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Small Computers in Organizations: Issues and Arguments - or - How to Fight With Computer-Enhanced Bureaucracy

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SMALL COMPUTERS IN ORGANIZATIONS: ISSUES AND ARGUMENTS--OR--HOW TO FIGHT WITH COMPUTER-ENHANCED BUREAUCRACY

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PREFACE

This paper has been produced within the task on "Management and its computer tools" in the Management and Technology research area of IIASA.

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SUMMARY

The continuous development of micro-electronics is changing the computer world. Small computers are becoming more powerful. The impacts are mainly to be found through the changing economy of computer use.

The new situation gives us the opportunity of widening the perspective in the analysis of costs. We can take into account a widened set of criteria such as the impact on organizational behavior, user psychology and broadened participation. The situation is therefore a challenge to scientists in many disciplines because these and other aspects formerly treated as secondary may now be entered into the economic analysis and could in fact be decisive for the final choice.

We will first highlight the development in some disciplines of technology and management sciences to point out the most important changes related to our field. Then we will speculate more carefully about changes in organizational behavior.

Some of the most important organizational characteristics influenced by the choice of small or big computers can be summarized by the concept of "bureaucracy." We will discuss specialization, standardization, formalization and centralization separately. Flexibility is involved in all four of these parts. In fact, flexibility is what is lost if we get too much of the other four qualities.

Behind the actual decisions one will often find different perceptions of the relationships between technology and the managerial situation. We will dwell on a discussion of different approaches because it shows that the changes we find in our particular field of technology are not caused by simple

intra-technical considerations. Rather, they result from very complex and non-transparent combinations of technological, economic, political and ideological factors.

It is essential that the full spectrum of issues be fully known to all parties involved in the evolution of a management system. Then the advent of small computers may give new life to management itself.

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SMALL COMPUTERS IN ORGANIZATIONS: ISSUES AND ARGUMENTS
OR
HOW TO FIGHT WITH COMPUTER-ENHANCED BUREAUCRACY

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INTRODUCTION

The continuous development of micro electronics is changing the computer world. Small computers are becoming more powerful, the architecture of large computers is changeing and the range of special purpose computers is widening.

The impacts are mainly to be found through the changing economy of computer use. We have already reached a point [Isacsson 1979] where there is no longer large scale economy in computer power itself. However, there is still scale economy in memory peripherals. We have reached the point where the traditional economic analysis of data processing in a continuously growing number of cases does not heavily favor large scale solutions. By "traditional" we here mean the traditional set of elementary costs considered in such an analysis, examples of which could be computer investment itself, software, implementation and training.

For the above reason, considerable attention has been paid to small computers for managerial tasks. "Small" is not a very precise description. Sometimes reference is made to microcomputers, a concept which is at least quite well defined from a technical point of view. Both concepts, however, refer to computers, the capabilities of which are increasing in time and which have continuously changing cost/performance indices. For the purpose of this paper we will avoid the fallacy of defining the concept of "small computers" more precisely. We accept that the meaning of these words changes over time. Every year however, there will be an acceptable level of consensus about its meaning as opposed to large mainframe and mini computers.

"Managerial task" is also loosely defined. Does it refer to all data processing in an organization except technical data processing, automatic control and the like (this would include e.g., all transactional data processing and MIS-type (Management Information Systems) of computer use)? Or does it refer to the improvement and support of decision-making by higher managers only?

This article will not assume either of these extreme ends of the spectrum but will tend to the latter rather than the former.

The new situation gives us the opportunity of widening the perspective in the analysis of costs. We can take into account a widened set of criteria such as the impact on organizational behavior, user psychology and broadened participation. The situation is therefore a challenge to scientists in many disciplines because these and other aspects formerly treated as secondary may now be entered into the economic analysis and could in fact be decisive for the final choice.

Unfortunately there is a vast literature on the use of small computers that has a "technology push" character. It seems to be taken for granted that small computers are more desirable than big ones. Sometimes the disadvantages of big computers are mentioned but a serious comparison of small stand-alone computers, time-sharing services to big mainframes and networks of different types are seldomly available. This paper will try to indicate some lines of thinking necessary--but not sufficient--for such an analysis.

