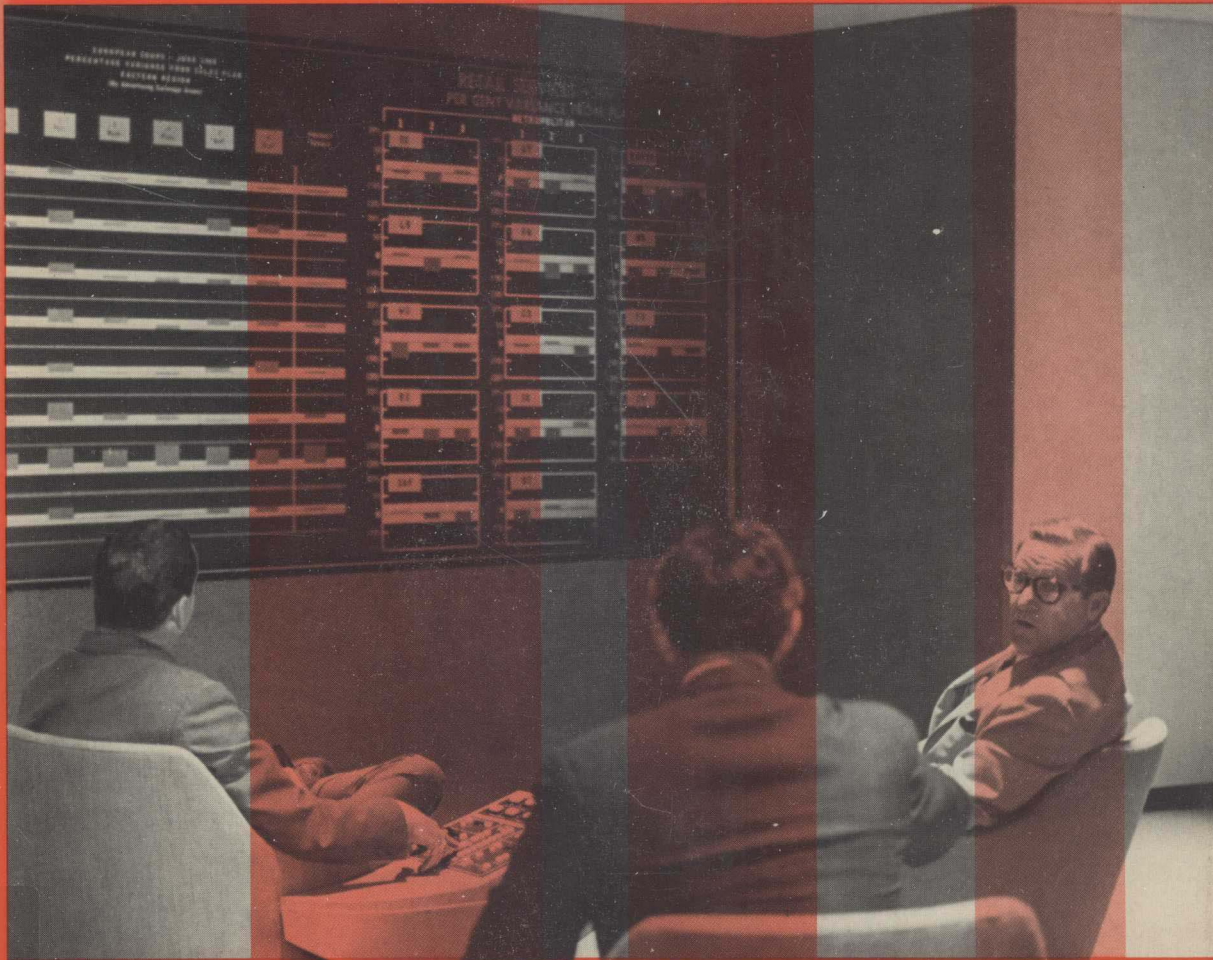


SYSTEMS ANALYSIS AND DESIGN OF REAL-TIME MANAGEMENT INFORMATION SYSTEMS

Robert J. Thierauf



**Combines both the underlying theories
and the practical applications of real-time
management information systems to the day-to-day business needs
of a typical manufacturing company**

ROBERT J. THIERAUF, Ph.D., C.P.A.

