THE GENESIS OF COMPUTERS II

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After having given something of the origin of computers, we will start opening some of the possibilities and problems computers raise. Our attitude to computers in the years to come will largely answer the persistent question: Computers - friend or enemy?

In the previous article we took a brief look at one of the central concepts on which computers are based - the fact that it is quite legitimate and meaningful to represent one thing by another thing provided that we agree on the representation - and we saw too how this fact had been long utilised to produce language, writing and arithmetic to name but a few applications.

CENTRAL CONCEPTS

Now let us look at the second of the central concepts behind computers. This is the idea of setting up a machine or mechanism to perform a pre-defined sequence of operations without further human intervention. We now call such a sequence a program.

Musical Boxes are probably one of the earlier applications of this idea. The ones I have seen consist of a single row of adjacent metal reeds, one per note, and these are plucked by little pegs projecting from a cylinder so placed that when it rotates the pegs strike the reeds.

Now in order to get a particular tune the pegs are so arranged on the cylinder as to cause the reeds to be struck in the desired sequence when the cylinder is rotated in a particular direction. Thus we can say that the arrangement of the pegs on the surface of the cylinder constitutes a program.

Another early application of the idea of programming machines to perform sequences of operations was the use of patterns of holes punched in cards to guide weaving looms.

How do these two ideas lead on to computers? Well now imagine yourself having the job of performing a set of calculations a thousand times or so, like calculating the wages for a 1000 monthly paid employees each with different deductions etc. One of the first thoughts that would come into your head no doubt would be a wish that somehow this business could be mechanised.

CALCULATING MACHINE

Obviously a first step in this direction would be to obtain a calculating machine to aid you in your arithmetic. Such a machine makes use of the representation idea in that each digital position, the units through to the millions say, is represented by a wheel with the digits 0 through to 9 written round its periphery. The position of any wheel therefore represents the quantity held in that digital position and by providing the wheels with a little lug between the nine and nought positions so that in turning from nine to nought or vice versa they drive their left hand neighbouring wheel through a tenth of a revolution backwards or forwards we have a machine which can add and subtract decimal numbers. All that is needed now is a facility for inputting the numbers and this can be provided for by allowing the wheels to be individually positioned by rotating them by a finger push. Actual calculating machines are much smarter of course. They allow you to adjust the positional counters by depressing numbered keys.

ONLY PARTIAL MECHANISATION

So now the wages calculations have been partially mechanised but the actual standard sequence of operations per employee i.e. inputting numbers, adding, subtracting them etc. etc., on the calculating machine and writing the results out, has still to be done by you 1000 times in all. It is a pity that the calculating machine can't be programmed to do it all automatically.

TOWARDS FULLER MECHANISATION

Let us see what would be required.

Firstly, as the calculator couldn't read from paper, the relevant numbers per employee would have to be held in some way, such that the calculator's counters could be set mechanically from them in turn.

One of the earliest ways in which this was done was to take standard sized pieces of card and to regard them as divided into 80 vertical columns. Each column was now eligible to be regarded as a digital position in a decimal number. The actual value held in the column was represented by a punching in one of the ten punching positions allowed for the decimal numerals - 0 through to 9.

CARD READER

Now all that is needed is a device to sense the holes in the card and set the calculator's counter accordingly: it is not surprisingly known as a Card Reader.

So we now have a means of getting the relevant numbers per employee into the calculator's counter, usually called a Register. The sensible thing to do here would be to keep the numbers for each employee on a separate card or set of cards.

The next requirement is for some way in which the calculator's results can be output. The simplest way in which this could be done is to link up a printing machine, such as a typewriter, so that in moving from left to right across the register the value held in each counter wheel would cause the equivalent of the depression of the correct key on the typewriter and so print out the result number in full.

We are left with a problem here, however, as we will have a list of calculated results for example salaries, but we won't know to which employees they apply.

OVERPUNCHING

The way around this is to have a further two punching positions allowed in each of the 80 columns of our standard size cards. Then in a column, a punching in the first of our extra positions plus a punching in the decimal 'one' position can be used to represent an 'A' or a punching in the decimal 'Two' position a 'B' and so on. This is called overpunching and by using the decimal nought position for overpunching too, we can represent 27 letters which is fine as we only require 26 letters in all.

Anyway this means we can now have the man's name on the card too and this can be read, in the form of electric pulses for each hole straight through to the printing device and printed before the result is calculated.

We are left with one last problem, a mechanism for controlling and sequencing these various operations as desired, i.e. a means of programming our input device/ calculator / output device combination to do what is required of it.

ELECTRONICS

Until the advent of electronics such a mechanism was not easy to produce and even if one could have been made the program would have formed an integral and therefore immutable feature of the mechanisms structure. So we would only have been able to calculate these particular wages with our machine and nothing else.

By means of electronics however it is possible to have a memory device in which programs can be magnetically stored in such a way that they can then be read out as a series of patterns of electric pulses.

These patterns of pulses are then interpreted by a controlling mechanism. That is it is designed to perform a certain action on the receipt of a certain pattern. e.g. one pattern will cause the contents of the calculator's register to be printed, another will cause a card to be read and so on.

So to program the machine we merely have to store the appropriate patterns (they are called instructions) in the sequence in which we desire the actions to be performed and we are ready to go.

'STORED PROGRAM DATA PROCESSING MACHINE'

We now have what is known as a 'stored program data processing machine' and because the program is stored, not built in, we can write an infinity of programs for the machine to follow.

This places at our finger tips a vastly enhanced data processing capability compared to that which is available when the only data processors around are human beings.

To return to our data processing machine once more; having provided memory storage for the program of instructions the logical thing to do is to increase the size of the storage so that our input data, intermediate results, and final results before output can all be held here as well. This enables a great complexity of operations to be performed on the initially input data.

SCHEMATIC SYNOPSIS

Finally to recap let us look at a schematic illustration of the data processing machine we have conceived in this article.