# GETTING IT ALL TOGETHER--MIS, MANAGEMENT SCIENCE AND CORPORATE MODELS

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## INTRODUCTION

Scarcely a month passes that another paper lamenting the short-comings of either Management Information Systems (MIS) or Management Science (MS) doesn't appear in the literature. It is unfortunate that these disciplines which have been universally commended to management and which obviously have great potential, have fallen into difficult times. It is likewise unfortunate that another promising construct--the corporate model--will likely meet a similar fater unless the present course of events is altered.

It goes without saying that managers are somewhat disenchanted with the impact Management Information Systems and Management science. What is needed now is not more papers publicizing theshort-comings of these concepts, but rather some tangible strategies for increasing the impact of the concepts on managerial decision-making. Several recent papers have treated factors which have limited the impact of either MIS or MS and some worthwhile strategies have been advanced [7], [8], [15], [16]. Curiously, nowhere has recognition been given to the idea that there exists a dynamic interface between MIS and MS and that it might be possible to mutually promote both disciplines by examining the nature of this interface. The interface is dynamic because of emerging technology in both disciplines, and this is where the corporate model enters the picture. Corporate models are bascically "super" management science models which draw heavily upon data descriptive of an organization. Thus, any effort to more closely co-ordinate the relationships between MIS and MS will enhance the value of corporate models.

In order to analyze the MIS-MS interface with a view toward promoting individual and joint impact upon decision-making, it will be helpful first to consider briefly the characteristics of MIS and MS which have contributed to the poor showing. It shouldalso be instructive to suggest what factors might limit the effectiveness of the corporate model.

### Why MIS is No Hit

As much literature has probabiy been written probing the failures of Management Information Systems as literature extolling its benefits [1], [5], [11]. There are many reasons why MIS has not fully achieved the potential ascribed it. Four characteristics of the existing MIS concept are responsible for most of the critcism; MIS's are (1) functionally oriented, (2) file constrained, (3) time constrained, and (4) computationally deficient.

**Functional Orientation.** Management information systems to date have mainly been function-

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ally oriented. Systems have been designed to support financial and accounting operations; logistical operations, including production scheduling and inventory control; legal services, including industrial relation and personnel functions; and, to some extent, research and development activity [5, pp. 93-94]. While these systems have supported functional decision-making more or less, effectively, the general conclusion is that they have not contributed much toward assisting decision-making which cuts across functional areas, i.e., top management decisions.

**File Constrained.** Asecond factor which has caused a high degree of built-in inflexibility in MIS's has been the approach to file construction used in most MIS's. Many information systems have been developed in modular fashion by programmers, each working on a separate problem area [15, p. 101]. There has been little effort to co-ordinate file design for the purpose of reducing redundancy and increasing conformability. Thus, data used in one application program is available for use in another.

**Time Constrained.** Data updating capability and time availability of data have posed problems for MIS users. The problems are not severe for routine data processing; it is the ad-hoc request for information required for a "one-shot" decision that gets axed. The standard response to such a request is "We can get that information for you by developing a special program and running it after routine monthly processing has updated all affected records, and it probably won't be in exactly the format you need." Small wonder that the V.P. of Manufacturing who must make an immediate change in production schedules to meet unexpected market fluctuations relies on intuition rather than hard data for his decision.

**Computationally Deficient.** A fourth characteristic of many MIS's which has had a subtle effect on MIS impact is computational deficiency and lack of selectivity. With today's data processing capability it is not difficult to inundate management with data. The challenge is to get relevant data to the responsible decision-maker in the appropriate format. Embedded statistical and mathematical models have not been used effectively to improve the selective and computational capability of the MIS [16, p. 10].

These are basically the limiting characteristics of MIS which should be resolved in any proposal to enhance MIS impact. What about Management Science?

