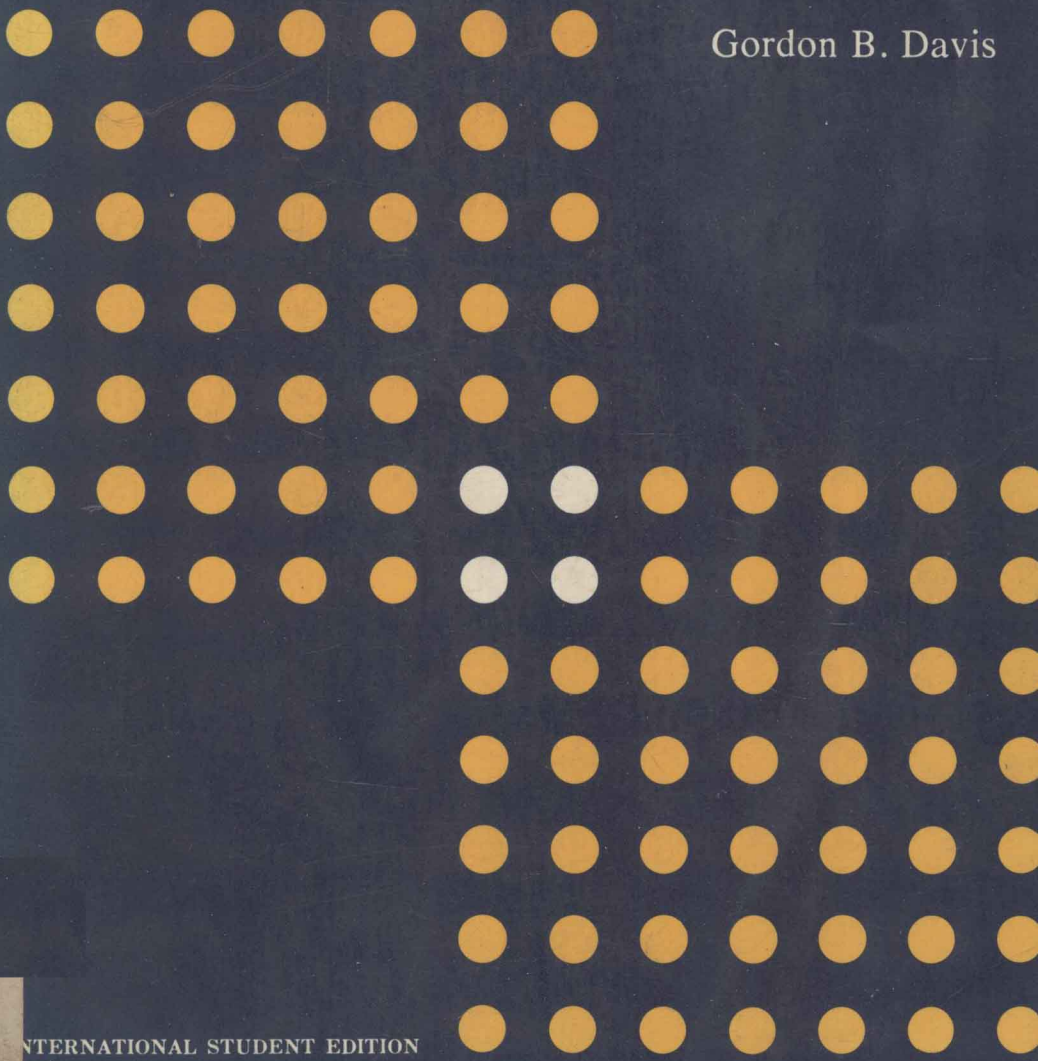
# Management Information Systems: Conceptual Foundations, Structure, and Development

Gordon B. Davis



INTERNATIONAL STUDENT EDITION

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Library of Congress Cataloging in Publication Data
Davis, Gordon Bitter.
Management information systems.
(McGraw-Hill series in management information systems)
Includes bibliographies.
1. Management information systems. I. Title.
T58.6.D38 658.4'5 74-2037
ISBN 0-07-015827-4

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TOSHO PRINTING CO., LTD. TOKYO, JAPAN

# Preface

A management information system, or MIS, is an information system that, in addition to providing all necessary transaction processing for an organization, provides information and processing support for management and decision functions. The idea of such an information system preceded the advent of computers, but computers made the idea feasible. Organizations have always required systems for collecting, processing, storing, retrieving, and distributing information. The computer has added a new and powerful technology to information systems, so that computer-based information systems can be radically different from systems using manual or electromechanical processing. And while organizations are changing their information systems in response to this technology, frequently their adjustment lacks an adequate understanding of the nature of the changes being made. To use the computer to do clerical

processing is a fairly simple matter; to apply the computer to provide support for management functions is more complex. Indeed, the latter application is so challenging that it has been identified by the Association for Computing Machinery as a new academic discipline.