Professor of Management

**Chairman, Department of Management
and Information Systems**

**D.J. O'Connor Memorial Professor
in Business Administration**

**Xavier University
Cincinnati, Ohio**

SYSTEMS ANALYSIS AND DESIGN OF REAL-TIME MANAGEMENT INFORMATION SYSTEMS

PRENTICE-HALL, INC., Englewood Cliffs, New Jersey

Library of Congress Cataloging in Publication Data

Thierauf, Robert J

Systems analysis and design of real-time management information systems.

Bibliography: p.

Includes index.

1. Management information systems. 2. System analysis. I. Title.

T58.6.T49 658.4'03 74-28368

ISBN 0-13-881219-5

© 1975

by Prentice-Hall, Inc.

Englewood Cliffs, New Jersey

All rights reserved. No part of this book
may be reproduced in any form or by any means
without permission in writing from the publisher.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia, Pty. Ltd., *Sydney*
Prentice-Hall of Canada, Ltd., *Toronto*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*

**SYSTEMS ANALYSIS
AND DESIGN OF
REAL-TIME
MANAGEMENT
INFORMATION SYSTEMS**

PREFACE

The outpouring of publications on real-time management information systems (MIS) has been unusually large. For the most part, the quality of these publications has left much to be desired. Only recently has worthwhile material on the subject been available. The direction taken in this book is to further the “how-to” knowledge of the academician and the practitioner in the analysis and design of real-time management information systems, particularly those operating in an operations research (OR) or quantitative environment. From this viewpoint, the book is a definitive work on real-time MIS, thereby adding another dimension to the growing body of information available about management information systems.

For the information systems student or journeyman, the purpose of the book is to broaden his expertise in designing real-time management information systems. Rather than talk in general terms, as most books do, about a firm’s major subsystems, the text presents a complete real-time management information system in some detail for a progressive manufacturing firm. Subsystems are analyzed, designed, and evaluated for corporate planning, marketing, research and develop-

ment, engineering, manufacturing, inventory, purchasing, physical distribution, accounting, finance, and personnel functions. Likewise, appropriate management science models are identified and related to each functional area of the firm. Because the book is not burdened with rigorous mathematics, the systems practitioner or student who has little or no knowledge of higher mathematics will experience no difficulty in comprehending the subject matter. The net result of this “nuts and bolts” approach is a comprehensive look at a complete real-time management information system unavailable in any other publication to date.

The text is suitable for an undergraduate or graduate business course covering the fundamentals of information system analysis and design or the fundamentals of management information systems. The material can be used for any time period, i.e., one quarter, two quarters, or one semester. Likewise, the text is designed for use in the field by the management information system specialist who wishes to broaden his perception of integrated and real-time management information systems in a manufacturing firm.

The structure of this book follows a logical sequence for treating comprehensive real-time management information systems. The major areas covered are as follows:

Part I, Introduction to Real-Time Management Information Systems. Chapter 1 briefly surveys various management information systems developed over the years, particularly integrated MIS. The essential characteristics of real-time management information systems are discussed in Chapter 2.

Part II, Feasibility Study Through Systems Implementation of Real-Time Management Information Systems. Chapter 3 concentrates on systems analysis to provide a comprehensive look at a present integrated management information system. In Chapter 4, design considerations for real-time MIS are discussed, with emphasis on designing MIS modules. Equipment selection and systems implementation in a real-time MIS environment are treated in Chapters 5 and 6, respectively.