### Management Science and the Manager

The sub-title of a recent article in the **Harvard Business Review** aptly describes the plight of Management Science. It states: "Management Science has now become arcane, or nearly so; a bridge must be built between it and the real world of the executive [7]." What are the characteristics of Management Science which accounts for the hesitance of executives to utilize MS techniques in decision-making? Six are prominent: (1) data requirements, (2) normative solutions, (3) assumptions, (4) time constraints, (5) problem orientation, and (6) vocabulary.

**Data Requirements.** Nolan [15] describes a mini-case which illustrates the difficulty of mating data from a real world data system to management science techniques. Unfortunately, the typical data maintained by many firms is simply not compatible with MS techniques. To support MS methodologies under existing information processing structures, either primary source data must be collected or data transformed from secondary sources. Either procedure is, of course, time consuming and costly.

In attempting to improve his relationship with the real world, the management scientist continues to devise complex models which require sophisticated data collection and identification techniques. He seems to be following what C. West Churchman calls a pigheadely wrong philsophy of developing models with "an unforgivable neglect of the problem of information [4, p. 160]."

**Normative Solutions** The "optimality syndrome" has impeded acceptance of management science techniques. The notion that a manager must either implement the optimal result of a MS model or he is stupid has often been conveyed by management scientists [16, p. 5].

**Unrealistic Assumptions.** The most frequently criticized property of MS techniques relates to the number and validity of assumptions that must be invoked in order to obtain an analytical optimum. The consensus is that MS models are so abstracted from reality that they are of little value to the manager. Whether this is true of all MS techniques is extremely questionable, but the Napoleonic dictum prevails and all are assumed unrealistic until proven otherwise.

An interesting paradox prevails herein. When the management scientist attempts to relax unrealistic assumptions in order to better describe a particular situation. model complexity increases at an alarming rate. Simultaneously, the need for additional and sophisticated data increases. Thus, the researcher loses no matter which approach he pursues.

**Time Constraints.** Grayson [7, p. 43] suggests that management scientists, because of the unpressured world in which they function, simply do not understand the constraint of time upon decision-making. *Modeling is a time-consuming process--one that managers can seldom afford.*

**Problem Orientation.** Another factor which has hindered the acceptance of Management Science is the difference in orientation between the management scientist and the manager. The former is problem oriented while the latter is decision oriented. The old saw that "Management Science is a technique in search of a problem" is not without truth. Complicating this problem of opposing orientation, is the isolation of the management scientist from the mainstream or organizational decision-making. Whether the isolation is a result of organizational design or problem sized assignments, the management scientist, prevented from viewing the larger picture, often fails to see the limited application of his model [3, p. 171-2].

**Vocabulary.** There is a little doubt that a communication barrier exists between management scientists and managers. Most executives could care less about the implications of a positive second derivative; yet, rather than trying to resolve this situation, the management scientist has often deliberately promoted the mystique which surrounds his work.

These are some of the reasons for the lack of acceptance of Management Science. What does the future hold for the corporate model?

**Corporate Models Aground?**

The corporate model, theoretically the effective blending of the techniques of the systems analyst and the management scientist, is likely to experience the same fate as MIS and MS for many of the same reasons.

**Data Limitations.** The corporate model is more than anything else a super mathematical model of an organization. As such, it is subject to the same data problems as conventional MS techniques; the only difference is in magnitude--more data is required--hence, the problems are

more grievous.

**Inflexibility.** Corporate models are by nature not very flexible or versatile. Once a complex model of the various controllable and uncontrollable variables describing a system has been structured, it is extremely difficult to add additional variables or to otherwise modify the model. Consequently, even though many different combinations of model variable values may be considered, different variable configurations offer problems.

A related problem is the diffficulty of suiting a large-scale model to a dynamically changing organization. This has been one of the criticisms of systems models--by the time a systems model is built, it represents a system that no longer exists.

**General Relationships.** A final characteristic of corporate models which has generated criticism is the quantitative-qualitative question. Many systems models are useful only in assessing the **direction** of system changes not the **magnitude**. This criticism has been less evident as system model sophistication has increased.

