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DECISION SUPPORT SYSTEMS:  
EMERGING TOOLS FOR PLANNING

Michael S. Scott Morton

May, 1979

CISR No. 44

WP No. 1070-79

**Center for Information Systems Research**

Massachusetts Institute of Technology  
Alfred P. Sloan School of Management  
50 Memorial Drive  
Cambridge, Massachusetts, 02139  
617 253-1000



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Michael S. Scott Morton  
Professor of Management  
Sloan School - M.I.T.  
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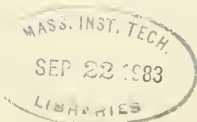
## DECISION SUPPORT SYSTEMS - EMERGING TOOLS FOR PLANNING

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### Introduction

Now is a particularly significant time in the evolving field of planning. We have, over the last twenty years, come through several phases including the emphasis on functional planning (36) and then stress on the process (28) by which an organization plans. Recently these views, and the term "long range planning", have been augmented by the term "strategic planning" (19). This change is more than mere words, it reflects a change in emphasis - a change from coordinating the activities of the organization and ensuring that the existing businesses of the organization run smoothly to one of ensuring that the direction and focus of the organization is correct. Strategic planning has a lot to do with major changes in the markets, products, manufacturing processes, and the style of the business. Such an approach carries with it a need for analysis and a level of managerial involvement even greater than that we have been used to in the past. Fortunately the new conceptual ideas and the new physical tools available seem to be equal to the task. The paper in this session that has just been presented by Walker Lewis (24) demonstrates, dramatically, the enormous changes that have occurred. The actual example he presents represents one illustration of the best of the current work going on in this country at the frontier of strategic planning. With this specific example in mind I would like to try to make some generalizations, and to provide some perspective, on what seems to be happening in the field at the moment.

Dewey



## Technological Changes

It is well known that computer technology is changing. What is less visible is how much it has changed. The term "computer" has become content free - that is, there are a wide variety of different types of computers that do quite different kinds of things, and by merely saying one has a computer it is not clear which sorts of tasks one's system can do well. The analogy that my colleague, Stuart Madnick, uses is effective here. Using the automobile industry one can get a general impression of how much things have changed; for example, if the automobile industry had experienced as much change over the past twenty years, that is from 1959 to 1979, as the computer industry, a Rolls Royce would now cost fifty cents and deliver fifteen million miles to the gallon! While this analogy is oversimplified and somewhat unfair, it does give a general flavor of the enormous changes that are going on. From what can be seen of the new technology that has been invented and is now coming out of the laboratories, we are looking for roughly a 20% improvement in the cost performance figures each year for the next ten years (11). Regardless of the future, the changes have already been sufficiently great that our conclusions about how and where to use computers have to be watched very carefully. What was a valid generalization about the use of computers in a company, particularly in planning, as recently as five years ago is quite possibly now out of date.

This evolving view of computers can be looked at in several ways. For example, if one looks at the diagrammatic representation in Figure 1, one gets a flavor for the enormous range of different kinds of computer power that are currently available. This matrix is a gross oversimplification of what really exists and it is drawn purely from a user's point of view.



As the user sees it, he has four different kinds of computer power available to him, namely:

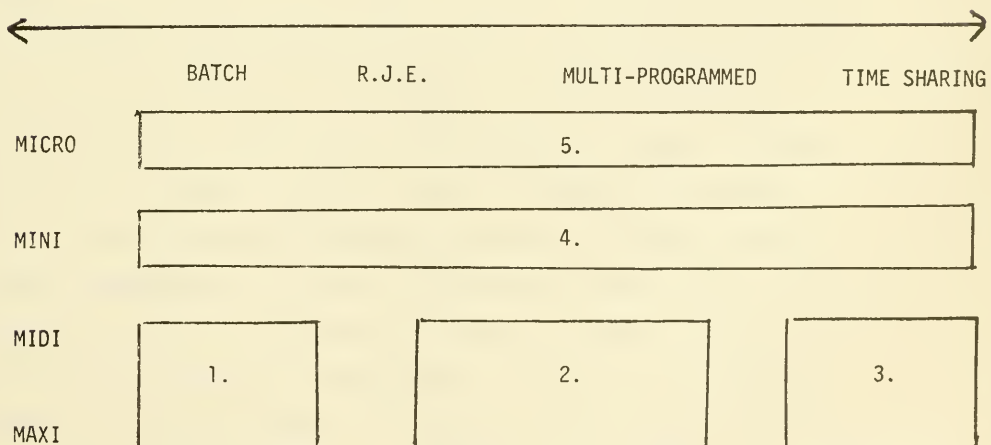
Batch processing - that is, one submits one's job to the computer center and in the fullness of time the computer center returns the output.