The field of study known as MIS—organizational information systems, computer-based information systems, etc.—is so new that the available text material is not well defined as to content and coverage. This text is unique in its attempt to provide a comprehensive conceptual and structural foundation for the study of the area. It is, in a sense, a first approximation to what is needed. It is difficult to make a satisfactory text until many different students, professors, and practitioners have had a chance to use the material. The publication of the text is therefore a step in defining the content required for an introduction to management information systems. The text could have been delayed for several more years of testing by the author and his colleagues. The "fine tuning" that could have resulted was considered less important than providing a broader use of the text in its current state of development. Comments and suggestions are therefore solicited from all readers and adopters of the text. A possible second edition would be able to reflect the suggestions, insights, references, etc., that are received. This process should have a significant impact in improving quality of text material in the information system area.

The text has been used in draft form by several professors at the College of Business Administration at the University of Minnesota. Students have been varied as to background and preparation: undergraduate and graduate students, MIS majors and nonmajors, business and non-business majors, students with good computer backgrounds and students with little or no knowledge of computers, regular degree students and evening continuing education students. The reaction of the students has been excellent. Students with little mathematics or statistics tend to have difficulty with the mathematical theory of information (in Chapter 2) and the value of information (Chapter 7). However, it is satisfactory to survey these topics for an intuitive understanding without attempting to learn the topics in depth. Students tend to have a better understanding of the material if they have had some introduction to computers. The content of most introductory texts is sufficient background (such as Gordon B. Davis, *Computer Data Processing*, 1973, or *Introduction to Electronic Computers*, 1971, both published by McGraw-Hill Book Company). However, some students have had good success in learning the material with no previous coursework in computers.

Although the text may be used as an introduction to computer-based organizational information systems without prerequisite coursework or

background, it is most appropriate as the text for a second or third course in information systems. Two possible sequences in which the text is used are:

| *Sequence 1* | *Sequence 2* |
|---|---|
| Introduction to computers | Introduction to computers |
| Introduction to MIS | Development of an information system |
| Development of an information system | Introduction to MIS |

Sequence 1 is currently the approach used at the University of Minnesota.

The text has been used in the Minnesota courses in the order followed in the text. However, an alternative order of use is possible.

Chapter 1 Overview
Section 2 Structure
Section 3 Development and management
Section 1 Conceptual foundations

In other words, the structure and development of an information system may be presented prior to describing the conceptual foundations. There are some references in Sections 2 and 3 back to Section 1, but these are not critical.

There are exercises at the end of each chapter but no cases. A case-oriented instructor would need to provide supplementary cases. A set of references at the end of each chapter provides for supplementary reading if desired. A separate instructor's guide contains instructional suggestions.

The pioneering nature of the text makes feedback from users very important. Comments and suggestions can be sent to:

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# Contents

# Management Information Systems

Chapter 1

# An Overview of Management Information Systems

In 1954 the first computer was installed for a business application: processing of payroll. By 1974, only 20 years later, there were over 100,000 computers in the United States and a like number in the rest of the world. Payroll processing by computer, which was a revolutionary idea in 1954, is now considered a rather routine application. Today the frontiers in information processing are systems which also provide information resources in support of managerial and decision-making functions. Such a system is commonly called a *management information system* or MIS. This chapter provides an overview of MIS and issues related to it. The topics will be discussed in more detail in subsequent chapters.

## DEFINITION OF A MANAGEMENT INFORMATION SYSTEM

There is no agreement on the term "management information system." Some writers prefer terms such as "information processing system,"

"information/decision system," or simply "information system" to refer to computer-based information processing systems which are designed to support the operations, management, and decision functions of an organization. This text uses MIS because it is descriptive and generally understood.

An organization has transactions that must be processed in order to carry out its day-to-day activities. The payroll must be prepared, sales and payments on account must be posted: these and others are data processing activities and might be termed clerical in nature; they follow rather standard procedures. The computer is useful for these clerical data processing tasks, but a management information system performs other tasks as well and is more than a data processing system. It is an information processing system applying the power of the computer to provide information for management and decision making. The management information system has been described as a pyramid structure (Figure 1-1) in which the bottom layer consists of the information for transaction processing, status inquiries, etc.; the next level consists of