Just because the above mentioned aspects of more organizational and technological nature can be brought into the economic analysis does not automatically mean that they will be. But along with the technical development there are changes in the opinion about the role of science and technology in society favoring this development. Unions and individuals have become more interested in the social aspects of the use of computers. Also from this end there is a push towards a widened spectra of criteria to be met in the design of new computer systems. An increasing number of companies and organizations have also experienced good results of efforts in this area. The experience of this author is unfortunately that too many small computer systems seem to be designed with the same relative value attributed to different design criteria (as was the case for a long time with systems based on large computers).

We will first highlight the development in some technical and related disciplines to point out the most important changes related to our field. Then we will speculate more carefully about changes in organizational behavior.

AREAS OF IMPORTANT DEVELOPMENTS

Basic Hardware Technology

The basic microelectronics technology itself is the easiest area to assess. The technical aspects are well covered in literature and periodicals. The manifold forecasts in this area [eg. Scientific American, Sept 1977, Science No 4283, Vol 195 1977, Computer Sept 1978] form a good consensus on price/performance index developments, the power of small computers and related developments. Interesting examples are e.g. that an almost full (CODASYL) data base management system is available on a micro computer (Auerbach 1978) and that in 1979 UNIVAC announced a mainframe computer 1100-60 being the first large computer entirely built from standard microprocessors. It is obvious that small micorprocessor-based computers, i.e., microcomputers, soon will have a capability similar to present day's powerful minicomputers. Large scale computing can be done on hardware with much lower cost than ever before. Qualitative changes occur where low cost and small computers enter new fields of application where they were not economically or technically feasible before.

Peripheral memory technologies, mainly different types of disc memories, are keys to many of the application areas. Very little will change if the computer able to host a data base management system is of low cost and small but the necessary disc memories still expensive. Fortunately, memory technology, e.g., the Winchester technology, continues to improve. Disc memories, however, contain a large part of precision mechanical parts not being subject to as dramatic price changes as microelectronics.

Personal Computing

We cannot avoid the concept of personal computing. It is not a good concept. "Personal" to many people has the connotation of private life in contrast to professional use. Personal computing therefore to many people has a flavor of home computing or hobby computing. It is true that low cost microcomputers are already used for such purposes but all attention given to this area blurrs the fact that the most important changes will occur in the work. A better concept would have been "computers for the individual" stressing that the computer will be priced so that it no longer needs to be shared as a resource at work.

Communication and Networking

The simultaneous arrival of cheap computers and cheap electronic communication facilities is a challenge from many points of view. Small computers are comprehensible and because they serve a small number of users, fewer compromises must be made between conflicting demands. Small computers obviously also have limitations. Networks may be established with the use of communication facilities to simultaneously take advantage of small and large computer facilities simultaneously.

Management Sciences

One of the most interesting developments in management sciences in relation to computer use seems to be in the field of decision support systems (DSS) [Keen and Morton 1978, Fick and Sprague 1981]. We will not get into the troublesome problem of definition but rather just say that management information systems (MIS) often refer to big systems integrating the processing of transaction data and the preparation of a large set of different, often scheduled reports. DSS on the contrary focuses on rather small, interactive systems with a fast response for managers to access a variety of data and small models to support them in understanding their tasks and to improve the decision process. DSS is applied mainly to "unstructured problems." Unstructured in that no procedure or structured approach is available to process this information as a routine task. It is also important to stress that DSS means support for the manager to make his/her decisions and is not a tool to routinize the decision making for the manager. It has been said that "the manager is beginning to realize that the real value of a model comes not from just using it but from creating it". Herbert Simon [1965] once coined the phrase of programmed and nonprogrammed tasks now more often referred to as structured and unstructured tasks. It is more correct to think of a certain task as being structured or unstructured not as such, but in the perception of a certain individual. The same task may seem unstructured to one manager but structured to a more skilled manager. DSS therefore has a focus on how to find structures for problems where. DSS stresses the experimental nature of the dialogue between the manager and the support system. It is also interesting to introduce experience from learning psychology to see if the structure of such a learning process could benefit from experience from other fields of learning. Such cross-disciplinary work has been done [Rockart 1975]. The structure of decision support systems involves among other things problems of man-machine interfaces, model availability, data query systems and data availability through networking. The focus of DSS is, however, on the evolutionary process of building the DSS and not so much on the system itself [Keen 1981]. Thus the DSS movement comes closer to the issues of the interactions between the DSS user, the DSS builder and the DSS itself. Therefore a focus on the cost elements mentioned above is of particular interest when studying small versus large computers.

