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A FRAMEWORK FOR MANAGEMENT INFORMATION SYSTEMS*

by

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Introduction

The years between 1955 and 1970 have witnessed an increasingly rapid and broad incursion of computers into industrial organizations. During this time, computer-related activities collectively termed "management information systems" have also grown markedly. But despite the growth in these two areas, very few of the resulting systems have had significant impact on management. Generally these systems have done little to effect the way in which management makes decisions. We contend that a major reason for this failure to improve the decision-making ability of management is a lack of an appropriate framework within which to view the range of potential systems applications.

In many groups doing MIS work, this lack of perspective prevents the full appreciation of the variety of organizational uses for computers. Without a framework to guide management and systems planners, the tendency is to serve the strongest manager or the greatest crisis. As a result, systems activities too often may move from crisis to crisis following no clear path, receiving only ex post facto justification. This tendency inflicts an unnecessary expense on the organization. Not only are costly computer resources wasted, but even more costly human resources are mismanaged. The cost of systems and programming personnel is generally twice that of the hardware involved in a typical project, and the ratio is growing larger as the cost of hardware drops and salaries rise. Competent people are expensive. More importantly, they exist only in limited numbers. This limitation

actively constrains the amount of systems development work that can be undertaken in a given organization, and so good resource allocation is critical.

The need to reassess the framework within which we view the allocation of resources to systems activities is underscored by developments in two distinct areas within the last five years that offer us the potential to develop altogether new ways of supporting decision processes. First there has been considerable technological progress. The evolution of remote access to computers with short turnaround time and flexible user interfaces has been rapid. Users can be linked to computer resources through low cost typewriter and graphical display devices. These developments offer new possibilities for management information and decision systems. The second development in the past few years has been a conceptual one. There is emerging an understanding of the potential role information systems within organizations. We are adding to our knowledge of how human beings solve problems and of how to build models that capture aspects of the human decision-making processes.

The progress in these areas has been dramatic. Entirely new kinds of planning and control systems can now be built -- ones that dynamically involve the manager's judgment and support him with analysis, models, and flexible access to relevant information. But to fully realize this potential, there must be an appropriate framework within which to view management decision making and the required systems support. The purpose of this paper is to present such a

framework -- one which we believe helps us to understand the evolution of MIS activities within organizations and to recognize some of the potential problems and benefits resulting from our new understanding and our new technology. Thus this framework is designed to be useful in planning for information systems activities within an organization and for distinguishing between the different kinds of model building, people, models, computer systems and so forth that are used for supporting decisions in the various categories. It is, by definition, a static picture, a snapshot, and is not designed to say anything about how information systems are built in each of the areas. For this purpose we would need a process model of information system implementation.

Our plan for the remainder of this paper is as follows. In the next section we want to consider some of the general advantages of developing a framework for information systems work. Then we want to propose a specific framework which we have found to be useful in the analysis of MIS activities. We believe that this framework offers us a new way to characterize the progress that has been made to date, and it offers us insight into the problems that have been encountered. In the third section of the paper we want to use this framework to help us analyze the types of resources that are required in the different decision areas and the ways in which those resources should be used. Our feeling is that there exists a tremendous potential to use new ideas and new technology to augment the decision-making ability of management, but unless the issues that we raise are met squarely,

it is very unlikely that this potential will be realized.

Framework Development

In this section we want to propose a framework for viewing managerial activities within organizations, but before doing that, we want to try to indicate some of the values which one can expect from the development of a framework in general. Basically, the framework of the type we are interested in is a structuring of ideas. The potential value of the framework arises from the organization it imposes upon our ideas in a given area.

The framework we will develop here is one for managerial activities, not for information systems. It is a way of looking at decisions made in an organization. Information systems should exist only to support decisions, and hence we are looking for a characterization of managerial activity in these terms. For reasons which we will make clear in the remainder of this paper, we believe that an understanding of managerial activity is a prerequisite for effective systems design and implementation. Most MIS groups are deeply involved in system development and implementation without a prior analysis of the variety of managerial activities. This has prevented them from developing a sufficiently broad definition of their purpose and has resulted in a generally inefficient allocation of resources.

In attempting to understand the evolution and problems of management information systems, we have found the work of two authors

particularly useful. The first is Robert Anthony, who, in his book Planning and Control Systems: A Framework for Analysis[1], addresses the problem of developing a classification scheme that will allow management some perspective when dealing with planning and control systems. He develops a taxonomy for managerial activity consisting of three categories and argues that these categories represent activities sufficiently different in kind to require the development of different systems.

