THE EDUCATION OF A DESIGNER OF INFORMATION SYSTEMS

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Mr. Davies began his lecture with a brief general description of the activities of the National Physical Laboratory. These cover a wide range of fields - routing of ships and strength of materials were amongst the examples cited. He then went on to discuss in more detail the work of the Computer Science division.

Research at the Computer Science Division is directed mainly towards advanced applications of computer systems, rather than their design. The principal user of the results produced there is the government. Since, on one hand, projects have become larger over the years and on the other, funds for expansion have not been readily available, the number of projects has had to be reduced. At present there are about 80 people employed in the division, of whom 30 have qualifications in computer science. In addition, collaboration between the division and industry exists, although on a smaller scale.

Mr. Davies then described some of the more important projects on which work is in progress at present. One of these projects was in the field of data communication systems, in which an investigation is being carried out into alternatives to the existing telephone system for data communications. The group concerned came up with a model and built an experimental network. Then, in order to examine the behaviour of such a network in a real-life situation, an extended model was simulated. Another field in which work is being done is that of pattern recognition, where a group is carrying out work on systems for reading hand-written numerals. Systems of that nature, Mr. Davies argued, will become increasingly important in the perhaps not so distant future. The computer user population is being joined by an ever widening class of people - most of them without special training. Thus there is a need for easing and simplifying the language of communication with a computer. In the long run, computers

will perhaps become accessible to the general public. Speech recognition is also not so very far away as thought.

A third major project is concerned with the storage and retrieval of factual information. This system is worked on in collaboration with and for the use of the Metropolitian Police. The nature of that organisation determined to a certain extent the character of the system. Police workers are usually well-disciplined and used to carry out instructions strictly. On the other hand, they are rarely technically qualified, therefore the system had to be designed so that it was simple and easy to use.

This naturally led to a discussion of the factors that influence the design of a computer system - especially that of an interactive one. Mr. Davies suggested that one of the most significant factors in the design of computing systems was that they had to be overlaid on an existing human organization, usually to forestall the need for recruiting extra staff by coping with an increase in work, rather than to replace staff already employed. He outlined three groups of problems in working in with an existing system of organisation, namely human factors, economic factors, and technical factors, with human problems being the most important.

Consideration of human problems at the design stage was, Mr. Davies suggested, mainly ad hoc, and confined to that provided by the engineer's intuition. Experiments in this area were difficult to carry out successfully, since human beings are so adaptable that the differences between one approach and another tend to be very small. One might deduce from this that it did not matter what approach was followed, but in fact the conclusions from practical observation are slightly different. It seemed that when a system is working well, the demands on human adaptability are within the limits of human tolerance. But when the system is working less well, or exogenous factors such as noise are beyond certain limits, or the operator is overtired, then small irritants in the system to which the human could normally adapt become beyond his adaptive powers. This kind of situation is very difficult to construct in test surroundings, or to test in real life. Certain

parts of the system may easily be tested for their suitability to human needs, for instance factors in the field of ergonomics, such as optimum seat heights. Other factors, more concerned with mental comfort, such as those to be considered in the design for an editing system, are much more difficult to assess and measure. Experiments to validate any particular design are lengthy and expansive guides to correct design are therefore needed, even if these are only ruleset thumb based on the results of controlled experiments.

Mr. Davies went on to outline one attempt, by Wiezenbaum in his system ELIZA to conceptualize at a more complex level. Wiezabaum's idea was that conversation involves images of the data structures comprising the thought patterns in the other person's mind. If it were possible to understand these data structures, then the implementation of genuinely natural conversation or machines would become easier.

