Discussion and Correspondence

Computers and the business information structure: new horizons in decision making effectiveness

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An important aspect of the computer revolution in business has been the need for managers to redefine their decision-making informational requirements.

This paper attempts to outline the impact of computers on managerial responsibility and to briefly survey some of the ways in which it has been suggested that managers might adapt to accommodate, harness and effectively utilise this new tool.

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Ought managers to welcome the transfer of existing information structures to a computer system with enthusiasm, apprehension or fear? The essence of this paper is to suggest emphatically that managers—far from having anything to lose—have more than a little to gain from the introduction of computers to business; since the managerial function, while perhaps becoming more exacting, may be executed at a level of efficiency, accuracy and effectiveness higher than was ever before possible. Reflections of the ultimate benefits of the new system will include the extended availability of information, the consequent improvement in decision credibility and hence the better utilisation of resources, improved co-ordination and more effective control.

Information evaluation and appraisal remains essential to the managerial task, but the comprehensiveness, relevance and variety of data taken from the new system will be greater than could ever be achieved by conventional clerical techniques. By creating an enhanced information structure and thus a new decision-making environment the computer will strengthen and fortify managerial effectiveness. Far from becoming a master, the computer—and the sophistication in administrative techniques it allows—will become a servant, both faithful and tireless, the most powerful weapon in the manager's armoury.

Perhaps the most immediate effect of the transfer of an existing business information structure to a computer system is the vast store of data which becomes available to management. Decision making will—thanks to the development of the concept of exception reporting—become more efficient because individual managers need spend less time in routine supervision than they did previously and will consequently be able to devote a larger proportion of their efforts to more important managerial tasks.

So extensive is the range and variety of data obtainable that a number of new managerial tools become available, in particular the advanced techniques of operational research, simulation and network analysis. Use of such techniques enables management to more effectively control the direction of the firm within its commercial environment. The more immediate provision of historical data enables trends in sales, prices, staff turnover, costs, etc., to be recognised and evaluated instantly. The computer is able also to apply to these calculations a number of variables and correlations previously inaccessible because of the heavy clerical work load involved.

The advance of technology has brought about an increase in the complexity of the production process. The more complex a product becomes then the more data is needed to describe its design, production and distribution. A further result of technological complexity has been the rapid introduction of new products, new processes and new relationships with customers and suppliers. To develop, manufacture and market these new products requires the use of such techniques as research and development, production planning, marketing and perhaps after sales service. All these operations place large data-handling loads on the firm and thus the amount and range of data that management must handle is extended—increasing diversity of operations within businesses is greatly adding to the variety of data to be handled. As firms continue to extend their field of operations, as they produce and market yet wider ranges of products then managements have to work with data relevant not only to a single product, but to many, and in particular their relationships to each other and the contribution of each to profitability, individually or with others.

To effectively function within the new decision-making environment managements must ask themselves a number of critical questions, if information is required then who needs it, when does he need it and why? In what form is the information required? What does the recipient do with the data when it is available? To answer these questions the availability of data has to be considered and it must be the systems analyst who will analyse the most efficient way of supplying such data to management. He must ascertain where the information originates, when and how it is best obtained and in what form.

Records carried within the organisation must reflect the decision taking function. Sometimes data produced for decision taking will act as initial input for the execution of that decision. While the quantity of such data may be quite small its impact and consequences are usually large. It follows that decision-making data must be accurate and also, the validity of decisions taken on the basis of such data must be assessed in terms of their contribution to the organisation as a whole. While the accuracy of data is the responsibility of the analyst its evaluation is rightly a function of management.

It should be emphasised here that the computer is not of itself a senior manager who sits calculating the welfare and livelihood of the company's employees. It is a tool, to be

used wisely or foolishly, and in part the manager of the future will stand or fall by his ability to make use of this tool—exacting as its effective utilisation may be.

Indications of the practical value of managerial uses of the computer may be had by briefly surveying a few currently accepted management concepts. The term 'Management strategy' is often used to describe long range business planning and the formulation of the policies which are to be the organisation's operational guide-lines in the years ahead. Decisions taken at this level determine the 'terms of reference' within which the business is to operate and compete in the future. Computers may aid strategy by working out the consequences of one or any number of alternative courses of action and the probability—in mathematical terms—of the success of each. Alternatives may then be compared and the most promising selected.

'Management tactics' are concerned with the more immediate decisions that have to be taken and are necessarily related to the strategies that have been adopted. Managerial responsibility at this level is as likely to increase as it is to diminish. Executives must specify and review the framework upon which decision taking is to be based. Deviations from predetermined norms must be investigated and their significance assessed—in terms not only of the work itself but also of the impact of the deviation in its organisational context. Since routine supervisory duties are reduced managers may devote yet more attention to analysing the significance of those events which have occurred, but have not been anticipated. Computers assist management tactics by providing the facts for specific decisions to be taken. It is in this area that the most practical benefits of the scientific approach to business problems made possible by computers may be most readily observed; for example the computer may control costs, schedule production, allocate resources, mix food or fill packages. Personnel records, pay slips, invoices or any other documentation may be analysed in a fraction of the time required by clerks to do the same job. Computers control the operation of automatic warehouses, translate foreign languages and optimise the performance of machinery. The inevitable term 'automatic decision making'—often used in these applications—is to be handled with care. For since the computer is but one component of the man-machine system, since 'automatic decisions' are input dependent, and since output is of use only when interpreted, evaluated and accepted, then in no way can managerial responsibility for these tasks be said to have diminished.