The first of Anthony's categories of managerial activity is strategic planning: "Strategic planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use and disposition of these resources."[2] Certain things can be said about strategic planning generally. First, it focuses on the choice of objectives for the organization and on the activities and means required to achieve these objectives. As a result, a major problem in this area is the development of predictions about the future of the organization and its environment. Second, the strategic planning process typically involves a fairly small number of high level people who operate in a nonrepetitive and often very creative way. The complexity of the problems that arise and the nonroutine manner in which they are dealt with makes it quite difficult to appraise the quality of this planning process.

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[1]Robert Anthony, Planning and Control Systems: A Framework for Analysis, Graduate School of Business Administration, Harvard University Boston, 1965.

[2]Op. cit, p. 25.

The second category defined by Anthony is that of management control: "Management control is the process by which managers assure that resources are being used effectively and efficiently in the accomplishment of the organization's objectives."[1] He stresses three key aspects of this area. First, the activity involves interpersonal interaction. Second, it takes place within the context of the policies and objectives developed in the strategic planning process. Third, the paramount goal of management control is the assurance of effective and efficient performance.

Anthony's third category is operational control, by which he means "the process of assuring specific tasks are carried out effectively and efficiently."[2] The basic distinction between management control and operational control is that between the activity properly referred to as management and activities that relate the the performance of specified tasks. Specifically we can say that operational control is concerned with tasks (such as manufacturing a specific part) whereas management control is most often concerned with people. Also, there is much less judgment to be exercised in the operational control area because the tasks, goals and resources have been carefully delineated through the management control activity.

We recognize, as does Anthony, that the boundaries between these three categories are often not clear. In spite of the limitations and uncertainties of these categories, however, we have found them quite useful in the analysis of information system activities. For example,

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[1] Op. cit., p. 27.

[2] Op. cit., p. 69.

if we consider the information requirements of these three activities, we can see that they are very different from one another. Further, this difference is not simply a matter of aggregation, but one of fundamental character of the information needed by managers in these areas.

Strategic planning is concerned with setting broad policies and goals for the organization. As a result, the relationship of the organization to its environment is a central matter of concern. Also, the nature of the activity is such that predictions about the future are particularly important. In general, then, we can say that the information needed by strategic planners has certain properties. First, it is generally aggregate information. Also, a large portion of the relevant information is obtained from sources external to the organization itself. Both the scope of the information and the variety of the types of information are quite large. At the same time, the requirements for accuracy of the information are not particularly stringent. Finally, the nonroutine nature of the strategic planning process means that the demands for this information occur infrequently.

The information needs for the operational control area, however, stand in sharp contrast to those of strategic planning. This contrast is a direct reflection of the basic differences between these two activities. The task orientation of operational control requires information of a well-defined and narrow scope. This information is quite detailed and arises largely from internal sources within the organization. Very frequent use is made of this information, and it is important that

the information be accurate.

In general along each of these dimensions, the information requirements for management control fall between the extremes for operational control and strategic planning. In addition it is important to recognize that an important part of the information which is relevant to management control is obtained through the process of interpersonal interaction.

In Figure 1 we have summarized these general observations about the categories of management activity. This summary is subject to the same limitations and uncertainties which are exhibited by the concepts of management control, strategic planning and operational control. Nonetheless, it does underscore our contention that because the activities themselves are different, the information requirements to support these activities are also different.

This summary of information needs suggests the reason why many organizations have found it increasingly difficult to realize some of their long range plans for information systems. Many of these plans are based on the "total systems approach." Some of the proponents of this approach advocate (1) that systems throughout the organization be tightly linked, with the output of one becoming the direct input of another, and (2) that the whole structure be built on the detailed data used for controlling operations. In doing so, they are suggesting an approach to systems design that is at best uneconomic and at worst is based on a potentially fatal misconception.