With this rather bleak picture of unfulfilled potential, what can be done to ameliorate the situation? It is imperative if MIS and MS are to effectively and simultaneously support management decision-making, that the complex relationships between the two concepts be investigated with a view toward harmonization. The purpose of this paper is to examine the nature of the MIS-MS interface to suggest some of the pivotal elements that must be considered in structuring an efficient interface, to locate responsibility for achieving an effective interface, and to consider benefits of an integrated approach.

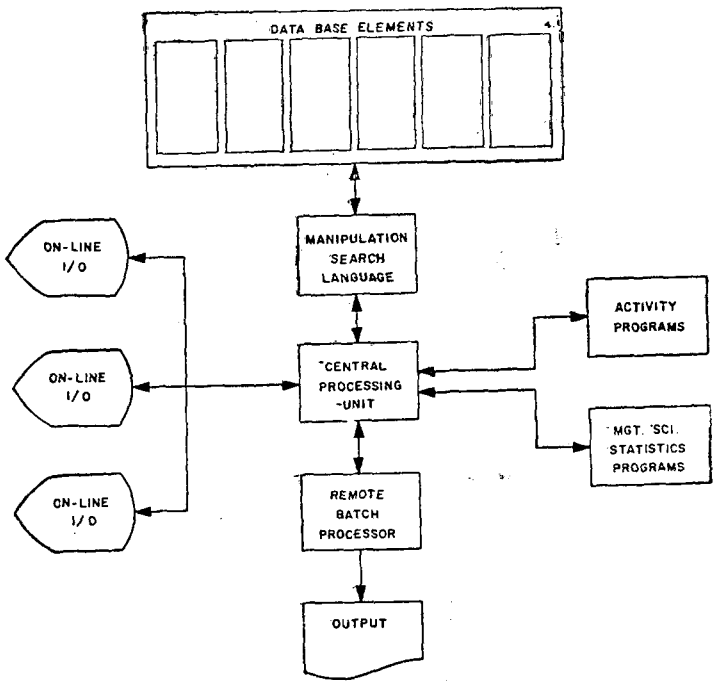


**Figure 1.** Schematic of a management information system incorporating data base technology with embedded management science and statistical techniques.

## MIS-MS INTERFACE

Given two areas in which technology is developing and changing at such a rapid pace, it is difficult to hypothesize what the nature of the joint interface should be. The interface between MIS an MS is and should be a dynamic construct--perhaps even a wil-o'-the wisp which is never possible to achive in practice. Nevertheless, it is necessary that efforts be made to consider and describe the nature of relationships in order to achive an effective combination in operating systems. In this section of the paper, the nature of the MIS-MS interface will be explored.

A schematic diagram of a real-time MIS utilizing an on-line, mass-storage data-base with embedded MS packages is illustrated in Figure 1. The key elements in the configuration shown are the data-bases, a data search and manipulation capability, and system compatible management science and statistical routines.

The data-base, as implied, should be predominantly on-line utilizing 3.5 generation mass-storage technology. Where capacity constraints are crucial, it might be necessary to store seldom-used data on external files. As Nolan [15] suggests, the data-base concept will obviate much of the rigidity which has plagued MS's heretofore.

The possibility of the data-base concept is contingent upon an efficient data search-manipulation capability. Without an efficient search, locate, use, update-modify capability, data arrays are impressive but rather useless assets. Thus, along with the hardware capability to store masses of date on-line must exist the software capability to use the stored data in real time [15, p. 105].

Which management science routines would be incorporated into the system would depend on the nature of the organization involved. Corporate models would be included as well as data analysis packages, e. g., statistical analysis, regression, ANOVA, etc. Optimization techniques such as linear programming might be included. So would forecasting models, simulation packages, and scheduling algorithms. In the past, it has been difficult if not impossible to embed MS models in an MIS because of data problems and compiler incompatibility (a problem which will be treated subsequently in this paper). Given a data-base with search-manipulate capability, data problems would be reduced considerably.