Software Constraints

Low cost computers will mean low cost computing only if combined with low cost software. We can see three areas where software is a potential bottleneck.

Man/machine interfaces must be simple and unambiguous and supporting. Large groups of application-oriented users cannot be expected to learn and use programs requiring a great deal of computer science education. The existence of friendly interfaces is a key issue if computer use is to become a real mass movement. In the case of text communication this means non-procedural interfaces. This is a group of techniques where the computational process is specified by the desired results instead of by control and data statements [Melichar 1979].

Production of software must be done with more high level approaches and automated tools if sufficient quantities of high quality software are to be made available. Traditional programming principles simply need too many programmers! Formal methods of algorithm descriptions and automated code generators seem in the long run, to be the solution to this problem.

Distribution of ready made software or software modules must be improved through better technology. Both the production and distribution of software seem to be good reasons for a large scale use of so called "solid state software" or ROM cartridges [Carroll 1977,Cragon 1979]. This technology means that a manufacturer develops a program, carries out careful program verification and stores the program in a read only memory (ROM). This ROM is physically a microelectronic chip that is included in a small cartridge to be plugged into your own computer. It can be sold in large quantities thus distributing development costs among a large group of users. This technology has a great potential and is prepared by several manufacturers. There is however a great risk that the low cost of such programs will force many users to use tools not particularly well suited for the problem. It is percieved as cheaper to change your problem to suit an existing tool than to create the tool for your particular problem. Uniformity of procedures may be a threat.

Diffusion of Technology

The rate of change and development in our field is so high that it is appropriate to treat the field with the tools of innovation science. The "receivers" within the firms who adopts the new technology are dependent on their informal information network and social system in which they pick up, evaluate and disseminate new information. It is difficult to organize and stimulate such an informal network and social context but nevertheless it is important for the diffusion process in a field of rapid change. In several studies of the diffusion of small computer systems into new firms and organizations the informal character of this penetration has been stressed. Furthermore the "gate keepers" within these firms and organizations seem mainly to have a technical rather than managerial background.

COMPUTER-ENHANCED BUREAUCRACY

Although the Darwinian message of "survival of the fittest" is questioned in many areas where attempts has been to apply it, it applies very well to organizational life. It has been a crucial focus point for many researchers in the field of management and control, to make a balance between an organizational rationality in order to achieve short term efficiency and to maintain the adaptability and flexibility needed for long term survival. I think we all perceive that the internal conditions and the external environment of an organization are changing faster than ever and the rate of change is increasing. This is not only a psychological illusion. Some of the most important organizational characteristics influenced by the choice of small or big computers can be summarized by the concept of "bureaucracy." It may cause confusion to use the word "bureaucracy" because it means different things to different people. But we will use it in the sense of signifying the state of affairs where so much effort has been made to achieve short term efficiency in this balance that the gain from it cannot pay for the costs entailed by reduced adaptability and flexibility. The balance and tradeoffs are problems, but due to the development of computer technology, the advantages of centrally developed and operated large computer installations which have been one of the main forces on the efficiency side of this balance are now changing at a high speed.

In several studies [Pugh et al. 1968, Kerlinger 1964] organizational structure has been studied in six dimensions:

- -- flexibility
- -- specialization
- -- standardization
- -- formalization
- -- centralization
- -- configuration

We can speculate how these dimensions may be affected differently by small or large computer systems when organizations in their strife for a higher degree of rationalism move towards a more bureaucratic structure. Bjoern-Andersen has suggested the term "bureaucratic rationalism" to signify this effect. We will discuss specialization, standardization, formalization and centralization separately. Flexibility is involved in all four of these parts. In fact, flexibility is what is lost if we get too much of the other four qualities.