FIGURE 1

Information Characteristics by Decision Category

Characteristics of Information	Operational Control	Management Control	Strategic Planning
Source	Largely internal.		→ External
Scope	Well defined, narrow.		→ Very wide
Level of Aggregation	Detailed.		→ Aggregate
Time Horizon	Historical.		→ Future
Currency of Data-Base	Highly current.		→ Quite old
Units	Largely others. . . . . (rate, # pieces, quality)		→ $ and others
Required Accuracy	High.		→ Low
Frequency of Occurrence of Information Change	High.		→ Low
Frequency of Use of Information	Very frequent		→ Infrequent

The first major problem with this view is that it does not recognize the ongoing nature of systems development in the operational control area. There is little reason to believe that this systems work in any major organization will be complete within the forseeable future. To say that management information systems activity must wait "until we get our operational control systems in hand" is to say that efforts to assist management with systems support will be deferred indefinitely.

The second and perhaps most serious problem with this total systems view is that it fails to properly represent the information needs of the management control and strategic planning activities. Neither of these areas necessarily needs information that is a mere aggregation of data from the operational control data base. In many cases if such a link is needed, it is more cost effective to use sampling from this data base and other statistical techniques to develop the required information. Seldom if ever does it make sense to directly couple managers in the management control and strategic planning areas to the masses of detailed data required for operational control. Not only is this direct coupling unnecessary, but it is often an expensive and difficult technical problem.

For these reasons it is easy to understand why so many companies have had the following experience. Original plans for operational control systems were met with more or less difficulty, but as time passed it became increasingly apparent that the planned systems for

higher management were not being developed on schedule (if at all). To make matters worse, the systems which were developed for senior management had relatively little impact on the way in which these managers made decisions. This last problem is a direct result of the failure to understand the basic information needs of different activities.

We have tried to show in the above discussion how Anthony's classification of managerial activities is a useful consideration for people working in information systems design and implementation. His ideas are an important component of the framework which we will present. When we have that framework in hand, we will then return to consider in more detail some of the implications of these ideas. At the moment, however, we would like to introduce a second way of looking at management activities into our discussion. Anthony's classification of managerial activity, from the viewpoint of planning and control, can be complemented by Herbert Simon's general discussion of human problem solving.

Simon's work is concerned with the manner in which human beings solve problems irrespective of their position within an organization. His distinction between "programmed" and "nonprogrammed" decisions is a useful one for us. He regards them as being at the opposite ends of a continuum, and he is careful to assert that they are not sharply defined categories. Simon describes these two types of decisions as follows:[1]

[1] H. A. Simon, The New Science of Management Decision, Harper and Rowe, 1960, p. 6.

1. Decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them so that they don't have to be treated de novo each time they occur.

2. Decisions are nonprogrammed to the extent that they are novel, unstructured and consequential. There is no cut-and-dried method of handling the problem because it hasn't arisen before, because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment. By nonprogrammed I mean a response where the system has no specific procedure to deal with situations like the one at hand but must fall back on whatever general capacity it has for intelligent, adaptive, problem-oriented action.

We will use the terms "structured" and "unstructured" for programmed and nonprogrammed because they imply less dependence on the computer and more dependence on the basic character of the problem-solving activity in question.

Distinguishing between these two types of problems is important because we approach solving the two types differently. Different procedures, different kinds of computation, and different types of information may be required depending on the extent to which the problem in question is unstructured. The basis for these differences lies in the fact that the human decision maker must provide judgment and evaluation as well as insights into problem definition in the unstructured case. Such a situation differs fundamentally from that associated with problem solving for very structured problems. Here much if not all of the decision-making process can be automated. Later in this paper we will argue that systems built to support structured decision making will be significantly different from those

designed to support managers in dealing with unstructured problems. Further, we will try to show that this difference can be traced to the different character of the models which are relevant to each of these types of problems and the way in which these models are developed.

This focus on decisions requires an understanding of the human decision-making process. Research on the problem of human problem solving supports Simon's claim that all problem solving can be broken down into three categories:[1]

> 1. The first phase of the decision-making process, searching the environment for conditions calling for a decision, I shall call intelligence activity (borrowing the military meaning of intelligence). The second phase — inventing, developing, and analyzing possible courses of action — I shall call design activity. The third phase — selecting course of action from those available — I shall call choice activity.
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> 2. Generally speaking, intelligence activity precedes design, and design activity precedes choice. The cycle of phases is, however, far more complex than the sequence suggests. Each phase in making a particular decision is itself a complex decision-making process. The design phase, for example, may call for new intelligence activities; problems at any given level generate subproblems that in turn have their own intelligence, design and choice phases, and so on. There are wheels within wheels. Nevertheless, the three large phases are often clearly discernible as the organizational decision process unfolds. They are closely related to the stages in problem solving first described by John Dewey: What is the problem? What are the alternatives? Which alternative is best?[2]

In this, Simon clearly makes the point that this problem-solving process is a highly iterative hierarchical process. For example, the

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[1] Simon, op. cit., p. 4.