The information processing capabilities of a system configured as suggested in Figure 1 are interesting, especially when contrasted to traditional MIS's. Considering three broad classes of information processing activity as query, routine processing, and ad-hoc requests, where the first two classes deal primarily with lower-level decision-making while the latter class is basically concerned with strategic or top-level decision-making, turns up some interesting comparisons.

**Query Processing**

The current state of any informational entity in the system could be queried in real time via the search-manipulation language. Additions, modifications,and deletions such as inventory adjustments, capacity changes, etc. could also be effected in real-time. With conventional MIS's such operations are possible only for on-line data files which might represent only a small fraction of the total data assets of the organization.

**Routine Processing**

Processing of recurring data operations could be effected by remote batch processing facilities utilizing activity programs linked to the data-base via the search-manipulation language, e.g.,

customer billing or payrolls. In addition, one-time analyses of data related to application programs could be accomplished by linking statistical programs with the data-base, for example, generating data for input to a stochastic decision model. What would amount to cross-file analysis in a conventional MIS could be readily accomodated with the suggested configuration. Such data analysis flexibility is generally not possible with conventional Management Information Systems.

**Ad-Hoc Processing**

The area in which traditional MIS's and MS techniques have contributed least is in support of strategic decision-making where the bulk of information needs are of an ad-hoc nature with rapid response times required. It is in this area that the proposed configuration would make the greatest contribution. A diverse analytical capability would be available to management in real-tme through the effective linkage of the data-base and MS packages.

As an example, suppose the Manufacturing V.P. referred to earlier needed sales forecasts by distributicn region for a particular product to assess the impact of a new product line on regional warehouse facilities. Under conventional MIS constraints, unless this eventuality had been foreseen and provided for, the chances are remote that the information could be obtained. Under the suggested system, the pertinent historical data would be fetched from the data-base an input to an embedded exponential smoothing package to obtain the required information.

Such a system would be considerably superior to conventional MIS's. The question is "are such systems within the realm of possibility?" Some experts think that a true real-time MIS with MS capability is a dream [5, p. 91], [7]. However, with recent technological developments, such a concept is not far-fetched at all. What, then, is necessary to make the transition from the current state to this ideal concept?

## STRUCTURING THE INTERFACE

Three factors are pivotal in making the transition from traditional MIS's to MIS's with embedded MS techniques. First, a change in the typical approach to MIS design must be made. Second, emerging technology must be incorporated where appropriate and technological advances must be initiated in certain areas. Finally, the "if-then" approach to decision-making must be promoted.

**MIS Design Controversy**

One of the interesting controversies about MIS that has continued in the literature is concerned with the proper design approach. Some proponents of MIS have argued that a systems or top-down approach ought to be employed [11], [17], while others argue that a modular or bottom-up approach is the only sensible design approach [9], [13]. It has been suggested that a combination of the systems and modular approaches is possible and desirable [12], yet the whole controversy has largely ignored what is probably the more important question which is: "where should responsibility for specifying the overall objectives of the MIS lie?"

Many MIS shortcomings can be traced to the fact that MIS design has often been in the domain of either systems or computer personnel rather than in the domain of management. Nolan notes that "management of data has continued to develop in fragmented fashion and at rather low

organization levels--at a subdepartmental or substaff level." When specialists design MIS's, the result will be specialized. It is necessary that top management play a more active role in dictating the performance characteristics of the MIS. It is only with a high degree of management influence that reasonable time constraints and information appropriate to support all levels of decision-making can be required of MIS designers.

This is not simply the 33rd verse of "Let's get management behind us!" What is necessary is that **management**, not systems people or computer people, specifies the requirements of the MIS.

**Utilizing and Initiating Technological Change**

The second necessity to realizing full MIS-MS potential is concerned with incorporating current technology in existing MIS's and initiating technological innovation. The data-base concept is the key technological concept which must be adapted; software standardization and software and compiler compatibility are areas where innovation is needed.