Part III, Systems Analysis and Design of Real-Time MIS Subsystems. The major subsystems of a complete real-time management information system operating in a manufacturing firm, called the Consumer Products Corporation, are presented in Chapter 7. Chapters 8 through 17 give a thorough analysis (systems analysis) of these MIS subsystems: corporate planning, marketing, research and development, engineering, manufacturing, inventory, purchasing, physical distribution, accounting, finance, and personnel. After exploring real-time MIS design considerations (data base elements, operations research models, and detailed design modules), real-time MIS subsystems and their appropriate modules are designed for the Consumer Products Corporation (systems design).

Part IV, The Future of Management Information Systems. The future thrust of management information systems toward data management and data communications systems is the subject of Chapter 18. Information systems that extend beyond the firm are also explored.

For an undertaking of this magnitude, I want to thank those who read the original manuscript and contributed helpful suggestions. I am deeply indebted to the following individuals and their firms (currently undertaking the implementation

of some aspect of real-time management information systems): William F. Carpenter, Procter and Gamble; Richard Curless, Cincinnati Milacron; Michael C. Drewes, Regional Computer Center, Cincinnati; Michael J. Free, Western Electric Company; Thomas R. Gilligan, Cincinnati Bell, Inc.; James Goughenour, Cooper Industries; Edward Hammann, General Electric, Evendale; Richard Hughenbug, Stearns and Foster; Donna Krabbe, Office of Solid Waste Programs, Environmental Protection Agency; G. A. Lasson, Industrial Nucleonics Corporation; David R. Meade, Management Horizon Corporation; F. W. Sweet, Merrell-National Laboratories; William Thiel, Cincinnati Milacron; David Tietsort, Champion International; Claude von den Broeck, Procter and Gamble; and Jacqueline Wyatt, Management Information Division, Department of Public Welfare, State of Ohio. I am also grateful to Michael Hendren of the Honeywell Information Systems, Neil G. Segars of the UNIVAC Division (Sperry Rand Corporation), and Frank B. Smith of the International Business Machines Corporation as well as Charles H. Kriebel of the Carnegie-Mellon University and Daniel J. Couger of the University of Arizona for their constructive comments. Finally, I would like to thank the following professors at Xavier University who offered their assistance: Daniel Geeding, John Niehaus, and J. Michael Thierauf.

ROBERT J. THIERAUF

CONTENTS

Preface

part one

INTRODUCTION TO REAL-TIME MANAGEMENT INFORMATION SYSTEMS 1

1

Systems Prior to Real-Time Management Information Systems 3

2

Real-Time Management Information Systems 35

Operations Research Models: Appendix to Chapter 2 68

part two

**FEASIBILITY STUDY THROUGH SYSTEMS IMPLEMENTATION OF
REAL-TIME MANAGEMENT INFORMATION SYSTEMS**

77

3**Systems Analysis of Real-Time Management Information Systems 79****4****Systems Design of Real-Time Management Information Systems 118****5****Equipment Selection for Real-Time
Management Information Systems 157****6****Systems Implementation of Real-Time
Management Information Systems 203**

part three

SYSTEMS ANALYSIS AND DESIGN OF REAL-TIME MIS SUBSYSTEMS

229

7**Major Subsystems of a Real-Time Management Information System:
Consumer Products Corporation 231****8****Real-Time MIS Corporate Planning Subsystem 262****9****Real-Time MIS Marketing Subsystem 291****10****Real-Time MIS Research and Development Subsystem
and Engineering Subsystem 324****11****Real-Time MIS Manufacturing Subsystem 353****12****Real-Time MIS Inventory Subsystem 397****13****Real-Time MIS Purchasing Subsystem 420****14****Real-Time MIS Physical Distribution Subsystem 446**