[2] John Dewey, How We Think, Chapter 8, D. C. Heath & Company, New York, 1910.

intelligence phase could be thought of as a subproblem which in order to "find" a problem requires the user to go through the intelligence, design and choice phases at another level from that of the initial problem statement. This interactive, hierarchical character is hard to represent on paper, but it should be kept clearly in mind during the following discussion.

A fully structured problem is one in which all three phases, intelligence, design and choice, are structured. That is, we can specify algorithms, or decision rules, that will allow us to find the problem, design solutions, and select the best solution. An example here might be the inventory control problem in a simple case --one where demand was known with a high degree of accuracy and replenishment times were very predictable with all costs known reasonably accurately. In such a case, we can set up criteria to tell us when there is a problem (the re-order point is broken). Given this condition, the solution generation process uses a known model (the re-order quantity formula) and the latest numbers and generates an answer which in this case is chosen automatically.

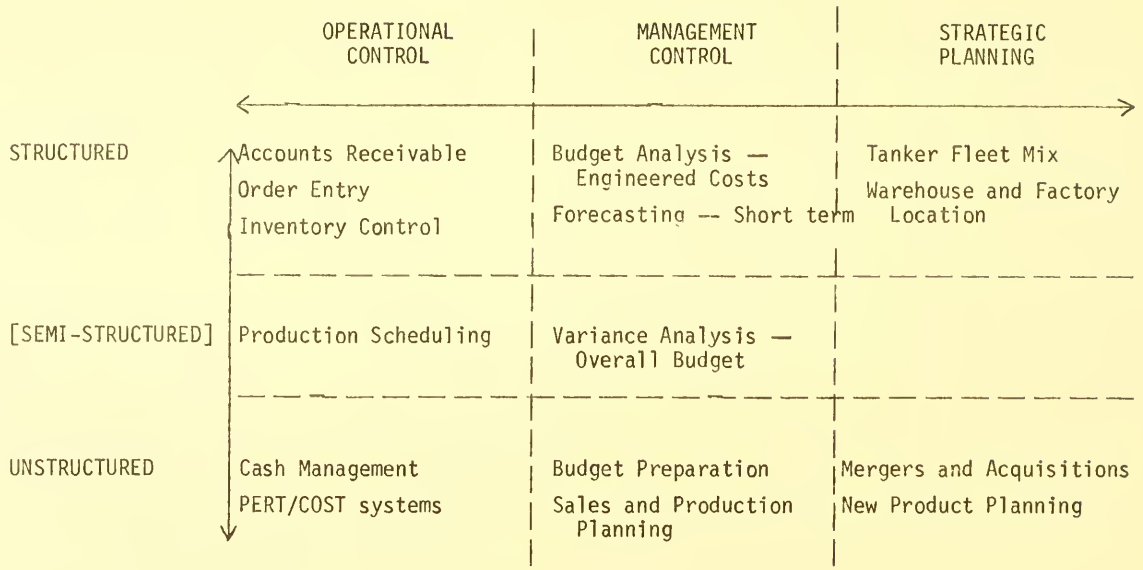
Similarly, in a semi-structured area we can find problems where the search for a problem is difficult, although the design and the choice of a solution is relatively easy. In such a case we might want to design a flexible man-machine interaction in the search activity and leave the design and choice to the computer. When all phases are unstructured, we can only provide access to data and

useful ways of displaying it.

In the ideas of Simon and Anthony, then, we have two different ways of looking at managerial activity within organizations. Anthony's categorization is really based on the purpose of the management activity, whereas Simon's classification is based on the way in which the manager deals with the problems which confront him. The combination of these two different views provides what we feel is a useful framework within which to view the purposes and problems of information systems activity. This combination is given in Figure 2 where we have further separated the class of decision we are calling semi-structured. These decisions are those with one or two of the intelligence, design and choice phases unstructured. It is this semi-structured area where the interactive terminal systems have their greatest potential. We have listed some examples in each of the cells but it should be stressed once again that these are not well-defined precise categories but rather general boundaries. Decisions that fall above the dividing line are largely structured and information systems that support these we have termed structured decision systems (SDS). Decisions below the line are largely unstructured and we have chosen to term information systems that support these Management Decision Systems (MDS). The SDS area encompasses almost all of what has been called Management Information Systems (MIS) in the literature -- an area that has had almost nothing to do with real managers or information but has been largely routine data processing. We exclude from consideration here all of the information

Figure 2

Information Systems — A Framework



handling activities in an organization. A large percentage of computer time in many organizations is spent on pure information handling with no decisions, however structured, involved. The payroll application, simple status report processing, etc. are examples.