Mr. Davies went on to talk about existing question-answer systems, taking an example from the medical world, implemented on an experimental basis at Glasgow. A series of standard initial questions which each patient at a clinic had to be asked was programmed as a branching system of question and answer posed through teletypes to patients, who were only given the alternative 'YES', and 'DON'T KNOW' in response - these were the only keys on the special mask laid over the teletype keyboard. The specialist was then able to study the patient's answers before his first personal encounter, resulting in a considerable saving of his valuable time. What is perhaps more surprising is that the system was popular with patients, who found it less embarrasing than full-face contact, and also less inhibiting because the influence of social class distinctions between doctor and patient were avoided. Mr. Davies pointed out that the scripting has been very carefully done, to include the appropriate use of local terms, to avoid being patronizing, and to strike a balance between brusqueness and verbosity.

Mr. Davies went on to discuss the economic factors involved. Regarding cost reduction, he suggested that it might be cheaper in the long run to make modules, independent of one another, rather than make the whole system as cheaply as possible. On the cost distribution factor, Mr. Davies discussed tariff design for communications network. He suggested that the tariff should be close to the true cost, since trouble would arise eventually if it were not. For instance, the telephone network in this country, if priced by cost, would charge mainly for rental of the line and hardly

at all for distance. As this was not done, when data communication systems are installed, it pays the user to load the local system as much as possible, and where possible concentrate his long-distance traffic. This will eventually give trouble to the Post Office by overloading local exchanges.

Another economic factor concerned the problems of selling the system to the customer. This had two aspects. First, the management had to be persuaded that they needed the machine. Then, people who would have to use it had to be convinced. In essence, a system should sell itself. Human interaction with the system was vital, and this should take account of the two phases in user behaviour, the learning phase and the experienced phase.

Mr. Davies then went on to discuss the technical factors. These were, he felt, less worrying because they are better understood. However, they were problems. Comparison between systems was very difficult. The shape of the system would therefore have to be decided when the performance of hardware and software were relatively unknown. Experimenting was difficult too, particularly as it was hard to persuade people to keep an open mind, and not take decisions too early. He suggested that it was much easier to analyse the tasks of the hardware, and therefore to buy a realistic system, than it was to assess software realistically. He felt that the modularity of the hardware was important, since it was vital to think about the possibility of performing a task in several different ways.

Another point of importance was that the description of an interface should be confined to describing what happens across the interface. With hardware this was fairly simple, but with software less so, since it was possible to do things in so many different ways that such description decides nothing.

Mr. Davies then outlined the experience of the Computer Science Division of N.P.L. in relation to one kind of interface problem. This involved devising standards for information transfer so as to achieve a standard interface. Several manufacturers already use this standard which enables the carrying of an 8 bit transfer uni-directionally by agreement. Further interface definitions could be based upon this one. Mr. Davies felt that in this context the term 'transparency' should be carefully explained. It was impossible to define any interface completely, nor was it desirable.

The art was to take the definition to the right level. The undefined levels corresponded to the 'transparency' of the interface.

When one went on to consider software design, Mr. Davies felt that there were many requirements to be considered, such as modularity, portability and so on. It was also important that software be written in such a way that its performance can be accurately assessed.

Mr. Davies concluded by suggesting some implications of his remarks for the teaching of computer design. Firstly, he felt that there need not be too great an emphasis on mathematical methods of design. Secondly he felt that it was as important for students to break accepted design rules occasionally and to challenge any dogma. The philosophy of teaching should not be too rigorous; a variety of teaching methods should be tried. Practical exposure should not begin at too low a level of detail because the development of abstract ideas is important at an early stage.

Discussion

Professor Sumner told the Seminar that his department tried to encourage students to appreciate the users' viewpoint by co-operating with other departments, for instance Architecture, on Student projects. Mr. Davies agreed that this was a good idea, and would prepare them for the fact that users' requirements were often ill-defined.

Professor Michaelson asked Mr. Davies to explain what he meant by 'the difficulty of analysing the behaviour of software'. Mr. Davies replied that he was thinking of problems of assessing the performance of software. The software writer tends to several levels of abstraction. Often the generalisation of a concept is unnecessary and inefficient; a specific program is sometimes better.