Specialization

The division of labor into basic parts and the distribution of work according to such a division as was advocated by Taylor in the early days has allowed for tremendous successes in the output of industrial production. It has, however, taken most people in organizations a very long time to realize that this division may also be a cause of decreasing productivity, decreasing job satisfaction and decreasing flexibility of the organizations. Weizenbaum [1976] has phrased it sharply: "an individual is de-humanized whenever he is treated as less than a whole person." The introduction of computer systems has been shown to increase the degree of specialization within several organizations. The establishment of large scale operation in general is often triggered by the desire to achieve high productivity through fragmentation of work and specialization. With a greater number of small computers operated by people with less specialization, the benefits of computer power may be preserved without the bureaucratic effect of individual specialization. The individuals will experience the satisfaction of serving a broader spectrum of functions and will have the additional satisfaction of gaining more control also of the computer itself.

Standardization

The standardization of procedures is another cornerstone of large scale data processing. It has enabled tremendous successes and has imposed a lot of rigidity stiffness in many processes. The effects are only too well known. Standardization also conflicts with the individual choice of fulfilling a task in the way that the individual finds most effective. That is an element of job satisfaction and in extreme cases a de-standardization is called upon to achieve the restauration of working skills.

Again the advent of low cost, small computers may reduce this dilemma. Because of its economy it is now feasible in many more tasks than before to let the worker or manager adopt the computer to fulfill the task in the way he perceives best. Next, upper level management may loosen the control of how things are done without loosening control of what is being done. This flexibility to choose your own personal style of computing is easier to achieve on a small computer with no complicated job control language and a full control of every aspect of computing. Of course, this has to be traded off against the more elaborate support systems available on larger computers. However, this argument seems to vanish partly as when e.g., such a user-friendly operating system as UNIX is now available on microcomputers.

Formalization

Formalization denotes the extent to which rules, procedures, instructions and communications are written. The introduction of computers has also meant a step towards increased formalization in the organization. Apart from its benefits in the form of the increased potential use of computers, there has often been the additional benefit of clarification of administrative procedures [Balle].

Here arises the question about what information may be formalized. Although the designer of a system may be aware of its limitations and honestly state how it may be necessary to treat the formal system just as a part of the total system to be studied, the actual use of the system may ignore these limitations. This type of behavior can often be observed. The use of computer conferencing and message switching systems has recently attracted a lot of interest. Two important surveys in this area have recently been published. Turroff and Hiltz [1978] point out that the use of computers for human communication "has dramatic psychological and sociological impacts on various group communication objectives and processes." But this should not only be thought of as constraints. They also stress that such equipment may "facilitate the richness and variability of human groupings and relationships almost impossible to comprehend."

An extensive summary of social evaluations of teleconferencing has recently been published by three scientists from the Institute for the Future in Menlo Park [Johansen et al. 1979]. The authors have made an analysis of several means of communications. They are very careful not to make any general statements about the future.

> Some personal skills seem to have surprisingly little effect in computer conferencing. The ability to type does not seem to be as large a barrier to participation as one would at first assume; nor does computer expertise.

The authors conclude

> the media do indeed offer real opportunities to improve communication by reducing the barriers of space and time. However, a central theme of this book has been that benefits are easily transformed into liabilities, promises into disappointments, and utopias into dystopias. For every possible improvement suggested by electronic media, it is necessary to add at least a word of caution.

It might be useful to remember one aspect of bureaucratic style as it has been expressed by the French sociologist Michel Crozier [1964]. He sees one aspect to be a shared "horror of face-to-face confrontations".

The use of computers necessarily involves formalized information. There seems to be a re-evaluation of the significance of this fact. The early optimists believed that a broad range of information involving human values and descriptions of human behavior could be formalized. The limitations of formalized information seem now to be investigated more in depth for instance by Dreyfus [1972] and Weizenbaum [1976]. The rational processes based on formalized information may not, in fact, produce the information needed as a basis for management and control. When justice, equality, tolerance and other human values are left external to the computerized system, the results of the systems may be of very limited value. Weizenbaum uses the term "instrumental reason" for such a limited process. He argues that "instrumental reasons can make decisions, but there is all the difference between deciding and choosing."

Recently the limitations of formalized information have also been discussed intensively in areas which only a short time ago were considered as domains only for formalized language. The most striking example has been provided by de Millo et al. [1979] who have claimed that proofs of mathematical theorems and computer programs are as much a social process as they consist of logic.