15	
Real-Time MIS Accounting Subsystem	472
16	
Real-Time MIS Finance Subsystem	504
17	
Real-Time MIS Personnel Subsystem	531
part four	
THE FUTURE OF MANAGEMENT INFORMATION SYSTEMS	555
18	
Future MIS—Data-Managed Systems	557
APPENDICES	
A	
Simulation	584
B	
Exponential Smoothing	585
C	
Pricing Model (Differentiation)	588
D	
PERT/Cost	591
E	
Linear Programming (Simplex Method)	593
F	
Markov Analysis	595
G	
Bibliography	597
Index	600

part one

INTRODUCTION TO REAL-TIME MANAGEMENT INFORMATION SYSTEMS

RELATIONSHIP OF SYSTEM TO INFORMATION
SIGNIFICANCE OF INFORMATION
THE NEED FOR INFORMATION SYSTEMS
BASIC COMPUTER DATA PROCESSING SYSTEMS
 BATCH PROCESSING
 BATCH PROCESSING MODE
 REAL-TIME PROCESSING
 REAL-TIME PROCESSING MODE
BASIC COMPUTER DATA PROCESSING SUBSYSTEMS
 HIERARCHY OF SUBSYSTEMS
UNDERLYING CONCEPTS OF COMPUTER DATA PROCESSING SYSTEMS
 THE TOTAL SYSTEMS CONCEPT
 THE MANAGEMENT INFORMATION SYSTEMS CONCEPT
 THE MODULAR SYSTEMS CONCEPT
SYSTEM DEVELOPMENTS DURING THREE COMPUTER DECADES
 FIRST COMPUTER DECADE (1952-1961)
 SECOND COMPUTER DECADE (1962-1971)
 THIRD COMPUTER DECADE (1972-1981)
DATA PROCESSING SYSTEMS PRIOR TO REAL-TIME MIS
 CUSTODIAL ACCOUNTING SYSTEMS
 RESPONSIBILITY REPORTING SYSTEMS
 INTEGRATED DATA PROCESSING SYSTEMS
 INTEGRATED MANAGEMENT INFORMATION SYSTEMS
SUMMARY

SYSTEMS PRIOR TO REAL-TIME MANAGEMENT INFORMATION SYSTEMS



An in-depth examination of any business system reveals some type of management information being generated. In a sole proprietorship or a small partnership, the management information system is very simple, with the bulk of the information transmitted orally. As the organization becomes larger and more complex, the information system is more formal and its output probably consists of written records and written reports, manually prepared. The next higher system level may utilize calculators, bookkeeping machines, and punched card equipment to process information for controlling the business. In a still larger firm, a computer or computers of varying speeds and types are employed for handling the desired information. In a very large firm, a large-scale computer system, possibly assisted by other computers, is connected to remote field offices, plants, and headquarters by data communication equipment. At this high level of computer sophistication, the information system operating cost is high, running into the millions of dollars annually.

Within this chapter, the need for computer information systems, the under-

lying concepts of information systems, and appropriate information system developments prior to real-time management information systems (MIS) are explored. Emphasis will be placed on custodial accounting, responsibility reporting, integrated data processing, and integrated management information systems. This orderly study of information systems evolution serves to place current and future MIS developments in their proper perspective.

RELATIONSHIP OF SYSTEM TO INFORMATION

Before discussing the need for information systems, it would be helpful to review the meanings of some basic terms—*data*, *information*, and *system*. The term *data* (plural of datum) is defined as unstructured facts, forming the necessary inputs to an information system. On the other hand, *information* is defined as selected data that represent output from a system and are meaningful to the user of that output. In simple terms, then, the function of the system is the transformation of data to information. As noted in Figure 1-1, a *system* is defined as an ordered set of methods, procedures, and resources designed to facilitate the achievement of an objective or objectives. This very general and simplistic definition also applies to management information systems.

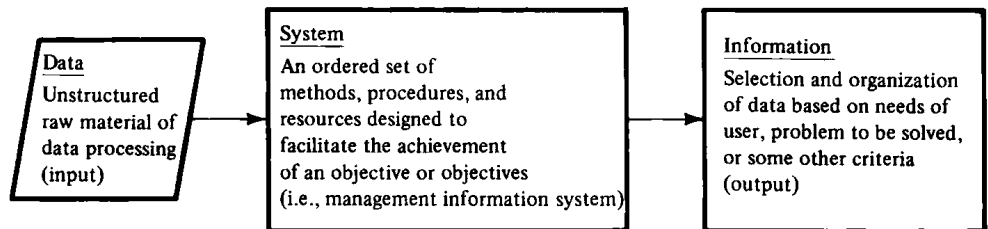


FIGURE 1-1. An effective system (i.e., management information system) stores, organizes, and retrieves the required data to produce meaningful information.

