COMPUTERS - A UNIVERSAL TOOL

by

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With the advent of the high-speed digital computer there has appeared, only for the second time in human affairs, a tool which is not restricted to a particular category of use. The steam engine made available to man a source of motive power other than muscles. The computer offers a source of information-handling power other than brains. There is accordingly a widely held belief, shared by the press writers, that the high-speed computer is a harbinger of a second technological revolution, the social and economic consequences of which may well make the first seem like a minor disturbance of human history. What is only now beginning to dawn on the lay spectator - with excitement or apprehension according to temperament - is that there is no corner or cranny of man's intellectual, technological or cultural life which is not capable of being penetrated and transformed by the computing methods of today and tomorrow.

Computer as intellectual match-maker

The first place in which the Protean capacities of the high-speed computer make themselves most immediately known is in a large University. Here is assembled within the same perimeter a sample from the whole kaleidoscope of arts, sciences and technologies which comprise our culture. A new dimension thus enters University work, when, for example, a Greek scholar and an entomologist can each discover not only that computing can solve his problem, but even on occasion that it is a problem which has basic features in common as between two apparently two remote disciplines. The classification of words and the classification of insects may require a strictly analogous mathematical and computational treatment.

Chromosomes and stars

Examples could be multiplied of this inter-disciplinary match-making rôle, and it is a rôle upon which Edinburgh University's new

Computer Unit places great emphasis. A recent instance is the liaison effected between the Medical Research Council's Cytogenetics Research Unit and the Department of Astronomy. The medical research workers are internationally known for their work on the microscopic examination of human chromosomes and have to their credit the successful correlation of various abnormalities in the chromosome pictures with congenital and other disorders. The astronomers have been working on the measurement and analysis of star pictures. At first sight it is not obvious that two such groups could have sufficiently in common to bring them together.

The counting and classification of chromosomes in hundreds and thousands of microscopic preparations is the basis of tedious toil upon which the investigations of the medical research group is founded, and the sheer mass of drudgery severely limits the rate of progress. The same can be said of the examination of endless

photographs of regions of sky taken under various conditions of filtering. What is required are computerized systems capable of recognising a chromosome in the first kind of picture and a star in the second. Yet these requirements prove not to be too far-fetched and the Computer Unit is now helping to tackle the problem. It can already be said that much of the equipment and basic logic will be common to the two projects.

Converting wavy lines into numbers

A problem common to a wide range of different Departments and projects concerns the processing of results initially recorded as wavy lines on paper. Before such a record can be handled by computer these continuous traces must be converted into a sequence of numbers. To effect this " analog-to-digital" conversion automatically is essentially the same problem, whether the traces have been obtained from an electroencephalogram, a barometer, a stress

meter in a wind tunnel, or a seismograph monitoring earth tremors.

It has in fact been the International Seismological Research Centre, recently established with government aid under the aegis of the University Department of Astronomy which has come to the rescue in this instance, and has generously made accessible to other research workers in the University a full scale conversion system of advanced type.

Liaison with linguistic and bio-medical groups

Another example of close liaison is that existing between the Computer Unit and the ~~Department of Scientific and Industrial Research supported~~ Linguistic Research Group, ~~situated~~ in the Department of English Language, which is supported by the Department of Scientific and Industrial Re: This group has recently passed an important milestone, the creation of a working computer program as part of a system designed to inspect a sequence of English words and to decide whether or not it constitutes a grammatical sentence. This

is a task which the reader doubtless finds straightforward enough, having been engaged on it fairly continuously since childhood. To mechanize the process is far from straightforward, but success in this limited objective is a key pre-requisite for the development of effective systems of machine translation.

Collateral links also exist between both the Computer Unit and the Linguistic Group on the one hand and on the other the Experimental Programming Unit of the Department of Surgical Science. This Unit is also supported by D.S.I.R. and has as its terms of reference the development of computer programs capable of showing "intelligent" behaviour, in particular of learning by experience.

Small computers in research

The situation on the medical side of the University is of particular interest, in illustrating an attitude to the rôle of the small computer. This attitude is quite new in this country

and points the way, we believe, to future University patterns. By a small computer we here mean one costing in the range of £10,000 - £100,000 rather than in the range of £100,000 - £1,000,000. The new feature is the realization that an important function of the small machine is as a tool of research into ways of more profitably utilizing large machines.

Other things being equal, it is always cheaper to do one's bread-and-butter computing on a larger machine, since speeds go up much faster than costs. But the research and development often needed to reduce a problem to the bread-and-butter stage is one that typically requires a very great deal of trial and error.

In the present state of the art, only the small machine is suitable for such "cut-and-try" work. This is the basis of a recent decision of the Advisory Council for Medical Research in Scotland to recommend the award of £50,000 from the Scottish

Hospitals Endowment Research Trust to a group of research workers in Edinburgh University's Medical School, and to earmark the bequest for research into new ways of putting computers at the service of scientific medicine.

Hardware

Everything which we have described so far is concerned with the side of computer science known as "software", in contra-distinction with the electronic "hardware" constituting the actual computing equipment. With regard to hardware facilities Edinburgh has chosen to travel a road of its own, and is venturing much in the hope of gaining much. Two years ago the University rejected the opportunity of accepting as its ration from the University Grants Committee a small, second-hand obsolete computer. Discussions were held with Dr. Jack Howlett, Director of the National Institute for Research in Nuclear Science, and generous

and timely assistance from this source enabled us to launch a very considerable experiment - the attempt to use, by telephone-wire connection, the giant Atlas computer at Manchester, 200 miles away. This venture is still in its early stages, and will shortly enter a new phase in which the connection will be to the Atlas at N.I.R.N.S. in Chilton, Berkshire. A quota of computing time on this machine is to be made available to all British Universities, initially free of charge. A start will also be made in operating "on line". By this is meant a system whereby the user and the remote machine interact directly back and forth along the wire, as opposed to the mere passive transmission of programs and data.

We see this program as short-range pioneering with a long-range purpose, this purpose being to train and discipline ourselves to the point where we can justly expect to be given a leading part in the development in Britain of the first large "on line" systems. In such

systems many users have simultaneous access to the central unit via a variety of input and output channels, including not only typewriter but also handwriting, drawing, speech, and visual displays of all kinds. These, as far as Britain is concerned, still belong to the future. Yet their potential impact, not only upon University research, but on industrial, commercial and military applications would be difficult to overestimate. To bring these systems within reach must therefore be viewed as an enterprise of more than academic, and more than local, importance.