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ABSTRACT

Electronic systems of the future are bound to be larger, faster, and more reliable. They will furnish management with uninterrupted services in a real-time mode for practically all applications. In short, they will provide computing power as a utility company of today provides electric power. But the most spectacular advance is likely to be the introduction of millions of terminals into offices and even homes, allowing most jobs to be done when and where they need doing. Thus, electronic systems will eventually take on practically all the tasks of rote and drudgery which nature and society now impose upon us. In the end, electronic systems will not only benefit our managers but all of mankind by allowing society to make human use of human beings. (Author)

Information Technology - Its Impact on Decision-Making

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Society is a vast and complex accumulation of living organisms and inanimate objects in a thermodynamic environment. It is a system in the most general sense. Subtle interrelationships exist in time and space between its component subsystems, between people, families, cities, states, and organizations all of which are motivated and stimulated by many endogenous and exogenous forces. For man to exist - and prosper - in such an environment, he must adapt and respond intelligently to the world he perceives. He must provide food and shelter for himself; he must also receive and process data and information available to him and make rational and intelligent decisions.

Our society must be looked at as a whole, as the synergistic sum of all its components and not just the parts by themselves. We must bring together the concepts of communications and control within purposive system. Our large societal systems tend to rely heavily on the use of electronic machines for calculation, data processing, and communications - and on simulation and modeling. Society tends simultaneously toward randomness (increased entropy) and organization (decreased entropy). Successful models of our cultural, political, economical and ecological environment must be developed from computer and communications control theory. Underlying these models will be assumptions about the ontological or teleological nature of societal systems in general and estimates of world computing power needed in the evolution of a mind-amplifying society.

The introduction of electronic data processing systems into management has brought about significant changes in requirements to operate these machines and to effectively interface them to their human customers. The significant trend is toward reduction of human intervention in purely operational matters, on one side, and the transition to realtime systems responsive to management's immediate needs, on the other. Specifically, the design and development of management information systems has made considerable progress, providing management with timely, accurate, and pertinent information at a reasonable cost. As a result, most managers feel that they are able to make better and more timely decisions, allocating their limited resources more effectively.

The availability of more advanced hardware, especially for displays and intelligent terminals, as well as the synergistic effect produced by combining computers with communications, have produced new challenges to our technologically oriented managers. Static management systems of the past are being re-developed to make them dynamic and interactive. Human decision making processes are being examined for consistency and algorithmic properties in the hope that we can codify them and give at least limited decision-making power to the artificial intelligence of computer models. Graph displays in realtime are beginning to displace the "classical" ledgers and computer printouts, allowing the manager to exercise his superior talents in the fields of pattern recognition and hierarchical examination of causal relationships.

The advent of interactive display systems and intelligent terminals has by no means come about without a struggle. Managers are not inclined to like the role in which they are now cast as pseudo-technologists. But in order to keep up with the rapid pace of their environment, they must pay more than lip-service to advancing their computer-oriented skills. Successful systems are most often designed by their own managers for growth, where the system matches operational needs. "Never bite off more than you can chew" is the best advice which can be given in response to the question what applications to implement first and what hardware to procure initially. Generalized software systems are universally non-existent and must be developed in house; before ordering a score of displays or intelligent terminals, the more enlightened manager starts with one each, to learn and plan for the rest. He does not introduce the most complex and sophisticated devices, such as Lightpens, Rand Tablets, Mouses, or Joy-Sticks, before experimenting with a simple-minded keyboard input in a truly interactive mode.

Nevertheless, successful applications of information technology can be found everywhere. There are probably over ten thousand displays in operation alone for airlines reservations (in realtime) and we would be hard pressed to operate our complex transportation system in any other way. Engineering design is gradually making room for graphic systems with lightpens, as is computer-aided instruction, and even computer-managed instruction. By the same token, management planning and control has taken on a new dimension, with the ability to select current data and summaries from massive data bases especially designed for their users. More advanced systems involving automatic controls are being developed for operational use. While the cost of hardware is steadily decreasing, the cost of developing systems is growing commensurate with their scope and complexity. For that very reason, it is important that managers very carefully keep in mind five key points in the planning and selection of information technological systems:

(1) Establish well-defined objectives and allow sufficient time for systems design, development, and implementation.