**The Data-Base Concept.** There has been much argument among information specialists about the data-base concept. What constitutes a data-base? Is the data-base an essential element of the MIS? Are data-bases possible with the existing state of computer technology? These and similar questions have been posed by proponents and opponents of MIS. The answers are just becoming apparent as new hardware and software capabilities are developing.

The data-base is no longer a figment of the computer scientists' imagination. Random-access, mass storage is available at realistic cost with predictions of tremendous cost reductions forthcoming. In addition, new software is available which is efficient in manipulating large arrays of data. Thus, the problem is no longer technological.

Nolan [15, p. 105] describes the problem: "today, however, many companies that have followed the traditional route, but have acquired up-to-date on-line storage systems, find they have the capacity to keep relatively huge amounts of data alive in the system. But their data are still organized and coded along first generation computer lines--that is, by specific programs." Nolan found that in a survey of ten diverse companies, five recognized the data-base concept; only two had "highly integrated" data-bases. These statistics must be reversed if MIS and MS are to fully achieve their potential.

**Software Standardization.** Computer software technology development has consistently lagged behind hardware development. One of the most critical areas of this lag has been in the standardization of software. To put it bluntly, software is simply not compatible across different hardware systems. FORTRAN is probably the most widely compatible language presently available, yet there is no single FORTRAN compiler which will interface all existing and emerging systems. The lack of standardization is considerably more evident with other languages and programs. The difficulty which this situation poses for the systems designer and user is not hard to envision. Suppose a firm has a particular process design problem which could be effectively treated using simulation analysis of a system of queues using GPSS or SIMSCRIPT. Required cost and performance data are immediately available from the data-base. However, the firm is tied to Brand X equipment which has no such simulation capability. The problem may be treated by: developing a simulator using a general purpose language, trial and error, intuition, or by relying on outside

assistance. None of these solutions fosters management confidence in the MIS.

The solution to the standardization problem is not for every hardware manufacturer to tailor every capability uniquely to his equipment--an approach that is generally popular. The solution is for the computer industry to provide standardized software. The American National Standard COBOL(ASCII) Data Manipulation Language developed by the Conference on Data Systems Languages (CODASYL) is certainly a welcome first step software standardization. Users must push for standardization.

**Software Compatibility**. Another factor which has often been overlooked in MIS development is software compatibility. There are essentially three facets of software compatibility: program-to-program, language-to-language, and program-to-data-base.

Most programs used within existing MIS's were developed for a specific purpose with a particular report generating output feature. Such programs are generally compiled and stored in a common library for easy access by all users. If an occasion arises to use output from one program as input to another program, it is usually necessary to first produce a hard copy of the output of the first program.The desired data is extracted from the hard copy and keypunched for input to the second program. If the output of the second program is required for use in another program, the procedure is repeated once again. This situation is common even in firms with sophisticated information systems.

To alleviate this problem it is necessary to develop program-to-program compatibility within the MIS. Each program used within the MIS should be designed so that its non-formatted output may be written directly on tape, disk-pack or punch card in a manner compatible with other programs in the system. Likewise, it is necessary that every program be able to accept its input in a standard form from any other program. Fortunately, the emerging data-base technology with the concept of a data-base administrator will do much to promote program-to-program compatibility.

Program compatibility as defined above relates to programs written in the same language. Extending the notion to programs written in different or a combination of languages introduces the problem of compiler or language-to-language compatibility. This problem exists largely because of the prevalent philosophy in the computer industry of designing specialized programs or languages for particular jobs or equipment with little attention given to total information systems. The result is that firms have many different programs--each a self-contained entity--requiring special developments for interface with other programs.

Pressure upon the computer industry to minimize compiler incompatibility is the only way this problem can be permanently overcome. Until the industry moves, systems designers must attempt to build compatibility in to MIS's by special programs which link languages.