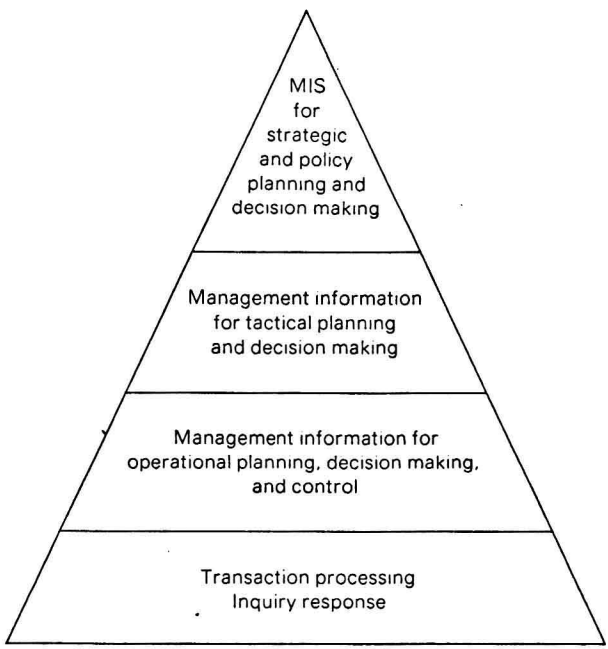


**Figure 1-1** Management information system. (*Adapted from Robert V. Head, "Management Information Systems: A Critical Appraisal,"* Datamation, *May 1967, p. 23.*)

information resources in support of the day-to-day operations management; the third level consists of information system resources to aid in tactical planning and decision making for management control; and the top level consists of information resources in support of the planning and policy making by higher levels of management.

A definition of a management information system, as the term is generally understood, is an integrated, man/machine system for providing information to support the operations, management, and decision-making functions in an organization. The system utilizes computer hardware and software, manual procedures, management and decision models, and a data base.

### Computer-based Man/Machine System

One can conceptually discuss management information systems without computers, but it is the power of the computer which makes MIS possible. The question is not whether a computer shall be used in management information systems, but the extent to which various processes should be computerized. The idea of a computer-based information/decision system does not mean complete automation. The man/machine system concept implies that some tasks are best performed by man, while others are best done by machine. For many problems, the man and machine form a combined system with results being obtained through a set of dialogs and interactions between the computer and a human processor.

The man/machine interaction is enhanced by online operations in which input/output terminals are connected to the computer to provide immediate input and immediate output for applications which can benefit from it. Online operation is required for man/machine dialog, but many clerical processing tasks are more efficiently done without terminal input or output.

The fact that an MIS is computer-based means that designers must have a good knowledge of computers and their use in information processing. The man/machine concept means that the designer of management information systems should understand human capabilities as information processors and human behavior in decision making.

### Integrated System with Data Base

Most early computer processing systems followed the manual processing system approach in which each application is processed separately by use of separate files. This method has processing and control efficiencies; however, it leads to duplication of files and to separate files, some having the same data fields but with the data frequently not in agreement. Also, in

this approach each application is restricted to the data planned for it. An analytical application using data from many applications would need to build a new file from parts of separate files.

An integrated system is based on the concept that there should be integration of data and processing. Data integration is accomplished by the data base. For an information processing system, this consists of all data that can be accessed by the system. In a computer-based MIS, the term *data base* is usually reserved for data that can be readily accessed by the computer. The management of the data base is by a computer software system known as a *data base management system.* Any application using a data item accesses the same data item, which is stored only once and made available to all applications. A single updating of a data item updates it for all uses.

Integrated processing is accomplished by an overall system plan. The system is usually designed as a federation of subsystems rather than a single system. This system design may mean a large central computer, or it can involve a network of smaller computers. The main idea is the planned integration of applications where this is feasible and effective.

### Operations Support

The advanced information processing system must still provide for processing of transactions. In fact, the processing of transactions (payroll, sales, accounts receivable, and others) provides input for the data base that is vital to advanced applications. The trend in transaction processing in advanced systems is toward online data collection and online inquiry. The updating of files may also be performed immediately, although other approaches are also used.

The online inquiry capability is very significant in operational support. It means that any authorized employee may obtain immediate response to an inquiry such as the current balance in a customer account or the inventory on hand for an item.

### Utilization of Management and Decision Models

It is insufficient for human recipients to receive only raw data or even summarized data alone. There needs to be a way of processing and presenting data so that the result is directed toward the decision to be made. The result should be decision-impelling. The method for doing this is processing data in terms of a decision model. For example, an investment decision relative to new capital expenditures might be processed in terms of a model of capital expenditure based on rate of return subject to constraints related to size and risk.

The decision-assisting models used in the system can be intelligence models to find problems; decision models to identify and analyze possible solutions; and various choice models such as optimization models that provide an optimal solution or satisficing methods for deciding on a satisfactory solution. In other words, there is a need for a variety of analytical and modeling approaches to meet a variety of decision situations. The following are some examples of problems and the type of model that might be included in an MIS to meet the need:

| Problem | Example of model |
|---|---|
| Amount of inventory safety stock | Inventory model which computes safety stock |
| Personnel selection | Personnel search and selection model |
| New product pricing | New product introduction model |
| Expenditure control | Budgetary control model |

The variety of decision models required means that an MIS has a set of general decision models useful for many types of analysis and decision situations plus a set of very specific models useful for restricted types of decisions. This is the model base or model bank[1] for the MIS.