Some illustruations of our framework categories may make their meaning clearer:

Structured Operational Control

Decisions on Order Entry. The decisions involved when a customer's order is received. Which discounts to apply, what price is applicable, which warehouse to fill the order from, the means by which it should be shipped and so forth. Each of these decisions is governed by well-defined rules and is an integral part of the ongoing operations.

Decisions on Inventory Control. A further example occurs on the inventory reordering decisions for the high volume parts a company stocks. When, and how much, to order are well understood structured decisions.

Unstructured Operational Control

PERT/COST Analysis. The use of a PERT/COST system in an ongoing project control situation involves judgmental inputs from the decision maker. Which tasks have become the most important problems, what might possible solutions be, what will the impact of any given solution be, which solution is the best? Many of these questions are unstructured and such a control system is part of an ongoing operational decision.

Job-Shop Scheduling. Decisions as to which jobs to schedule on which particular machines for what time period is an operational control decision for which there exists no good automatic decision process. Good models do not exist for its solution; judgment plays an important part.

Structured Management Control

Budget Analysis. The variance analysis of "engineered" costs is a management control activity that is largely structured. The cause and effect relationships are directly determinable from the data.

Forecasting Short Term. Production and sales decisions based on short term forecasts are well understood decisions. The forecasts themselves can be done tolerably well and their relationship to sales or production decisions is almost automatic.

Unstructured Management Control

Budget Preparation. The setting of budget levels and the variables to be included are both decisions which often require significant managerial inputs. How much to expand or increase any given line item, new expenses to be considered and so forth.

Sales and Production Planning, Decisions for the future for sales or production levels and the co-ordination between them

are all unstructured areas where decisions on a three to twenty-four month horizon are often critical.

Structured Strategic Planning

Tanker Fleet Mix. Decisions on the strategy to employ with regard to the composition of the distribution system for an oil company are determined in large measure by economics. Large vs. small tankers vs. pipelines, etc. are all trade-offs which are heavily influenced by the economics of the system involved. Simulation models are likely to yield a solution which will determine the final answer.

Factory Location. Factory or warehouse location decisions, in fact the structure of the distribution system, are a further class that are likely to be determined by models. These decisions can often be largely structured.

Unstructured Strategic Planning

Merger & Acquisitions. Decisions on expansions and purchases of other corporations. The timing and price of an acquisition. Capital placements and other fund-raising activities. These and a host of similar problems of growth are unstructured.

New Product Planning. New product decisions, their pricing, manufacturing methods, staffing and timing decisions are all unstructured to some significant extent.

Each of these examples is meant to be illustrative only. At any organizational level the important decisions can be classified into these six cells. The boundaries are admittedly fuzzy but at least for the majority of decisions in each class there are quite different implications involved for each of the six cells. We explore these in the material that follows.

Implications of the Framework

Planning

An immediate observation can be made in looking at this framework. Almost all the so-called MIS activity has been directed at decisions in the "structured" half of the matrix and within this in the "operational control" cell.

As is obvious from this rough categorization, most of the interesting areas that really concern managers, areas where decisions have a significant effect on a company, are in the lower half of the diagram. That is, managers of stature deal with unstructured decisions, if not most of their working time certainly for most of their significant decisions.

This implies of course that computers and related systems which which have so far been largely applied to the structured area have not yet had any real impact on management decision making - and that the areas of high potential do not lie in bigger and better systems of the kind most companies now have. Most of the opportunities for improving

the "effectiveness" as opposed to the "efficiency" of an operation lie below the line separating structured from unstructured.

Therefore in planning the allocation of resources to the information systems area, an organization should assess its activities in each of these six areas. To have all the effort in only one of the cells suggests at the very least a severe imbalance and that some consideration be given to applications in the other areas.