Program-to-data-base compatibility is evolving with data-base technology. In existing MIS's the emphasis has more often been output oriented; in emerging MIS's the emphasis must also focus upon updating procedures. Every program used within the MIS must have internal update capability. A rather monumental philosophical barrier exists in this regard--who would ever imagine updating a data-base from the output of a management science model?

Software standardization and compatibility are indeed important concepts to the understanding

of the MIS-MS interface. Efficient operating systems will require continued emphasis to promote standardization and compatibility.

**If-Then Decision Making**

A final factor necessary in moving toward an integration of MIS and MS involves popularization of the if-then management approach. There is perhaps enough interest in "pretesting" decision alternatives for the if-then approach to succeed with no stimulus from management scientists. However, since management scientists will be required to develop if-then methodology, it appears that they must abandon some of their "optimizing" pursuits. The proof of a discipline is the use to which it is put. If an if-then approach will elevate Management Science to its perceived potential, what is to be lost by the change? Of course, as such an approach becomes popular, the corporate model as an aid to management will come into its own.

## WHO IS RESPONSIBLE

As Grayson suggests [7], responsibility for progress in this whole area of integration rests with the participants: managers, computer scientists, and management scientists.

Managers must take the lead in requiring management information systems which deliver information necessary to support strategic decision-making within acceptable time constraints. They must also make the effort to move from intuitive decision-making to MIS-assisted decision-making. Further, managers must insist that management science efforts be evaluated on a "value-added" or usefullness basis. Such actions will no doubt remove some of the glamor from both the computer and mathematical models. When mystique and status replace results as performance criteria it is perhaps time for "deglamorizing".

Computer scientists, on the other hand need to discard their program oriented approaches to MIS development. They need to focus their attention on the whole realm of ad-hoc information processing. Finally, they must make software standardization and compatibility pursued objectives.

Management scientists must recognize both the limitations of optimum solutions and the time constraints faced by managers. They should concern themselves with aiding decision-making through development of if-then models of reality. They must forsake the data limitation "crutch" and develop capability for file analysis approaches to data collection.

## BENEFITS OF MIS-MS INTEGRATION

What benefits accrue to the organization supported by the concepts suggested in the foregoing paragraphs? Several are noteworthy.

**Flexibility of Decision Horizons**

Decision-making has traditionally been closely tied to calendar time periods--the day, week, month and year. Conventional management information systems reflect system status at the end of day, week, month or year. With the system proposed in this paper, time-information relationships move from discrete to continuous. Any decision horizon imposed upon the decision-maker can be accomodated by the system.

**Uniformity of Data**

Another advantage of the proposed system is uniformity of data at all organizational levels and within all organizational divisions. It is not uncommon in today's environment for two or more decision-making units to be simultaneously using different values for the same variable set. Such inconstencies are the result of file redundancy, update irregularities and a host of other reasons. With integrated, on line, real-time systems such problems are minimized.

**Structural Compatibility**

Integrated information systems have the desirable quality of being conformable to any organization structure. One of the disadvantages of functional organizations is the tendency toward over specialization--suboptimization. The proposed approach tends to overcome many of the undesirable features of specialization with no apparent harmful side eflects.

**Supportive of Top Mangement**

Finally and perhaps most importantly, the proposed structure holds promise as being truly supportive of top management decision-making. The day of infatuation with Management Information Systems and Management Science is over. The challenge to computer scientists and management scientists should be to effectively support interfunctional decision-making. The MIS-MS relationship is one key to the challenge.

## CONCLUSIONS

The authors are not naive enough to believe that what has been suggested herein is a panacea for all the ills which have befallen Management Science and Management Information Systems. It is hoped that the ideas presented will draw attention to the complex relationships between Management Science and Management Information Systems and that the result will be a stimulus to the reliance decision-makers place on both concepts. The technology for developing a MS integrated MIS which effectively supports decision-making is reality. Are managers, management scientists, and computer scientists up to the challenge?

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