In addition to decision models, there should be planning models and planning model software to assist managers in the planning function. These are generally most effective when the manager can use online man/machine dialog to build a plan.

Control models are included to report actual performance compared with planned or standard performance and to analyze the reasons for significant differences.

### The Minimum MIS

An MIS is an organizational information system which supports not only operations but also the management processes. Since every MIS will perform transaction processing as one of its elements, a rather mundane data processing system might be identified as an MIS by the addition of a simple data base, retrieval capabilities, and one or two planning or decision models. Is this an MIS? This is not a useful question. MIS is a concept and an orientation toward which an information system design moves rather than being an absolute state. What is most significant is the

[1]For a discussion of model bank concept, see Hartmut J. Will, "MIS—Mirage or Mirror Image?,"*Journal of Systems Management*, September 1973, pp. 24–31.

extent to which an information system adopts the MIS orientation or an information system supports the management functions of an organization. The answer is usually a matter of degree rather than a simple "yes" or "no."

It is difficult to support management and decision-making needs without technical capabilities for information retrieval upon request. But this need not be online with immediate response. Immediate response is an enhancement rather than a fundamental requirement for many situations. A variety of analytical and decision-making models need to be available if management is to receive useful information. An MIS should, however, not be measured by the complexity and sophistication of its model base. Fairly simple models are often more useful and more used—depending on the organization and the experience of its executives in using such models.

## EVOLUTION OF THE MIS CONCEPT

The idea of an information system to support management and decision making predates the use of computers, which have extended the organizational capabilities for implementing such a system. This extension of capabilities is so significant that MIS is new in the sense that it is now feasible. Many of the ideas which are part of MIS evolved as part of other disciplines. Four major areas of concept and system development are especially significant in tracing the evolution of the MIS concept: managerial accounting, management science, management theory, and computer processing. The MIS concept may be viewed as a substantial extension of the concepts of managerial accounting taking into consideration the ideas and techniques of management science and the behavioral theories of management and decision making. The capabilities of computers have added to the development of the MIS concept because new hardware and software have offered new dimensions to be considered in conceptualizing the information system for an organization.

### Managerial Accounting

It is useful to think of the field of accounting as being divided into two major areas, financial and managerial accounting. Financial accounting is concerned with measurement of income for specific periods such as a month or a year (the income statement) and reporting of financial status at the end of the period (the balance sheet). Since an organization operates continually through time, the measurement of income for a period involves questions of measuring revenues applicable to a period and

identifying and matching the applicable expenses to arrive at a profit. The need for investors to receive this information and for the reports to be relied upon by parties not connected with the accounting process means that the basis for measuring income and financial condition should be as free as possible from personal bias, speculation, and forecasts. The primary set of users for financial accounting results can be thought of as investors outside the firm. As a result, financial accounting has limited usefulness for managerial decision making. Managerial accounting, on the other hand, is concerned with cost behavior and other analysis useful for managerial decisions.

The rise of the large corporations in the late 1800s created a need for an information system larger and more complex than systems designed for the fairly small enterprises existing prior to that time. Early efforts at managerial control concentrated on simple cost accounting and budgeting. The movement to business budgeting and cost control developed strength during the 1920s and 1930s.[2] The simple cost computations of the early 1900s were often found lacking in terms of management decision making. The 1930s and 1940s saw theoretical work related to costs for decision making and the use of decision-making models. Much of this work was from the field of microeconomics (also termed "economies of the firm" or "managerial economics"), but it was through managerial accounting that these conceptual developments were implemented in organizations. The changes resulted in improved cost analysis and in improved reporting methods.

The reporting systems for organizations developed by managerial accountants have generally reflected the idea of responsibility[3] and profitability[4] accounting. In these approaches, each manager receives reports covering his or her responsibility. The report is organized to identify variations from planned performance and the reasons for the variations. Lower-level reports are summarized to provide summary reports to the next level of management, etc., until the top management receives summary reports which identify problem areas and causes, but not in the same detail as for lower-level managers.

Cost analysis is used in managerial accounting to determine the most relevant cost for decision making. Relevant cost may be full cost, direct

[2]The first book on business budgeting did not appear until 1922 (James O. McKinsey, *Budgetary Control*, The Ronald Press Company, New York, 1922).

[3]John A. Higgins, "Responsibility Accounting," *The Arthur Andersen Chronicle*, April 1952.

[4]Robert Byer and Donald J. Trawicki, *Profitability Accounting for Planning and Control*, 2d ed., The Ronald Press Company, New York, 1972.