If someone believes that the demand for formalized data excludes "only" values, feelings and similar non-formalizable information, Weizenbaum quotes a beautiful counter example. In a statistical study of seismic data scientists deliberately omitted all reference to earthquakes recorded before 1961. They lost a factor of two in information content, because information after that date was more easily accessible in a formalized form. Weizenbaum concludes "the computer has thus begun to be an instrument for the destruction of history" [Weizenbaum 1976 p.238].

Systems built upon heuristic principles is another area of concern. Many large management information systems (MIS) are incomprehensible to the users and thus there is a high risk that a MIS of this sort may be used mechanically and without serious intellectual considerations. Weizenbaum [1978]:

> The secret of the comprehensibility of some large computer systems in the scientific domain is that these systems are models of very robust theories. When they go wrong the errors they produce result in behaviors which contradict their theories.

This is not the problem area but, to continue to quote Weizenbaum, this is in contrast to:

> Large computer systems are typically not designed in the ordinal sense of the term. Though they begin with an idea--a design, if you wil --which is then implemented, they soon undergo a steady process of modification, of accretion to both the control structures and their data bases, which changes and continues to change them fundamentally. Typically too, this sort of surgery is carried out, not by the original programmers, but by people who come and go from and to other assignments. As a result again typically, no individuals or teams of people understand the large systems. Modern large scales system simply have no authors; they have in Minsky's words, evolved into whatever they have become [Weizenbaum 1978].

The incomprehensibility and anonimity involved in MIS of this kind probably result in an irresponsible and mechanical use of such systems. Today an organization has such a fast changing environment and changing demands that such behavior probably will lead to inferior management.

Another aspect of the heavy use of computers for managerial control is that almost no resources for research and development in this area are devoted to methods not using computers. Stewart [1977] phrases this dilemma:

> the individual's commitment to a particular tool or technique may create a set which leads him to overlook and not even consider representations of the problem which are not amenable to that approach.

Almost all R&D in the area of management and control is devoted to computerized techniques. This may be a correct and healthy development but I have a firm belief that often these decisions are taken without considering an alternative approach.

I have difficulties seeing how cheap and small computers may come to reduce the disadvantage of formalized communications within an organization. Due to individualization of computers there may of course be a wider choice of actual formalization.

Centralization

Economy of scale in computer hardware and computer service operations is obviously the main driving force for centralized computer installations. In many application areas, as already mentioned, the first of those aspects is no longer appropriate. Economy of scale has in many areas turned into diseconomy of scale with software as the pivoting element.

The disadvantages of centralized systems are due mainly to the size and complexity of such systems. Gorskii [1978] has summerized the characteristics of large systems:

> Large systems, besides size, are burdened by three other "curses":
>
> subjectivity caused by the presence of human beings in their governing (management) networks;
>
> a large number of changing and contradictory objectives. The development and functioning of large systems is always conditioned by a multiplicity of objectives, one portion of which because objective and subjective causes prove to be contradictory and changing in time.
>
> uncertainty. The development and functioning of large systems always takes place under an undetermined degree of uncertainty which permeates the whole sphere of management (the limited certainty of their external

environment, of the internal properties of large systems and the limited certainty of their goals).

It is, on the other hand, somewhat meaningless to talk about [Cornell 1979] "decentralized" data processing to replace or to be a complement to centralized activities. This concept has different meanings such as interactive data processing, regional data bases, distribution of power and influence, distribution of hardware etc. Decentralization of the design and development of a system is necessary if the psychological advantages of small systems are to be reached. The distribution of small units of hardware is not enough. This development is not without problems. Barsamian [1979] states:

> The trend toward distributed systems will inevitably lead to the distribution of data bases, thus adding new complexities to the perennialy critical design problems of data integrity, recovery, security and privacy.

Configuration

It is too early to judge all the implications for the organizational configuration of small computers in management. For other than managerial tasks it has been observed [Pugh et al. 1968] that:

> a symptom of bureaucratization may be the number of clerks. A clerical job is defined as one where the main prescribed task is writing and recording, but where there is no supervisory responsibility for subordinates other than typists.

With more small computers for word processing and similar use this type of bureaucratization may be reduced.