A second point to be noted on the planning question is the evolutionary nature of the line separating structured from unstructured decisions. This line is moving down over time. As we improve our understanding of a particular decision we can move it above the line and allow the system to take care of it, freeing the manager for other tasks more suited to his skills. For example in previous years the inventory reordering decisions in most organizations were made by a well-paid member of middle management. It was a decision that involved a high degree of skill and its quality could make a big difference to the profits of the organization. Today that same decision has moved from the unstructured operational control area to the structured. We have a set of decision rules (the EOQ formula) which on average do a better job for the standard items than most human decision makers. This movement of the line does not imply any replacement of managers since we are dealing with an infinite set of problems. For every one we solve there are ten to turn our attention to.

It is worth noting that the approach taken in building systems in

the unstructured area hastens this movement of the line since it focuses our analytical attention on decisions and decision rules. This would lead us to expect a continuing flow of decisions across the line, or at least into the "grey" semi-structured decision area where either the intelligence, design or choice phases are unstructured. In other words through the development of a model of a given problem solving process, we can establish the character of each of the three phases. To the extent that any of these phases can be structured, we can design direct systems support. For those aspects of the process that are unstructured (given our current understanding of the situation), we would call on the manager to provide the necessary analysis. Thus a problem might be broken down into a set of related subproblems, some of which are "solved" automatically by the system and the remainder are dealt with by the user alone or with varying degrees of computational and display support. Regardless of the resulting division of labor, however, it is essential that a model of the decision process be constructed prior to the system design. It is only in this way that a good perspective on the potential application of systems support can be ascertained.

Structured/Unstructured

There is a series of implications that flow from the distinction that has been drawn between structured and unstructured decisions.

A major focus of information systems ought to be on the important decisions of the organization, many of which, as we argued above, are

unstructured. The realization of this focus should be the development of a model of the decision process that is involved. This model development is fundamental, because it is a prerequisite for the analysis of the value of information, and it is the key to the understanding of the portions of the decision process that can be supported or automated. Both the successes and failures of the use of computers in organizations to date can be understood largely in terms of the difficulty of this model development.

Our discussion of SDS work showed that the vast majority of the effort (and success) has been in the area of structured operational control. The fact that this area is structured implies that there exist definite, routine procedures for dealing with problems. Secondly, in the operational control area, there is relatively little ambiguity as to the goals sought. For example, the typical inventory control problem can be precisely stated, and it is clear what the criterion is by which solutions are to be judged. Hence we have a well understood optimization problem. This type of problem lends itself to the development of formal, "scientific" models, those typical of operations research.

Another important characteristic of problems of this type is that they are to a large extent "organization-independent." By this we mean that the essential aspects of the problem tend to be the same in many organizations, although details may differ. The generality of the

has two important effects. First it encourages widespread interest and effort in the development of solutions to the problem. Second, it makes the adaption of general models to the situation in a particular organizational setting relatively easy.

The situation with regard to areas of management decision making below the line is quite different. To the extent to which a given problem is semi-structured or unstructured, there is an absence of a routine procedure for dealing with it. Also there is a tendency for there to be some ambiguity in the problem definition. This is because of a lack of formalization of any or all of the intelligence, design, or choice phases of the decision making process. Confusion may exist as to the appropriate criterion for evaluating solutions, or as to the means for generating trial solutions to the problem. In many cases, this uncertainty contributes to the perception of problems of this type as being unique to a given organization.

In general, then, we can say that the information systems problem in the structured operational control area is basically that of implementing a given general model in a certain organizational context. On the other hand, work in the unstructured areas is much more involved with model development and formalization. Furthermore, the source of the models in the former case is apt to be the operations research or management science literature. In the latter case, however, the relevant models are most often the as yet unverbalized models used by

the managers of the organization. This suggests that the procedure for the development of systems, the types of systems, and the skills of the analysts involved may be quite different in the two areas.

First consider the people involved in the systems development work. The evolution of information systems activities in most organizations has led to the accumulation of a variety of technical skills. In many cases, the collective knowledge of computers and telecommunications is impressive. In many of these same organizations, however, the impact of computers on the way in which top managers make decisions has been minimal. The reason for this is that the support of these decision makers is not principally a technical problem. If it were, it would have been solved. Certainly there are technical problems associated with work in these problem areas, but the technology and the technological skills in most large organizations are more than sufficient. This missing ingredient, apart from the basic awareness of the problem, is the skill to elicit from management their view of their organization and its environment and to formalize models of this view.