Remote job entry - similar to batch in the sense that the user has little control over timing and sequence, but it does provide physical input/output somewhat closer to the user.

Multi-programming - a form of computer power that allows the user to choose among several queues in which to place the job. The queues will have different prices and if one is willing to pay a higher price one will get a response sooner.

Time sharing - a form of computer power that guarantees a fast response to jobs requiring limited resources although it becomes prohibitively expensive for large ones.

Figure 1



NOT "A" COMPUTER BUT A "SMORGASBORD" OF COMPUTER POWER



On the other axis is a simple size spectrum running from maxi - that is to say the large computers - through to micros, the ultra small form of computer which currently has limited applications in a business setting, a situation that is bound to change over the next ten years. The numbers 1 through 5 on the diagram represent a crude view of the sequence in which these became available to companies. The resulting matrix is far too simple, and anyone who understands the computer world appreciates the enormous liberties that have been taken to generate something of only two dimensions. However, for our purpose here it provides an indication of the range of computer power that is available in many organizations today. It is not that one of these sixteen cells somehow provides better computer power than another one of the cells, but merely the different cells are quite different as the user perceives them. Thus we would never dream of printing the paychecks for a 20,000 person division on a time-shared mini-computer. This would be an absolutely nonsensical use of a particular kind of computer power. It also follows, I would submit, that using a large batch oriented maxi-computer to provide the vice-president of sales with a system to help him on the bids that have to be made for the company's products and services is equally ridiculous. Similarly, to believe that one of these cells will solve all of a company's computer support requirements for planning is a level of generalization well beyond the economic realities of modern computer technology. In planning one might need a very large data base, or need the ability to run some large optimization model or to have flexible, local, access to a simple "what if" capability for cash flow analysis. To do all of this on one physical computer may no longer be sensible.

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PHILOSOPHY DEPARTMENT

PHILOSOPHY 101

LECTURE NOTES

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CHAPTER 1

INTRODUCTION

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CHICAGO, ILLINOIS

1998

The preceding discussion has raised the idea of the evolving nature of computer power and the implications implicit in this for the strategic planning process. However, apart from the computer itself, there are changes in other aspects of this technology. There has, for example, been substantial progress in the kind of data base management languages available on computers. A recent example of this is the relational (9) data base, a form of data management language that provides significantly different access to information than has been available heretofore - a form of access to the data which is particularly useful for strategic planning. In a similar way we have much more powerful languages available to us, and so the use of APL, for example, provides a form of power which was not available in any practical way to most organizations as recently as just a few years ago. Perhaps in its most embryonic state, and yet eventually a change with the biggest impact, are the developments in the communications field. Extensive use of wide-band communications channels via satellites at low cost offers a level of potential which, if talked about at the moment, sound like the newest science fiction. However, there is enough substance behind some of these claims to suggest that we are not very far away from seeing enormous changes in our ability to share data with different parts of the country, or indeed, the world (10).

However all of this discussion has been merely technological change. It is perfectly obvious that changes in hardware and software themselves are not enough to have a real impact on strategic planning. These changes in technology are a necessary but not sufficient condition to allow us to begin to go about strategic planning in a different way and with a greater impact than we have been used to up till now. Fortunately there are other changes as well.

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### Conceptual Changes

One of the ideas that has emerged over the last few years has been the concept of decision support systems. This is the recognition that there are situations in the management of an organization where it is not reasonable to expect to replace the human being, be it a clerk or be it a manager, with the fully automated computer system. So our classical use of computers, in the data processing sense, applies only to a certain class of problem - the class of problem that we now think of as "structured". There is obviously a large class of decisions in a management setting which are fully unstructured; that is, there are problems which are not well understood, ones that have to rely almost entirely on intuition, and will never lend themselves to analytical support of any form. It has recently been realized, however, that there is also a large class of problems (13) which fall in between these two extremes; problems where neither the manager alone, nor some kind of automated system alone, can make as good a decision as the two in combination.

