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MANAGEMENT INFORMATION SYSTEMS THE STATE OF THE ART

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DEFINITION:

Having adopted the title for this paper, I consulted "The Penguin English Dictionary" (13) to find out what was talking about.

System: Methodically arranged set of ideas, principles, methods, procedures, etc. (For purposes of this paper "etc" includes computer hardware, software and application programs.)

Information:act of telling or of imparting knowledge.

Management: Group of executives directing an industrial undertaking.

Read in that order, those definitions provide a reasonable description of what is generally thought of today as a Management Information System. The "Macquarie University Calendar" (11) informed me that: "Statistics, in its broadest sense, is the art of summarizing and extracting information from data, building models to simulate reality, and making decisions on the basis of these models."

A management Information System is not an accounting system; both should draw on common data but the information required differs. Baker (12) expands on this point: "Financial accounting is transaction-based and export. It was not designed for planning purposes or for measuring performance against organizational objectives. Management accounting subroutines, because they are developed in a financial accounting context, have been limited in their ability to extend beyond the traditional accounting role of historical analysis. The accounting model, with its aggregations as required by custom and statute, very often falls short of providing useful information for management decisions. Not only are the decisions confronted in operations numerous and heterogeneous, but also they may be only partly anticipated at the time accounting data is collected. The data for decision models must encompass both the historical and the predictive.

A management information system must provide information which will assist managers in making their decisions. As every manager is an individual, each will have a unique approach to any given problem. This, together with the often unpredictable changes which are occurring in our socio-economic environment, calls for such flexibility as to preclude a useful didactic definition. At best one can say:

Ideally, a management information system must be capable of instantaneously and interactively being all things to all men.

The operation of the ideal management information system is easy to describe. The managers themselves sit down at a video terminal and issue a few crisp commands through the keyboard, may be make a few artistic strokes with a light pen, and the information they require, no matter how abstruse, flashes up on the screen in glorious high resolution color graphics or characters as appropriate. A deft touch on the appropriate button and a high speed multipen plotter gives them a hard copy in well under a minute. We have all seen versions of this information system in science fiction movies, in glossy magazines and in visions conjured up by computer salesmen as they tempt us with their further out offerings.

Indeed, the technology exists to make this possible. However, anything even approximating such an information system is a dream. The reality is very different.

EVOLUTION

An organization's involvement in computing is typically a gradual process. Prior to 1960 a large progressive company or government agency might have had some electro-mechanical, punched card accounting machinery. This would have been replaced with an early computer and some additional areas of work computerized. As time has passed, the computer equipment will have been expanded and more systems added to the computerized repertoire. Depending upon the industry, and to some extent the personalities who were involved whilst the systems developed, there might now be separate accounts receivable, accounts payable, materials inventory, investment accounting, general accounting cost accounting, payroll and other high transaction volume applications. These systems will have been separately designed, developed and implemented to reflect the hardware technology, software engineering and system design philosophy operative at the time they were conceived, there have been profound changes in all these.

Depending upon the geography of an organization's operations, its organizational philosophy and power structure this development of computerized systems will have taken place either within a headquarters computer service organization and been installed on a machine or machines in a central complex or, on separate machines, often from different manufacturers, in different locations.

Over the course of fifteen years the cost of computer hardware has fallen by a factor of 1.000. This has made it economic to apply the theoretical and practical developments in programming languages and system design which, while they use up more computer hardware resources, have according to Evans (6) effected increases in programming productivity by a factor of 2 or 3 over the past ten years. However, computer systems are still expensive. A large organization which has been involved in computing for about fifteen years might be operating an historical pot-pourri of systems whose replacement cost, apart from hardware, will be in the order of $5-10 million.

Like any other investment, a computer system should not be replaced until it is costing more to maintain than it is worth, or a more cost effective system can be introduced which will justify the expense of its installation. One must also remember that once a successful system is implemented it becomes set in the social concrete of the groups which use it. Thus in practice it has not been possible to change computer systems nearly as fast as the changes in hardware, software and system design technology might have warranted.