Unfortunately, success in operational control applications is no guarantee of success in the unstructured problem areas. We have discussed the fundamental differences in the two types of problems in order to underscore this point. In many cases, the view taken by systems people experienced in the operational control areas is at best inappropriate for MDS work.

Consider an extremely elementary view of a decision process. The

picture is of a 'black box' with information as inputs and decisions as outputs. The aim of a systems designer should be to improve the quality of the decisions which are produced by the process. Basically this can be done in two ways. Either the quality of the information inputs can be improved (assuming that the actual decision process remains unchanged), or the decision process can be altered (given the same information inputs). Of course, there is always the possibility of changing both aspects at the same time.

Because of the existence of a variety of optimization models for operational control problems, there is a tendency for less emphasis to be placed on the decision process in this area. In many cases, systems designers know how to make optimal decisions (e.g., inventory control) or at least very good decisions (e.g., production scheduling). The emphasis in this area is on the improvement of the information inputs to the decision model. Hence the importance of real time systems and telecommunications and the like is great.

Although this emphasis on the quality of information inputs is appropriate for structured operational control problems, it can retard progress in developing support for unstructured problem solving. The difficulty with this view is that it tends to attribute low quality in management decision making to low quality information inputs. Hence, systems are designed to supply more current, more accurate, or more detailed information. In the extreme, managers are inundated with such information.

While improving the quality of information available to managers may improve the quality of their decisions, we do not believe that major advances will be realized in this way.[1] This is because we believe that most managers do not have great informational needs, but rather they have need for new methods to understand and process the information already available to them. Generally speaking, the models that they employ in dealing with this information are very primitive, and as a result, the range of responses that they can generate is very limited. For example, many managers employ simple historical models in their attempts to anticipate the future.[2] Further, these models are static in nature, although the processes they purport to represent are highly dynamic. In such a situation, there is much more to be gained by improving the information processing ability of managers in order that they may effectively deal with the information that they already have, than in adding to the reams of data confronting them, or in improving the quality of that data.[3]

If this view is correct, it suggests that the MDS area is important and that systems to support decisions may best be built by people other than those currently involved in the operational control systems area. The requisite skills are those of model building based on close interactions with management; structuring and formalizing the procedures employed by managers; and segregating those aspects of the decision process that can be automated. In addition, systems in this area must

[1] R. Ackoff, "Management Misinformation Systems", Mgt. Sci., vol. 14, no. 4, Dec. 1967, pp. B147-156.

[2] W. F. Pounds, "The Process of Problem Finding", Industrial Management Review, vol. 11, no. 1 (1969), pp. 1-20.

[3] G. A. Gorry, "The Development of Managerial Models", Sloan Management Review, (in press).

be able to assist the evolution of the manager's ability to deal with the problems confronting him through increasing his understanding of the environment. Hence, one important role of an MDS is educative. Even in areas in which we cannot structure the decision process, we can provide models of the environment from which the manager can develop insights into the relationship of his decisions to the goals he wishes to achieve.

In discussing models and their importance to systems in the MDS area, we should place special emphasis on the role which the manager assumes in the process of model building. To a large extent, he is the source upon which the analyst draws. That is, although a repertoire of "operations research" models may be very valuable for the analyst, his task is not to simply impose such a model on the situation. These models may be the building blocks. The analyst and the manager in concert develop the final structure. This implies that the analyst must possess a certain empathy for the manager and vice versa. Whether the current systems designers in a given organization possess this quality is a question worthy of consideration by management.

Notice that this approach in no way precludes normative statements about decision procedures. The emphasis on the development of descriptive models of managerial problem solving is only to ensure that the existing situation is well understood by both the analyst and the manager. Once this understanding has been attained, various approaches to improving the process can be explored. In fact, one of the chief benefits of the

development of descriptive models of this type is that it exposes management decision procedures so that they may be analyzed. Hopefully, this analysis will lead to improvements in these processes.

Decision Categories

The distinctions we have borrowed from Anthony have a set of implications distinct from those discussed in connection with the structured and unstructured areas. The first of these has to do with the systems design differences that follow from supporting decisions in the three areas. In particular the "total systems" concept and the popular "integrated data-base" notions can be seen to be badly misleading if taken to their often advocated extremes. These points are most easily made in relation to the information requirements. As was seen earlier, the characteristics of the information differ sharply among the three areas. There are few occasions in which it makes sense to directly connect systems across these boundaries. Aggregating the detailed accounting records to provide a base for a five-year sales forecast is an expensive and unnecessary process. This is a poor example perhaps but nevertheless we can often sample, estimate, or otherwise obtain data for use in strategic planning without resorting to the operational control data-base. This does not imply we should never use such a data-base, but merely that it is unlikely to be the best way of obtaining the information.