Clearly there are only certain classes of problem where this is true. Many situations yield either to formal models and to optimization or to other less complex data processing solutions. There will continue to be a number of these important problems for organizations to work on. However there is a class of problem (20) where a Decision Support Systems (D.S.S.) approach can pay off; situations where the concern is with a specific decision or decisions that must be made, not with the overall functioning of a particular part of the organization. A situation where the focus is on supporting the manager, or managers, not replacing them with an automated system; where the focus is on the system, including the organizational



context in which decisions must be made, and not just the computer itself. Thus a decision support system is a different kind of a tool than a functionally based clerical-replacing computer system.

The implications that flow from these differences are considerable. They are discussed in detail elsewhere (20) but in summary these differences can be grouped in four areas:

1. People - The skills necessary to do a decision analysis of a significant semi-structured problem are typically not the same as those that are required for the classical data processing applications.
2. Process - The process by which such systems are built, the understanding of the business problem and the connections with the organizational dynamics, and the ongoing evolution of the managers' understanding of the problem, lead to a considerably different implementation process.
3. Models - Fully structured problems lend themselves to a clear statement of all the variables and the objectives involved, and as such often lend themselves to a solution by elaborate formal models. To the extent D.S.S. deal with fuzzy, ongoing, poorly understood problems, such models are frequently of limited use. There needs to be a greater reliance on "heuristics" and the kind of models and data bases that provide managers with help.
4. Technology - The technology that is required has the characteristics of flexibility and immediate accessibility coupled often with graphical features which allow patterns to be more readily detected.

The decision support system idea is not new - its successful practical implementation is. Figure 2 provides twelve examples. These are given, not because they are all unusually successful D.S.S., but merely because



they are all written up in the published literature and therefore accessible.

Figure 2

Examples of Computer-Based Decision Support Systems

	<u>Strategic Planning</u>	<u>Management Control</u>	<u>Operational Control</u>
Marketing	New Product Introduction (40)	Brand Management (25)	Media Selection (26)
Production	New Facilities Location (6)	Setting Production Plan (35)	Portfolio Management (12)
Finance	Impact of Acquisition	Setting Budget Levels (30)	Cash Flow Management (31)
Personnel	Long-Term Manning Needs	Staffing Strategies (4)	Personnel Selection (4)

On almost any dimension these twelve examples present an enormous range of characteristics. For example, one of these systems, media selection, has a very sophisticated and elaborate model that lies at the heart of the system. At the other extreme the staffing support system for manpower levels contains no models at all, but merely provides the manager with flexible access to a complete data base. Both are regarded as successful by the managers who use them and the organization in which they reside. Some of these systems use large, powerful, sophisticated computers - others are based purely on dedicated and extremely simple mini-computers. All, however, share the characteristic that they have had an impact on the managers' decisions.

THE HISTORY OF THE UNITED STATES

The history of the United States is a story of growth and change. From the first settlers to the present day, the nation has evolved through various stages of development. The early years were marked by exploration and the establishment of colonies. The American Revolution led to the birth of a new nation, and the subsequent years saw the expansion of territory and the growth of industry. The Civil War was a pivotal moment in the nation's history, leading to the abolition of slavery and the strengthening of the federal government. The 20th century brought significant social and economic changes, including the rise of the industrial revolution and the emergence of the United States as a global superpower.

THE AMERICAN REVOLUTION

The American Revolution was a period of significant change in the history of the United States. It began in 1775 and ended in 1783. The revolution was fought between the thirteen original colonies and the Kingdom of Great Britain. The colonies sought independence from British rule, and the revolution resulted in the creation of the United States of America. The revolution was a turning point in the nation's history, leading to the adoption of the Constitution and the establishment of a new government.

THE CIVIL WAR

The Civil War was a period of significant change in the history of the United States. It was fought between the Union and the Confederacy from 1861 to 1865. The war was a result of the growing divide over the issue of slavery. The Union emerged victorious, leading to the abolition of slavery and the strengthening of the federal government.