The most obvious change to come--and in many organizations it has already come--is the transformation of the traditional data processing departments. Their importance for the organization will not be less in the future, but their role will be different. They will be transformed to the information management department to plan the information flow and distribution throughout the organization. The forward-looking data processing managers are starting to plan for this role now.

THE ROLE OF SCIENCE AND TECHNOLOGY IN SOCIETAL DEVELOPMENT

Due to the similarity in costs for large or small computer based systems, as mentioned in the introduction, the necessary choices of system specifications, system development strategy and system components seem to be more open than ever. The people who choose the technology have a wider choice than ever. The arguments of avoiding "computer enhanced bureaucratization" may be of decisive value. Because (at least no short term) economic arguments are decisive, their application seems to be dependent to large degree on the values held by the decision-makers. Behind the actual decisions one will often find different perceptions of the relationships between technology and the managerial situation. Robin Roy has made a concise classification of different approaches to the role of science and technology in societal development [Roy 1976, Persson 1979]. He emphasizes the failure of four basic deterministic models of behavior in which one factor--technology, economics, politics or ideology--is chosen to determine everything else. His general findings may also describe four aspects of behavior in our present context.

With technological determinism technological change is seen as the driving force of society. Organizations are ranked according to the level of technological development they have reached and the nature of an organization is determined by the characteristics of its technology. The industrial revolution may be seen as a direct consequence of technological innovations. This model may seem very convincing but it cannot explain why most inventions failed to survive or why some companies fail to use their superior technological knowledge. In short, this model cannot explain why technological development has been as it is.

In economic determinism one focuses on economy as a dominating criterion for technological choice. The technologies developed and selected at a given time and place, are those most suited to the prevailing economic conditions. They are modified by commercial pressures for cutting costs and expanding sales. Roy mentions as an example that the level of mechanization in Ford car factories is lower in Britain than in the United States. This is due to differences in the relative cost of labor to machinery in the two countries, plus a common desire of British and American management to minimize the cost. The product and service technologies adopted will tend to be those which will be commercially successful. Much of the technological development can apparently be explained by these mechanisms, but not all. In many areas like medicine, weapons and space exploration apparently political, human and other considerations play a greater role.

Another way to explain technological changes is through a model of political determinism. This is based on the view that both economic and technological development are in turn determined by "political" forces. The two other models do not take into account "the inequalities of power among the individuals, groups, and institutions within it." It would therefore not be surprising if the technologies developed and adopted by an organization reflected the interest and values of the more powerful and influencial members of that organization. It seems however that all technological change cannot be explained in terms of the political strategy by the powerful.

"This brings us to ideological determinism , which is based on the view that whatever the apparent economic or political factors influencing technological development, at a more fundamental level these are themselves underpinned by a hidden set of beliefs and values which taken together make up the world view or ideology." Such an ideology can be traced back to historical developments and the emergence of the belief that the use of technology would liberate mankind from material want, from disease and toil. But have our ideologies grown by themselves? Are they the independent driving forces of technology? Apparently not.

Roy concludes his review by rejecting each of these models as the only one to explain technological development. He argues that a modern view must be an integrated one; combining elements from each of the models already discussed. They all interact with each other in a complex manner with one or the other variable being of particular importance under different circumstances. The most important implication of his analysis is that solving important industrial problems:

> requires not only changes in society, and in the way of life of its members, but also changes in the criteria used in the choice and design of its technologies. The outcome of such changes would be both an 'alternative' technology and an 'alternative' society.

We have dwelled on this discussion because it shows that the changes we find in our particular field of technology are not caused by simple intra-technical considerations. Rather, they result from very complex and non-transparent combinations of technological, economic, political and ideological factors. These factors will play an important role in the decisions to be made about trade-offs between small and large computers in organizations. It would be naive to "define" them from our deliberations.

CONCLUSIONS

We have seen how technological development in the computer field now makes it economically feasible to satisfy a wider set of criteria than was permitted by earlier technology. Instead of focusing on short-term efficiency only and treating areas like bureaucratization effects as secondary or tertiary issues, several of these hitherto too neglected considerations can be upgraded to play a decisive role in the design of management systems with computers. Such an approach may take advantage of a more flexible and adaptable organizational structure. There are as many bottlenecks in the system development process as there are people involved. It is therefore essential that the full spectrum of issues be fully known to all parties involved in the evolution of a management system. Then the advent of small computers may give new life to management itself.