Similarly there are issues in the collection and maintenance of data. Techniques appropriate for operational control data such as on-

line data collection terminals are rarely justified for strategic planning systems. Similarly, elaborate environmental sampling methods may be critical for the success of a system to support strategic decisions and unimportant for an operational control decision. In looking at each of the information characteristics in Figure 1 it is apparent that quite different data-bases and computer systems will be required to support decisions in these three areas. Hence different personnel skills, computer resources and software support will be needed.

The systems distinctions made above are true for both structured and unstructured decisions in each of the three areas.

A second distinction is the organizational structure and the managerial and analyst skills that will be involved across these three areas. The managerial talents available, the numbers and training of the managers involved differ sharply between these categories. Strategic decisions involve senior managers, and corporate staff in an informal, highly iterative process with only a few people involved. The decision process, the implementation process, and the level of analytical sophistication of the managers (as opposed to the staff) all differ quite markedly from their counterparts in operational control. The decision makers in operational control have a more constrained problem. They have often had several years in which to define the general nature of the problem and possible solutions. In addition, to the extent these managers have a technical background, they are more likely to be familiar

with the analysis involved in looking both at structured and unstructured problems. In any event, in the operational control area the training, style, numbers and frequency of the decision all tend to produce design and implementation problems of a different variety. The managers involved are from the decision area in question, be it strategic planning, management control or operational control. As a result their training, background and daily pattern of activity are different. This means that the types of models to be used, the method of elucidation of these from managers where appropriate and the skills of the analysts will all differ across these three areas.

As the types of skills possessed by the managers differ so will the kinds of systems analysts that can operate effectively. We have already distinguished between analysts who can handle the structured versus unstructured model building. There is a similar distinction to be made between the kind of person who can work well with a small group of senior managers (on both a structured or unstructured problem) and the person who is able to communicate with, for example, the various production personnel on an unstructured job-shop scheduling problem.

In addition the managerial and analyst issues raised above there is the further difference in the way the information systems group is organized. A group dealing only with operational control problems would be structured differently and perhaps report to a different organizational position than would a group that dealt with all three areas. It is not our purpose here to go into detail on the organiza-

tional issues but from the material above suggests that on strategic problems a task force reporting to the user and virtually independent of the computer group may make sense. In management control a single user although still dominant in his application, has problems of interfacing with other users. An organizational design that encourages cross functional (marketing, production, distribution, etc.) cooperation is probably desirable. In operational control the organizational design should include the user as a major influence but he will have to be balanced with operational systems experts and the whole group can quite possibly stay within functional boundaries. These examples are merely illustrative of the kind of organizational differences that are involved. Each company must examine its current status and needs and make structural changes in light of these — however the different decision areas do require different treatment.

The third distinction is between the types of models involved. Again looking at Figure 1 and the information differences it is clear that the models required to process this will be different. Techniques such as technological forecasting, and other models to deal with the future are much more prevalent in strategic planning than they are in operational control. Another example of model differences occurs due to the frequency of decisions in each area and their relative magnitude. A strategic decision to change the whole distribution system occurs rarely. It is significant in cost, perhaps hundreds of millions of dollars and it therefore can

support a complex model, but the model need not be efficient in any sense, whereas an operational control decision may be made frequently, perhaps daily. The impact of each decision is small but cumulatively by the end of the year large sums of money are involved. Models for the decision may have to be efficient in running time, have ready access to current data and so forth.

Summary

The information systems field absorbs a significant percentage of the resources of many organizations. Despite these expenditures there is very little perspective on the field and the issues within it. As a result there has been a tendency to make incremental improvements to existing systems.

The framework we suggest for looking at decisions within an organization provides one perspective on the information systems issues. From this perspective it becomes clear that our planning for information systems has resulted in a heavy concentration in the operational control area. In addition there are a series of implications for the organization that flow from the distinction between the decision areas. Model structure and the implementation process differ sharply between the structured and unstructured areas. Systems personnel, organizational structure and computer systems configurations all differ along the Strategic Planning to Operational Control axis.

We are arguing, above all, that each organization should share some common framework among its members if it is to make effective use of information systems. We suggest this framework is an appropriate place to start.

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