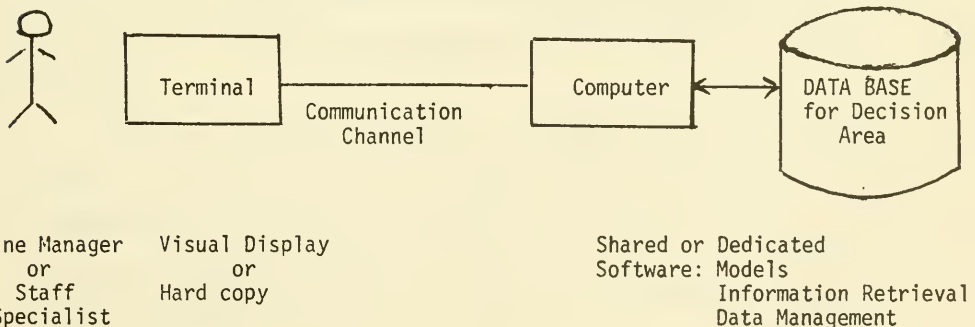
It is worth pointing out that the fact that they have had an impact on the managers' decisions does not necessarily imply that the manager has to physically use the system himself. The idea of a "chauffeur", who uses the system for the manager, is in many cases much the most sensible way of proceeding. The acid test is whether or not the results of the use of the system have an impact on the quality of the decision that finally gets made.

In all these twelve cases the configuration of the system involved is shown in Figure 3. This figure is largely self-explanatory, but it should be stressed that the manager, or managers, involved are focusing on a particular decision, and the data base that is implied in the diagram is not a corporate data base or a totally integrated data base or anything as sophisticated and fancy as these terms imply. Rather it is a data base that bears on the decision being made and is therefore appropriately focused to contain relevant information, rather than masses of data.

Figure 3

## DECISION SUPPORT SYSTEMS

When a D.S.S. is computer based it would use the following configuration.





### Impact on Planning

The preceding two sections have very briefly outlined some changes in hardware technology and some changes in conceptual technology that are currently going on. At both levels these changes have been going on quietly for some years and have now reached a point where they have passed a threshold of usability, and are now powerful tools, available to be applied in any area where organizations have opportunities. One such area is the field of strategic planning. We are fortunate that in this field of strategic planning there has been considerable progress over the last five or six years. This progress can perhaps be exemplified by looking at the evolution and impact of the Boston Consulting Group's emphasis on market share and their portfolio planning techniques. Although both these ideas have obvious limitations, they nonetheless marked a real change in thinking about the problem of strategic planning and the way an organization should view this task. This evolution in thinking and change in approach has been nicely captured in Hofer and Schendel's book (19) and will not be elaborated on here. This approach of focusing on the content of strategic planning is being extended by the best practitioners in the field. Walker Lewis' paper presents one such extension of the concepts. For our purposes, however, I would like to focus on the tools he has developed, not the powerful new concepts involved.

These tools form part of a D.S.S. for certain aspects of strategic planning. They do not solve, or automate, the planning problem. However if one takes the generic steps involved in strategic planning, there exist certain forms of support for each step. Some support is sophisticated, some merely clerical in nature. The net result, however, is



a powerful impact on the quality of the planning that gets done.

Figure 4

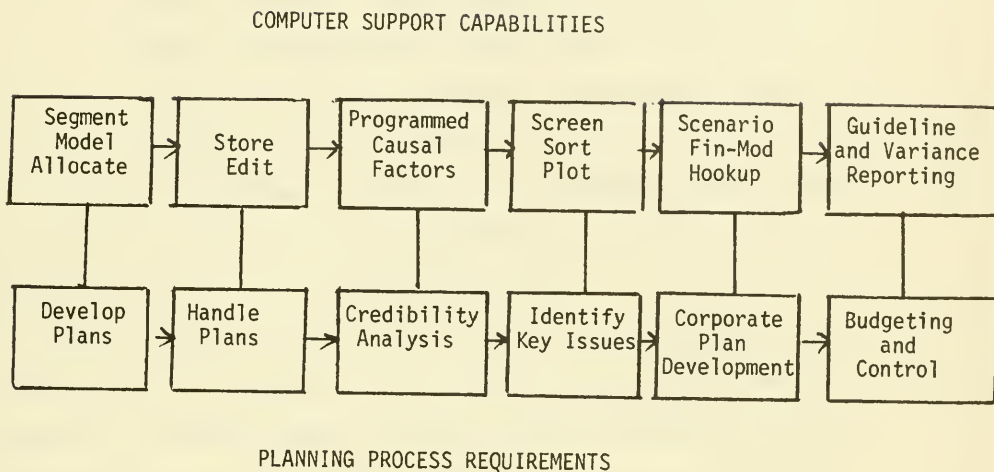


Figure 4 is taken from Lewis' talk and represents an oversimplified view of the generic steps in the planning process. There are other ways of looking at these (18, 22) but for our purposes here this is a useful one. For each of the steps he lists he has developed a support tool(s) for that stage of the process. If one was to look at these particular support characteristics from a decision support systems standpoint, one could argue that there are three different types that have been developed:

Type 1 support represents the more mechanical aspects of the process, that is, the data, the editing of the data, and the displaying what is there in a way easy for a human to understand.