(2) Consider trade-offs in development of the necessary management information systems software and use in-house talent only if it is available and competent.

(3) Purchase packaged applications even if they don't quite fit the stated objectives. It is often better to force-fit the objectives than to flounder in the rough sea of writing special-purpose software.

(4) Start realtime, interactive systems with a simple terminal and add capability as required.

(5) If the present system works, don't tamper with it. The glamour of pioneering more advanced systems has a high price tag.

The design and development of advanced information systems for management has received considerable and ever-increasing attention. Many published studies indicate that their goals are not as readily achieved as would be apparent from the large number of systems in existence and in the planning stages. It has been pointed out that the problem of organizing an effective management information system has become progressively more complex as computer applications are extended to cover wider areas of interest to management. Present concepts seem to have fallen short, in many cases, of providing a real solution to the problem, even under the guise of "total systems", "integrated systems", "real-time system", or other cliches with which the field abounds. Most such systems provide, at best, dated and voluminous outputs which tell little more than could have come from "ye olde tab shoppe".

Nevertheless, a good case can be made for electronic data management systems designed to provide current data and selected information. More advanced systems, such as Management Information and Control Systems (MICS) and General Information Systems (GIS) are beginning to emerge and are coming into operational use. It is safe to predict that future managers will indeed be able to make intelligent use of intelligence systems, to paraphrase a well-known expression by Norbert Wiener. Some day such systems will provide not only factual data in real-time, but also statistical extrapolations, decision functions, and even the calculated risks associated with alternative courses of action.

If the snail's pace of these developments troubles you, think about the historical development of our society, its governments, the population explosion. You will find that society grew not only in terms of sheer number, but concurrently it grew exponentially in complexity. There is a saying among technologists that complexity begets complexity. That is, the more complex our systems grow, the more complexity is demanded in return. Our technological society is already totally integrated and its complexity is so great that few can assess its total dimension. In this complexity, we find a major component: Data Trails.

How many data were left behind by the aborigines who inhibited the jungles ten thousand years ago? Zero bits per person per lifetime! They were born, led a miserable life trying to survive, and finally died. Yet there's nothing recorded about them, not even a count!

And how many data do we leave behind in terms of brown folders, punch cards, or magnetic tapes? Today we record, on the average, one million characters of information per person per year, and data banks are springing up everywhere. In fact, even the number of such data banks cannot be estimated! Like olives in martinis, they come in all sizes: large, extra large, giant and colossal. The rapid growth of the computer industry is something of a sad tribute to our mania for collecting, processing and preserving all these data!

There is no question that the U.S. is the world leader in developing computer power, in building machines to take care of activities which were formerly done by man himself but ought to be relegated to a machine. Servan-Schreiber, the French journalist and politician examined this proposition in his very stimulating book: The American Challenge. If you haven't read it, you ought to!

He points out that the achievements of this country result from the fact that we are the world's leader in terms of data processing or computing power. Now let's analyze this. What do we mean by "computing power"? Obviously, we have here machines which are not muscle-amplifying devices, like the car, the steam shovel, or other mechanical contraptions, but serve as mind-amplifiers! They do "mental work" faster and more accurately than you and I can ever dream to accomplish.

Now we can make our assessment. There are about 80,000 computers in this country, some of which are very large. So large, in fact, that they can outperform a human being by a ratio of 100 million to one! I would like to propose to you a single number to show you how well Servan-Schreiber understands this new form of power. The total data processing capability in our country equals a workforce of 400 billion human beings; it is "owned" by 200 million human beings, who are managed by a million managers; and we have elected a few thousand to control our societal processes. But it is electronic power which drives our integrated system where already 99.9 percent of all work is done by machines.

The efficient operation of these large, electronic data processing systems has also brought about the need for extensive and powerful executive or operating systems. The reason for introducing this interface between the machine and its (still) human customer is strictly economical: Best use of the very costly hardware can be made only if we hold man's intervention to a minimum.

