market, this makes possible yet quicker functioning.

Control Unit

Looking at our computer configuration once again, refer to the diagram below:

The control Unit determines the executing and interpretation of instructions (program) in proper sequence. This means it has to translate each instruction into action. It looks after the proper sequence and applies the proper signals to the arithmetic unit and other pigeon-holes in accordance with the decoded information.

The operation of this unit is very complex. It is designed to permit the machine to work at the highest level of efficiency.

Having briefly gone through what the computer is, it should make possible a better appreciation of the problems involved in introducing it for productive use in the service of mankind.

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