Type 2 support is simple manipulation and is represented by the ability, in the hands of the user, to screen the data for certain characteristics, to segment it in ways that make sense as the planning process evolves, and to allocate numbers according to whatever



heuristics or algorithms are appropriate.

Type 3 support represents the use of models. These are the more sophisticated causal models that are appropriate for the industry in question, the financial models that allow financial impacts to be understood, and the detailed models of segments that may be required for certain kinds of analysis.

To be truly effective, of course, all these different kinds of support have got to be "natural" to use and sufficiently robust and flexible to be able to adapt to an evolving situation (27).

The DSS concept has a great deal in common with the classical use of computers and the classical use of the best of the operations research field (20). However, there is a subtle and very fundamental difference between the classical use of management science tools as well as the D.P. view of computers, and the decision support systems idea. This fundamental difference can be shown with an analogy from the field of chess. The attempts by the Artificial Intelligence community to replace a human being with a computer system that plays chess have been modestly successful; that is, there are chess playing programs which do a good job of beating a poor chess player and can provide a limited amount of challenge for a decent chess player (21), a challenge until the chess player discovers the inherent weaknesses which are always there in the automatic program he is playing. This suggests that replacement of the human is limited to certain classes of problem. If one takes a slightly different tack and sets a different objective for the system, that is, to have an objective not to replace the chess player but rather to support the chess player, to some a subtle difference in emphasis, then



the approach becomes fundamentally different. In a support mode we can divide the game into three pieces - the opening, middle and end game. In the opening game we can provide access in a pure information retrieval, data-base sense, to all the famous opening moves that have been played by grand masters. If we get to the end game we can move to an optimization technique, and with only two or three pieces left on the board it would become possible to develop an optimal move. In the middle game, which is where all the trouble arises, we can get the best heuristics that are possible and proceed in one of two modes; either the player can test the implications of a move he is thinking of making via his terminal to see if the heuristics in the system can come up with any objections to that particular set of moves; or the player can simply ask the system for a suggestion and, given the heuristics involved, the system may suggest several alternative moves which the player can then evaluate himself and decide which one he would like to make. At the three different parts of a chess game, we have come up with three different support mechanisms to improve the ability of the chess player to deal with his opponent. There is no one answer - it is not a better DB or a better model or a better man/machine interface. It is a better system, combining appropriate elements of all three; where "appropriate" is defined in terms of helping the decision maker (chess player) do a better job.

The same is true in strategic planning. There can be no one model, or language or data-base to "solve" the strategic planning problem. However, one can produce a D.S.S. which delivers different kinds of power to different users. It is an exciting area, and one in which I would expect to see considerable changes continuing over the next few years.