Formerly, computer operations made great demands upon the ingenuity of the console operator, and upon the dexterity and skill of other personnel handling tapes, cards, and hard copy. Even under the most favorable circumstances with highly trained personnel, such systems could never exploit the machine's full power. By contrast, the newer generation of multiprogrammed computers and the event of multiprocessing have greatly changed this picture. We are learning how to organize modular hardware functions and how to place operations under control of a decision-making executive (software) monitor. The design goal has been the more effective utilization of the hardware; but we have also learned that relevant software systems were difficult to construct unless certain hardware features were available.

A good deal of "brainware" has been expended thus far to make operating systems of third-generation computers more powerful and flexible. Certainly the systems designer must think about such management functions as allocation of resources and scheduling; about job mixes which include real-time, batch processing, and conversational or time-sharing elements; about communications with its human "masters" through a variety of peripheral devices and about the operation of remote devices over many types of communication links. Therefore, we are examining the role of the systems architect and determine the impact which his design work will have upon our customers.

Let me also remind you that technologists are monitoring and predicting cost and performance improvements for these systems which seem to follow an almost natural law, year after year. In fact, by 1980 you will have machines with the power of today's maxi for the price of today's mini. Not to mention the fact that intelligent terminals will be available for about $100 -- or less. Thus our concern need not be with hardware cost but with a rational, well-managed system design plan. It is obvious that the computer industry has a vested interest in this scheme and that somebody is going to sell many machines and terminals. But our concern ought to be with the master plan and its management.

Nevertheless, as we have here probably another application of computer power, we might raise the basic question, why do we need all these computers in the first place? I'll tell you why. Because man is basically dishonest! Have you ever thought about why so many computers are at work doing payrolls, inventory controls, data base management and thousands of other applications? Because people are constantly stealing, lying, cheating, thereby violating the rules of ethical conduct! If we lived in a perfectly honest society, we wouldn't need any computers except for scientific and humanitarian purposes. Think about this! What would a perfectly honest society look like? For example, how would we handle the payroll? Very simple: a messenger leaves the office on Friday morning and goes to the open doors of the nearest bank, where all cash is kept in an open vaultto protect it from the rain. He scoops up the money he needs, puts it in a basket, returns to his office, and deposits his basketful of cash in the entrance of his building. As the employees leave on Friday afternoon, they take out their own share honestly, even make change! We do it with newspapers, why can't we do it with other transactions? But as long as society is basically corrupt, we will need computers.

In a corrupt society, the odds are always against the individual who must do battle against that huge complex of dishonesty. He must also pit his measly, personal fortunes against billion dollar corporations heavily favored by their financial weight. Therefore, only mind-amplifying power can give him better odds. And what better mind-amplifying power than the computer and a computerized national information system? If society makes this project its prime target, we will have such a system. But obviously without brown folders and punch cards. It must be an interactive, real-time system in which man and machine play their assigned roles. Man must not approach the machine with hesitation, but he must consider it his friend and trust it.

I submit that you cannot develop systems of this nature deductively; you can only build them through an inductive process. You cannot now write down the complete specifications for the "final" scheme of the grand overall information system program! It's far beyond our powers of comprehension. What you <u>can</u> do is design the system by stages and learn from the first how to design the second and later stages.

In summary, electronic systems of the future are bound to be larger, faster, and more reliable. They will furnish management with uninterrupted services in a real-time mode for practically all applications. In short, they will provide computing power as a utility company of today provides electric power. But the most spectacular advance is likely to be the introduction of millions of terminals into offices and even homes, allowing most jobs to be done when and where they need doing. Thus, electronic systems will eventually take on practically all the tasks of rote and drudgery which nature and society now impose upon us. This event was already forecast by Norbert Wiener when he observed that "it is a degradation to a human being to chain him to an oar and use him as a source of power; but it is an equal degradation to assign him a purely repetitive task in a factory (or office) which demands less than a millionth of his brain capacity." In the end, electronic systems will not only benefit our managers but all of mankind by allowing society to make human use of human beings.