'Management control' involves the direction and control of business operations once the tactical decisions have been made—clerical operations, file maintenance and the actual physical activities of the firm in relation to manufacture, marketing, transport and distribution, the procurement of raw materials and so on. Computers introduce a potential for the eventual integration of a great many of the informational clerical duties associated with each of the firms activities, the greater the extent to which such integration has been planned as a feature of the system then the simpler and more efficient will information provision and related clerical work be, and the more effective will be decisions made on the basis of such data.

A multiplicity of (often nebulous) alternative courses of action are forever presenting themselves in each of these areas of management responsibility. The computer introduces clarity and precision into the manager's decision criteria by making available accurate, comprehensive facts, estimates, correlations and interrelationships.

Machines are often more economical and less variable than are people, performance may be predicted more easily. More importantly, this machine, the computer, presents fresh horizons to the ambitious management and new concepts of organisation, administration and control are needed. For instance, no longer need a manager wait until a project is near completion before he is able to assess the efficacy of his plans against actual achievement. By wise computer usage estimates may be monitored against physical events as they happen and the very moment things begin to go wrong remedial action may be taken.

If managers are to effectively seize the initiative and extract maximum advantage from a fast changing, economic environment then they cannot afford to ignore the benefits a computer system will bring. Computerisation does not infer a diminution of managerial responsibility but rather an extension of managerial potential, and the consequences for the individual firm and indeed for the community will be great.

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To the Editor

The Computer Journal

Sir,

With regard to the convergence problem discussed in J. N. Lyness's paper, 'The effect of inadequate convergence criteria in automatic routines' (*The Computer Journal*, Vol. 12, No. 3, pp. 279–281) and in Lyness's and J. V. Garwick's letters on page 121 of *The Computer Journal*, Vol. 13, No. 1, I would like to point out that a criterion similar to that suggested by Garwick was used in SHARE subroutines QATR and DQATR (Romberg Integration) for the IBM system 360. The test is just that described in the second paragraph of Lyness's letter (terminate the calculation as soon as $|u_s - u_{s-1}| > |u_{s-1} - u_{s-2}|$), but is not applied until $s > 3$.

In their certification of the subroutines (SHARE SSD 187, 25 October 1968), W. J. Cody and K. E. Hillstrom observed that 'our results indicate that the method used to detect roundoff is unreliable unless the roundoff is fairly large . . . on the other hand, we have given two examples in which variations of the magnitude of the differences detected by the test are entirely unrelated to roundoff but are essential to the proper convergence of the algorithm. Our feeling is that the algorithm would be improved if the test were simply removed'. Thus it seems likely that Dr. Lyness's 'more humane approach' will be more successful.

Incidentally, there is a misprint in Dr. Lyness's paper (on page 279 the double inequality should read $2 \leqslant j \leqslant 14$) and another in Mr. Garwick's letter (the first if statement should read **if** $d > 10^{-3}$ **then goto** $L1$).

Yours faithfully,

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To the Editor

The Computer Journal

Sir,

The letter from Mr. E. S. Deutsh (*The Computer Journal*, Vol. 12, p. 412) dealt with a line thinning scheme suggested by D. Rutovitz (1966) in his review paper on pattern recognition.

Subsequent work and publications by this Unit have refined this technique and extended its applicability; for example, it is now suitable for use on pictures containing grey level information, and not just binary pictures.

Anyone interested in this type of technique is referred in particular to Hilditch (1969).

Yours faithfully,

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To the Editor

The Computer Journal

Sir,

In *The Computer Journal*, Vol. 12, No. 4 (November 1969, p. 316), Prof. M. V. Wilkes reviewed *The Art of Computer Programming*, Volumes 1 and 2, by Donald E. Knuth. With all due respect to Prof. Wilkes, I beg to disagree with him about a couple of points that he made about Volume 1.

In way of explanation let me say that I view computer programming as consisting of three related, but distinct, phases, namely synthesis, analysis, and communication. The synthesis phase consists of the design and construction of the algorithm; the analysis phase consists of testing for correctness and the analysis of the run-time and storage required; and the communication phase consists of communicating the algorithm via an appropriate language.

It seems to me that most of our programming textbooks concentrate on the communication phase, i.e. the teaching of a programming language and say very little about the important synthesis and analysis phases. On the other hand Knuth's Volume 1 is the only textbook, that I have seen, that introduces and applies mathematics that is useful for the analysis of algorithms. This, to me, is one of the real beauties of the book, and I think that it is unfortunate that Prof. Wilkes chose to characterise this mathematics by saying that 'The first 119 pages of Volume 1 are about general mathematics and could just as well have appeared in a book on, for example, quantum mechanics.' Prof. Wilkes also states that '. . . the overwhelming, almost overbearing, atmosphere of the book is one of mathematics'. I would say, rather, that the atmosphere of the book is the exposition of the mathematical beauty of computer programs. Furthermore I am not inclined to fear that 'It would be unfortunate if some ordinary mortal, attracted by the title and charmed by the style, were nevertheless, led to conclude that he needed a high standard of mathematical knowledge in order to understand programming.' Instead would it not be wonderful if we ordinary mortals learned the power and beauty of the mathematical analysis of algorithms?

Alas, it appears that this ordinary mortal has indeed been 'attracted by the title and charmed by the style'.

Yours faithfully,

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