BIBLIOGRAPHY

1. Allison, G. T.: Essence of Decision, Little Brown, 1971
2. Alter, Steven, L., "A Study of Computer Aided Decision Making in Organizations," Ph.D. Thesis, Sloan School of Management, Massachusetts Institute of Technology, 1975.
3. Anthony, Robert N., Planning and Control Systems: A Framework for Analysis, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1965.
4. Berger, Paul and Franz Edelman, "IRIS: A Transaction-based DSS for Human Resource Management," Data Base, Vol. 8, No. 3 Winter 1977.
5. Boulden, James: Computer-Aided Planning Systems, McGraw-Hill, 1975
6. Buffa, E.S., G.C. Armour and T. E. Vollman, "Allocating Facilities with CRAFT," Harvard Business Review, Vol. 42, No. 2, March-April 1964.
7. Business Week: The New Planning, December 1978.
8. Carlson, E. D. (Editor), "Proceedings of a Conference on Decision Support Systems," Data Base, Vol. 8, No. 3, Winter 1977.
9. Codd, E. F. "A Relational Model of Data For Large Shared Data Banks". Communications of The ACM, 13, 6 (June 1970) 377-387.
10. Data Communications - McGraw Hill
11. Dertouzos, J. L. and Moses, J. (Eds.): Future Impact of Computers: A Twenty Year View, M.I.T. Press, Cambridge, Mass. 1979.
12. Gerrity, Thomas P. Jr., "Design of Man-Machine Decision Systems: An Application to Portfolio Management," Sloan Management Review Massachusetts Institute of Technology, Vol. 12, No. 2, Winter 1971.
13. Gorry, Anthony M. and Michael S. Scott Morton, "A Framework for Management Information Systems," Sloan Management Review, Massachusetts Institute of Technology, Vol. 13, No. 1, Fall 1971.
14. Eckstein, A. and Sinai, Al: The Data Resources Model of the United States Economy, North Holland Publishers, (forthcoming).
15. Forrester, J. W.: Collected Papers of Jay W. Forrester, Wright-Allen Press, 1975.
16. Galbraith, J. R., and Nathanson, Daniel A.: Strategy Implementation: The Role of Structure and Process, West Publishing Co., 1978.
17. Hall, William K.: "Strategic Planning Models: Are Top Managers Really Finding Them Useful?" Journal of Business Policy, vol. 3 No. 2, 1973.



18. Hax, A. C., Majluf, N. F.: Toward the Formulation of Strategic Planning - A Conceptual Model, Technical Report No. 2, Sloan School of Management, Massachusetts Institute of Technology, 1978.
19. Hofer, Charles W., and Schendel, Dan: Strategy Formulation: Analytical Concepts, West Publishing Co., 1978.
20. Keen, Peter G. W. and Michael S. Scott Morton: Decision Support Systems: An Organizational Perspective, Addison-Wesley, 1978.
21. Levy, David: Chess and Computers, Prentice-Hall, 1976.
22. Lewis, W.: Planning by Exception, Strategic Planning Associates, Watergate 600, Washington, D. C., 1977.
23. Lewis, W.: Planning for Change and Changes in Planning, Strategic Planning Associates, Inc., Watergate 600, Washington, D. C. 1978.
24. Lewis, W.: "Systematic Computer Support for Strategic Planning", Paper given at TIMS/ORSA meeting at New Orleans, May 1979. Strategic Planning Associates, Watergate 600, Washington, D. C.
25. Little, John D. C., "BRANDAID: A Marketing Mix Model. Part I: Structure; Part II: Implementation, Calibration, and Case Study", Operations Research, Vol. 28, No. 4, July-August 1975.
26. Little, John D. C. and Leonard Lodish, "A Media Planning Calculus," Operations Research, Vol. 17, No. 1, January-February 1969.
27. Little, John D.C., Managers and Models - The Concept of a Decision Calculus, Management Science No. 16, B446-485, April 1970.
28. Lorange, Peter and Vancil, Richard: Strategic Planning Systems, Prentice-Hall, 1977.
29. Lorange, Peter, and Rockart, John F.: "A Framework for the Use of Computer-based Models in the Planning Process," Section 3, Chapter 1, in Lorange, Peter and Richard Vancil: Strategic Planning Systems.
30. McCosh, Andrew M. and Michael S. Scott Morton, Management Decision Support Systems, The MacMillan Press, Ltd., London, 1978.
31. McInnes, J. J., "An Organizational Perspective on the Use of Simulation Methods in the Planning and Control Process," Proceedings of the Summer Computer Simulation Conference, Chicago, Illinois, July 1977.
32. McInnes, J. M.: "Computer-based Support Methods in the Planning and Control Process", Working Paper, M.I.T. Sloan School of Management 1978.
33. Naylor, Thomas, and Horst Schauand: "A Survey of Users of Corporate Planning Models," Management Science, May 1978.
34. Rockart, J. F.: A New Approach to Defining the Chief Executive's Information Needs, Harvard Business Review, March/April 1979.