THE STATE OF THE ART

Nevertheless it is the data which passes through and accumulates in the files of these systems from whence management information is drawn, any attempt at being systematic is fraught with difficulty; typically these files will ran the full gamut of boxes of cards in the oldest systems to random access files addressed through a data base package in the newest. In such an environment extracting the initial data for an exercise in preparing management information becomes a complex task if the files of more than one system must be read concurrently in a coordinated manner. It will usually require the services of systems programmer, or some-other specialist who works close to the machine, and it will always take more time than the manager at interest thinks it should. If the exercise is to be carried out in an organization which has developed its computing system on separate machines within different departments, the combination of technical incompatibility and organizational parochialism might prove too great to overcome.

As early as ten years ago software packages started to appear which could address a wide variety of the sequentially organized files available at that time. Provided the relationship between the files containing the data at interest could be logically described, then the data could be readily extracted and the information reported by the package if the task was computational simple, or the data could be prepared in correct input format for the more potent statistical packages like the Bio-Medical Programs (BMD) or, more recently, the Statistical Package for the Social Sciences (SPSS) to prepare the information. The most successful of these information retrieval packages was undoubtedly Informatics MARK IV which is still available in greatly enhanced form with options available to extract data through interfaces with the more common data base management packages. IBM's package, RPG is also widely used for this type of work; according to Leach (7) RPG is being "resurrected" by many programming groups at the moment.

If an organization has a management information system today, as we have defined one, it will be built around such an information retrieval package and based somewhat shakily on a miscellany of files. At least some of the following difficulties will restrict its utility:

a) Any task at all complex will require the attention of some already overworked specialist.

b) Not all of the files are compatible with the package

c) The computer services organization(s) is (are) against the concept.
d) Control of data definitions rests with user departments who change

them unilaterally in order to achieve short term, narrowly based objectives.

e) Accuracy of data is inadequately controlled.

A primary requirement for a successful management information system is that the definitions of the data are stable in time and constant across the system. It is also important that the data are timely and accurate if information drawn from the system is to have acceptable credibility. The historical development of the application systems one at a time, usually as automation of preexisting manual systems. has led to the entrenchment of the "Electronic Data Processing (EDP) mentality" in the users of the systems. It is their view that it is their data which is processed, stored in their files and given back only to them; if this as allowed to persist it is not possible to provide a sound base of data on which to rest a management information system.

It is necessary to centralise control of the data definitions, capture methods and accuracy. Logical as this may sound it is nonetheless a traumatic change to effect in most organizations. For a start it cuts across generations of accounting and auditing practice and possibly even some of the principles. Richards (14) when relating practical experience in the Anglo American Corporation of South Africa, views centralized data administration as part of a "function of major importance" when setting up corporate wide systems. This centralization of data control and definition infers organizational shifts in responsibility; this is a change of a social nature and it is axiomatic that it will be resisted.

The smaller companies who have installed computers only during the last few pears will not escape these problems. They have been tempted by the dual benefit of the still rapidly declining cost of the computer system and the investment allowance. Over the past few years there has been a veritable flood of the complete system based on mini-computer and disc technology, and designed on data base principles. These systems are cheap and small; in most instances they are probably too small. Neither the technology nor its application is yet nature and it will not belong before the majority of these companies wish to buy another computer either to take advantage of the features of the newest entrant into the market, or to expand the scope at their applications. They may find that it is no longer possible to buy the same machine as it has been superseded; or if they can still buy one, it is difficult to recruit and retain staff to develop systems for an outmoded machine.

Standardization will not be maintained and costly conversions or inflexible diversification will be the order of the day. The older computer systems have all gone through this trauma already and IBM, the market leader, appears very reluctant to ever introduce another generation of hardware which is not upwardly compatible with its predecessors. It will still take some time for the mini computer system market to relearn this lesson.

Even though these small new systems are organized on data base principles and often provide simple inquiry facilities, changes are still required in the organizational structure regarding the collection of data before a management information system can be implemented. This to my mind is the dominant factor regulating the speed at which a truly flexible, complete, management information system can develop. When any company does make such a change it creates head-line news in the computing press.