SIGNIFICANCE OF INFORMATION

Information, the logical output of an information system (Figure 1-1), is of vital importance to the managers of a firm to achieve short-, intermediate-, and long-range goals. Management needs a fairly accurate measurement of its sales and cost factors for various time periods. It must maximize its income through higher selling prices and/or larger inventory turnover, and minimize costs of products and services. In short, management wants a combination of selling prices, turnover, costs, and profit per unit that will provide the highest return on invested capital. Given adequate information on these essential facts, management can rely more on deductive and analytical methods than on guesses and intuitive judgment, which it must employ when many of the relevant facts are missing. Many wrong decisions have been the result of insufficient or inadequately processed information.

There is a growing awareness that accurate and timely information is a vital resource of the firm and that an effective information system is a means of providing the needed information. Many top managers are finding that information is a source of competitive power. It gives them the ability to out-manuever their rivals at critical times, especially when introducing new products. If the data processing system does not have the information necessary for management to handle its operations effectively, an “out-of-control” condition may result and the firm may never recover. An examination of firms that have experienced difficult times over the years will verify this point.

THE NEED FOR INFORMATION SYSTEMS

The need for effective information systems is of paramount concern to the firm now, as well as in the future. Because the firm does not operate in a vacuum, it must coordinate its operations with the business universe. Of prime importance is information about markets in which the firm operates, current knowledge of its customers and competitors, availability of capital, capabilities of available personnel, and knowledge concerning sources of supply. Increasing prices of purchased materials, rising labor costs, and foreign competition signal the need for an information system that describes the firm’s economic environment and coordinates the external environment with the internal factors to provide meaningful management information (Figure 1-2).

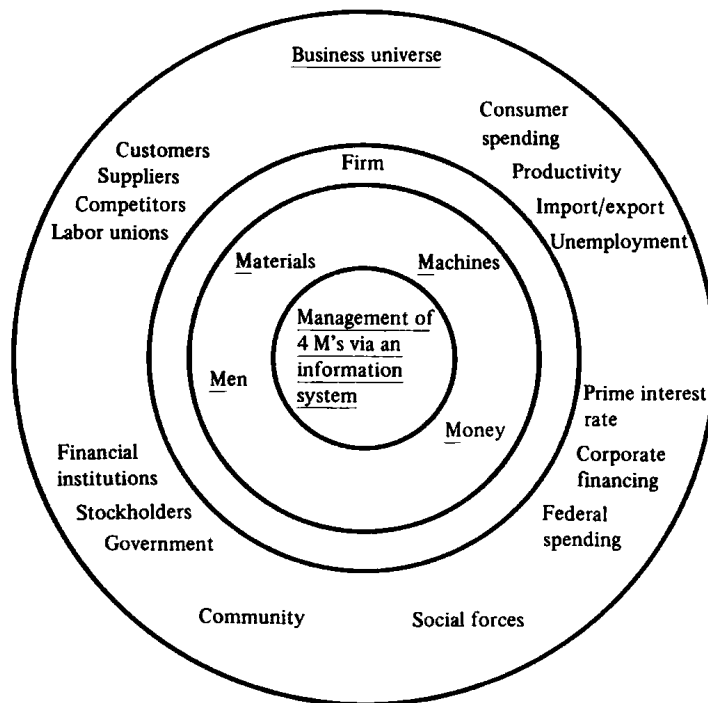


FIGURE 1-2. The relationship of the internal and external factors to the firm's information system.