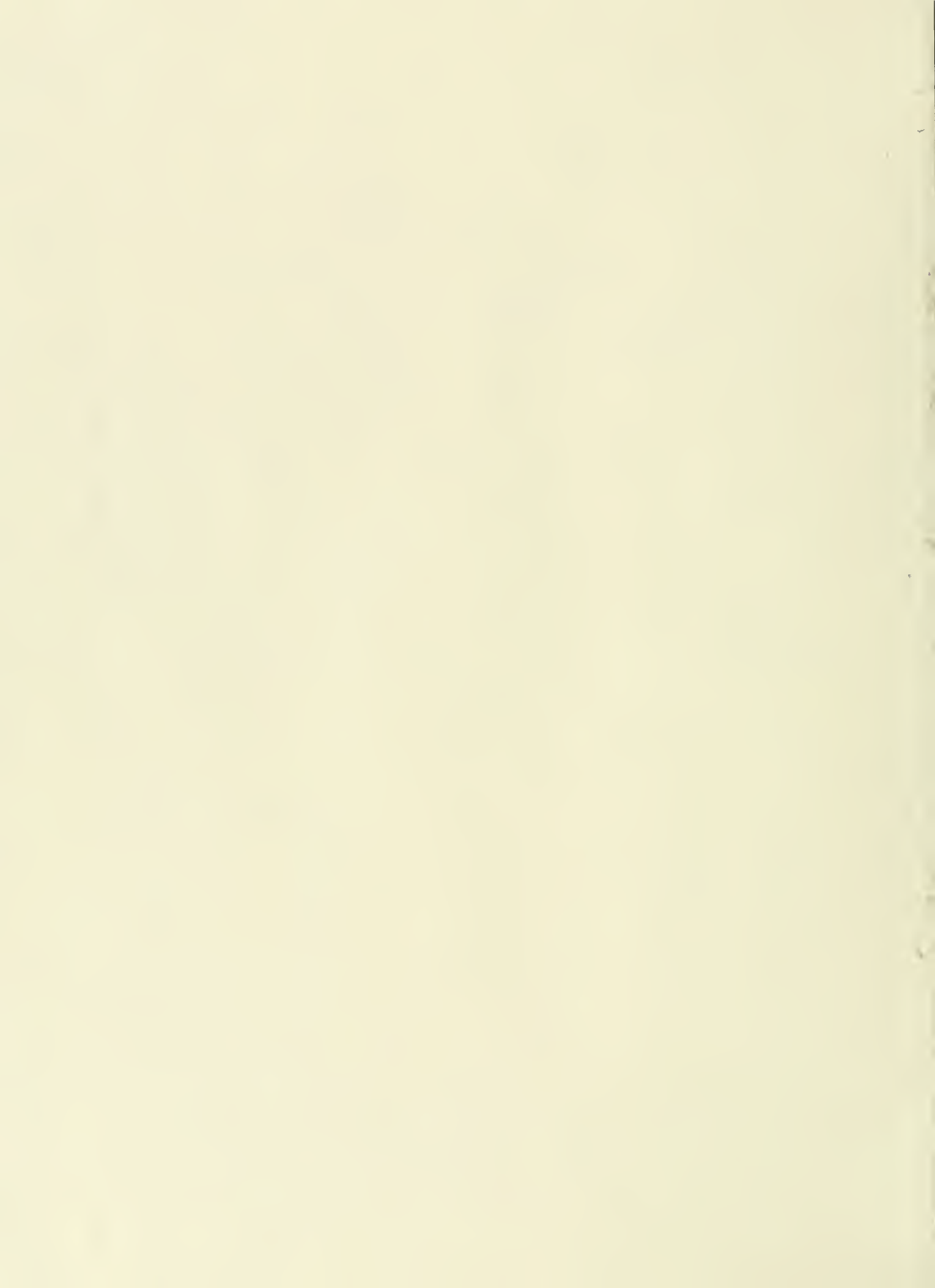
35. Scott Morton, Michael S., Management Decision Systems: Computer-Based Support for Decision Making, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1971.
36. Steiner, George W.: Top Management Planning, MacMillan & Co., 1969.
37. Stewart, Robert F. and Doseher, Marion D., The Corporate Development Plan, Report Numbers 183, Stanford Research Institute, Menlo Park, 1963.
38. "Texas Instruments Shows U.S. Business how to Survive the 1980's", Business Week, September 18, 1978.
39. Thackray, J. "GE's Planned Prognosis: in Management Today, London, August, 1978.
40. Urban, Glenn L., "SPRINTER Mod III: A Model for the Analysis of New, Frequently Purchased Consumer-Products," Operations Research, Vol. 18, No. 5, September-October 1970.
41. Wilson, S. H. and Tombs, J. D., Improving Profits through Integrated Planning and Control, Prentice Hall, 1968.













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