That is the present reality of information systems. They are usually a loosely coupled collections of separate accounting systems which can sometimes be addressed concurrently by an information retrieval package. The separate systems are up to fifteen years old and show their age. Any outsider approaching the computer department with a request for information which will cross several of these main-stream systems might well be astounded at the complexity of the operations involved in fulfilling what to him appeared to be a simple, logical requirement.

CURRENT TRENDS

However, the state of the art does not consist of only a static view but must also examine the trends of the changes taking place. What are the factors influencing the direction of development of Management Information Systems?

Firstly, there is the hardware. The thirty odd years since world war II have unfolded a remarkable story of faster, smaller and cheaper computers and their ancillaries; it is widely accepted that the price of equivalent computing hardware falls by a factor of ten every five years.

All the forecasts indicate that this trend will continue. Lecht (7) discusses the emerging Josephson Junction technology, and predicts that the resulting: "Incredible speeds and capacities will dramatically change the way we program future computers. There will no longer be much concern about efficient code or wasteful use of main memory.

In fact, programmer/analysts can try all possible solutions to a problem since it will take a few nanoseconds per try. Trial and error, interactive programming and analysis would increase greatly with this kind of capability, and drastically change the way we create software.

There has also been remarkable development of data communications. This has paralleled computing, as the some basic electronics technology is behind the ability to reliably transmit, control and decode signals of ever increasing frequency on which the communications revolution is based. The economic competition between satellite, terrestrial micro-wave link and coaxial cable services carrying these very high radio frequency;digitized services has led to significant advances in all, another technology has recently emerged and that is the optical fibre, using light as the carrier and according to Boyle (3) capable of transmitting data at over 40 megabits/second through a single glass fibre a fraction of a millimeter in diameter.

However, competition from radio technology is still developing, with yet higher frequencies becoming available for transmission and relay of signals through larger more powerful satellites which are to be launched by the Space Shuttle.

The programming languages available and system design techniques have also changed dramatically over the course of twenty years.

At first computers were programmed in binary machine code or at best a symbolic equivalent (Assembly Language); this involved the rather tedious task of specifying; in detail every movement of data and every arithmetic or logical operation that was to be performed. The introduction of FORTRAN and COBOL about 1960 was a giant step towards more productive deployment of programmers'personal effort. This was at the expense of using compilers in the computer itself to translate the FORTRAN or COBOL statements into machine language. In addition to performing this translation, the compilers also are able to detect syntactical errors and some types of logical error in the program.

As McCracken (10) points out COBOL and FORTRAN are procedural languages; what is required is the ability to "tell the computer what we want and let it figure out how" McCracken goes on to describe the movement to "non-procedure oriented languages." These languages generally separate the description of data from the program to provide data independence; this is the very basis of the current movement to data bases and greatly improves program flexibility and maintainability.

There is also a widening variety of specialized application packages directed to particular areas where a recurring class of problem has been identified and algorithms for their solution formalized. To name a few are linear programming, statistical calculations, dynamics of electrical networks, queuing processes and financial planning.

Lecht (7) notes that the major progress in the development of special purpose languages have been in the: "Areas of mathematics and engineering... because they have been formalized and reformalized and refined over many years. The activities of government agencies and corporations-even in narrowly defined areas such as accounts receivable and payroll processing-have never been rigorously specified....................................

In addressing the problem of industry, software specialists have tried to impose incomplete and often incorrect models of an enterprise because their knowledge of it is frequently so superficial."

However, he goes on to comment that progress is being made in this area by inter-disciplinary teams and predicts that: "during the 1980's there will be a proliferation of such
(non-procedural) languages characterized by progressive growth in sophistication."

Communication between human beings is a labor intensive activity. It has been my observation that the conventional method of writing computer programs to solve specialist problems-that is the specialist briefing and analyst antler programmer who then write the programs-consumes about four times the manhours as when the specialist writes the program himself in say, FORTRAN. If a suitable specialized application package is available for the particular problem the ratio can be as high as ten.