The information system, in addition to recognizing trends external to the firm, must treat changes that have occurred and will yet occur in the internal business environment. Advancements in the behavioral sciences, continuing developments in management science, and increasing utilization of paperless computer output terminals must be reflected in the design of the information system. Interdepartmental approaches have transcended the traditional, functional lines of business in complex systems. Still other system technology developments have occurred regarding methods, procedures, computer equipment, and data communications equipment. By no means is this listing of internal factors complete, but it does serve to exemplify what is causing the firm's information system to change.

The changes taking place within and outside the firm generally do not stand alone; each advancement tends to effect and overlap another development. As a result, there is a need for management information systems capable of integrating these advances with the needs and capabilities of the firm. It is a generally accepted notion that more frequent and more accurate information leads to better decisions, thereby enhancing operational efficiency.

BASIC COMPUTER DATA PROCESSING SYSTEMS

Management information systems, like many other data processing systems, can be characterized as two basic types:

- batch processing
- real-time processing

Under the first approach, transactions are accumulated into batches and the batches are processed periodically. The transactions in a batch may be in sequential or random order (explained below). Using the on-line real-time processing approach (often abbreviated OLRT), records are stored on line and updated as the transactions occur. The term *on line* refers to the fact that input/output devices, data files, and comparable equipment are connected to a computer in such a way that a transaction may be entered at once or information may be retrieved relatively quickly at any time. The concept of *real time* means that information may be retrieved in sufficient time to control the operating environment. When comparison is made between these two basic computer data processing systems in an MIS environment, the requirements for processing on-line data in real time are found to be considerably different from those used in a batch processing mode.

Peripheral file storage devices attached to computer systems can be of two types:

- sequential access
- direct (random) access

In sequential access files, the data are stored in some predetermined order. Before a record can be read, all preceding records must first be read, as in magnetic tape

files. When operating with direct or random access file equipment, it is possible to locate and read any record without having to read others first. On-line computer devices that have this latter ability are magnetic drums, magnetic disks, magnetic strips, and magnetic cards.

BATCH PROCESSING

The batch processing approach to MIS is characterized by the periodic processing of transactions accumulated into batches over a period of time. Normally the accumulated transactions must be sorted into a desired order, and there must generally be a sufficient number of transactions accumulated before it is economically feasible to process the data further. Batch processing is normally associated with records that are maintained on punched cards, magnetic tape, magnetic disk, or bulk core.

Sequential Access Files

In a sequential access system, the entire master file is read and written each time transactions are processed against the master file. This updating procedure requires sorting all input data (i.e., transactions) in the same sequence that is in the master file (Figure 1-3). Batch processing with sequential access file storage is ideally suited for payroll and accounts-payable applications. It usually costs less (per transaction) to process batches than to process each transaction, as it occurs,

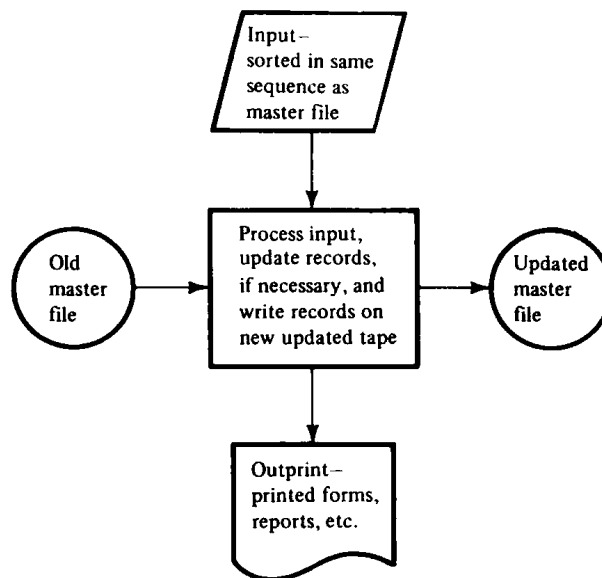


FIGURE 1-3. Batch processing with sequential access file storage--magnetic tape.