REFERENCES

Auerbach Computer Technology Reports. On International Data Base Systems Inc, Auerbach Publishers Inc, Pennsauken, USA, 1978

Balle,C (1977) Computers and Structural Changes in French Business Firms. Working paper, Centre de Sociologie des Organisations, Paris. Quoted by Bjoern-Andersen.

Barsamian,H (1979) Technology and Architecture for Data Management, Computer May 1979 p8-10

Bjoern-Anderson, N. (1979) Myths and realities of information systems contributing to organizational rationality. Proceedings from Second IFIP Conference on Human Choice and computers, June 2-8, 1979, Baden, Austria. North-Holland Publ. Co. (Forthcoming)

Carroll, J.A. (1977) Solving Mass-Produced ROM Programming Problems With Base Registers. Computer Design, Aug 1977:99-105

Cornell,L (1979) Avskaffa uttrycket decentraliserad databehandling, (In Swedish) Data-nytt No 5(1979) p9

Cragon, H.G. (1979) The Economics of Solid State Software or Software Is Cheap, Hardware Is Expensive, Article issued by Texas Instruments Inc., Dallas, Texas, USA

Crozier,M (1964) The Bureaucratic Phenomenon, Chicago:University of Chicago Press. Quoted in Turkle (1978)

Dickson, D (1974) Alternative Technology and the Politics of Technological Change. Glasgow:Fontana Books

Dreyfus, H.L. (1972) What computers can't do. Harper & Row.

Fick, G. and R. Sprague Jr., eds. (1981) Decision Support Systems: Issues and Challenges. Oxford: Pergamon Press.

Gorskii, I.M. (1978) Information aspects of governing and modelling. (In Russian) Moscow: Nauka

Hiltz, S.R. and M. Turoff (1978) The network nation. Addison-Wesley Publ. Co.

Isaacson, P. (1979) 1984's information appliances. Datamation Feb. 1979

Johansen, R., J.Vallee and K.Sprangler (1979) Electronic Meetings - Technical alternatives and social choises. Addison-Wesley Publ.Co.

Keen, P.G.W., M.S.S.Morton (1978) Decision Support Systems: An Organizational Perspective, Addison-Wesley Publ.Co

Keen, P.G.W. (1981) Decision Support Systems: A Research Perspective. In Fick G. and R. Sprague, eds, Decision Support Systems: Issues and Challenges. Oxford: Pergamon Press.

Kerlinger, F (1964) Foundations of Behavioral Research New York:Holt,Rinehart and Winston

Melichar, B (1979) Non-procedural Communication Between User And Application Software. WP-79-115. Laxenburg, Austria: International Institute for Applied Systems Analysis.

De Millo, R.A., R.J. Lipton and A.J. Perlis (1979) Social Processes and Proofs of Theorems and Programs. Com. of the ACM. 22(5):271-28Ø.

Persson, A. (1979) Att taenka paa framtiden. Report No.153, May. Stockholm:The Royal Swedish Academy of Engineering Sciences. (In Swedish)

Pugh, D.S., D.J. Hickson, C.R. Hinings and C. Turner (1968) Dimensions of Organization Structure. Administrative Science Quarterly, June:65-1Ø5.

Rockart, J.F. (1975) Computers And The Learning Process Report CISR-15 SLOAN WP 8Ø2-75 August 1975 Center for Inf.Sys.Res. MIT, Cambridge

Roy, R. (1976) Myths about technological change. New Scientist. May 6.

Simon, H.A. (1965) The Shape of Automation for Men and Management, New York, Harper & Row.

Stewart, T.F.M. (1977) Side Effects of Computer Aided Problem

Solving. In: A. Parken ed. Computing and People. London:Edward Arnold Limited.

Turkle, S. (1978) Pschoanalytic Politics. New York:Basic Books.

Weizenbaum, J. (1976) Computer power and human reason. San Francisco: W.H. Freeman and Co.

Weizenbaum, J. (1978) Once more--a computer revolution. The Bulletin of Atomic Scientists. September:12-19.