This approach is employed at some cost in hardware resources. However as the price/performance ration of computer hardware improves by an order of magnitude every five years and the productivity of programmers is no more than two or three times what it was ten years ago, I agree with McCracken's (10) prediction "that (specialized applications) packages of this sort will proliferate in the next few years."

McCracken (10) sums up as follows: "There will always be programmers, but in the future most of them will be involved in writing the software tools, not actual application programs. As best it appears now the productivity of those programmers will not improve bsy a great deal, but as result of their work, the overall efficiency of the use of computers will improve markedly over today's status.

A FORECAST

Now then are computer systems likely to develop in organizations wishing to use them as the basis of a management information system? For a start all of the items of computing equipment must be capable of communication with one another, for the foreseeable future, while the art of management information systems is still developing, this will involve a centrally controlled corporate hardware acquisition policy.

Will the cost of communications remain high enough in relation to computing equipment to continue what appears to be a trend to set up networks of mini-computers or will new development result in a return to the system based on a large central computer serving geographically distributed terminals? Unfortunately, this problem is anything but deterministic.

As Martin (12) points out, the prices of communication services are usually subject to strong government regulation and therefore politically based; this can retard the introduction of new communications technology in the future.

Another important factor in the economics of the centralized versus decentralized system is the cost of new development. In spite of improvements in technique, system development is labor intensive and costs are rising with inflation. The technology of the large centralized computer system serving geographically dispersed simple terminals is well understood and established. There are large investments in this type of system already whilst the concept of the system based on a network of connected mini-computers is relatively new and to a certain extent is still a gleam in its designers eye.

The human factor must also be considered. It is much easier to maintain the discipline and control needed to operate a geographically distributed system if it is based on centralized computing equipment and simple terminals. The organization necessary to maintain a system based on a network of computers will be much more difficult to manage then that of the centralized system. The primary requirement for a management information system is a stable, timely, accurate data base; this is much easier to achieve initially if the data is all in one place; later, if the design of management information systems becomes an established discipline and their operation is recognized as an essential service to most organizations, it will be possible to geographically distribute the data it the economic factors warrant.

It is my opinion that the centralized system will win out. This will be based on:

(i) Big, fast hardware capable of accommodating vast amounts of data and supporting the wide range of very sophisticated, flexible software necessary to provide our ideal systems.

(ii) Fast, cheap communications services which can economically provide an interface between the system and managers at any location.

A significant point in favor of this view is that IBM are continuing the development of larger, faster computers and have also invested hea vily in establishing the Satellite Business Systems Corporation. IBM's prophesies have a way of becoming self-fulfilling.

In addition, McCartney (9) reported that Citibank, who only six or seven years ago embarked on a program of replacing its large IBM computers with mini-computers now appear to be "experiencing some serious second thoughts about the project."

How then will these information systems develop? Firstly, data collection will tend to move towards its source. A wide variety of both automatic and specially designed manually operated devices based on micro-processor technology will be connected to the central computing site; to this extent the intelligence will be distributed. As Amdahl (1) said this will make it economic to collect additional data which cannot be afforded using today's methods.

Secondly, data will be organized independently as a corporate wide data base with massive amounts on line and yet move fairly readily retrieved from archives. This will involve tighter discipline and a great deal of development work in furthering the understanding of data itself.

Thirdly, special purpose hardware and software combinations designed with the end user of the management information system in mind will become available. This line of development has already made several excellent general purpose graphics hardware-software packages available in the market place.

Fourthly, language development will continue to be oriented toward the final problem to be salved and more independence from the data upon which it is necessary to draw to produce and answer will be provided.

Considering the inertia provided by the combination of economic and organizational problems standing in the way of their development, such systems are probably ten years away on a large scale. However, I believe they will eventually make the practicing statisticians - or in the context of this paper are they Management Informers - very productive individuals. They will be freed from the drudgery of manual collection of data and the need to learn the complexities of some low level programming language and the ideosyncracies of the particular computer system where they work in order to practice their chosen profession. The tremendous computing power which will become available, will enable them to regularly test several approaches to the one problem before finalizing on a solution.

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