Gregory and Van Horn

AUTOMATIC DATA-PROCESSING SYSTEMS

Principles and Procedures

second edition

Robert H. Gregory
Richard L. Van Horn

Automatic Data-Processing Systems

Principles and Procedures

SECOND EDITION

Chatto and Windus Limited
London

 Printed in the United States of America

Automatic Data-Processing Systems

Principles and Procedures

SECOND EDITION

Wadsworth Accounting and Data-Processing Series
Robert H. Gregory, Editor

FEDERAL INCOME TAX FUNDAMENTALS
William E. Dickerson and Leo D. Stone

AUTOMATIC DATA-PROCESSING SYSTEMS, Second Edition
Robert H. Gregory and Richard L. Van Horn

BUSINESS DATA PROCESSING AND PROGRAMMING
Robert H. Gregory and Richard L. Van Horn

IBM MACHINE OPERATION AND WIRING
Lawrence J. Salmon

PREPARING FOR THE CPA EXAMINATION, Volumes 1 and 2
Robert J. Smith

USING ACCOUNTING IN BUSINESS
Robert H. Van Voorhis, Clarence L. Dunn, and Fritz A. McCameron

Preface

Automatic Data-Processing Systems: Principles and Procedures is an introduction to business data processing and does not require previous knowledge of electronic computing systems. Processor programming and systems analysis are covered in detail. New developments in these areas and new tools and techniques for management information are discussed. The book attempts to blend a theoretical with a practical approach in order to explain the *why,* as well as the *what* and *how,* of data processing.

In the short time since the development of the first electronic computer in 1947, more than 12,000 electronic computers of various sizes have been built for business, engineering, and scientific purposes. However, despite the great advances in processor technology, electronic processors have not yet made business management a "push-button" process, nor are they likely to do so in the near future. In order to successfully apply automatic data-processing systems to business problems, it is necessary to have imaginative and analytical thinkers in systems analysis and design, programming, operations, and management. For, since these systems are capable of producing such vast amounts of information, management may find itself lost in a morass of detail unless the systems are effectively controlled.

At the heart of this book is a distinction between information and data: the information that management wants must be distilled from data. Although the concept is simple, the problems of putting it to work are often complex. Information must be defined and measured before a system can be designed that will automatically produce more informative reports. And the value of such a system cannot be measured merely by its technical virtuosity; the costs of designing a superior processing system must be compared to the value obtained by having the improved information that is produced.

Systems analysis and design in Chapters 6 and 7 include two new

features: information-flow analysis and decision tables. Unlike traditional systems-analysis work aimed at a single application, information flow analysis analyzes the flow of data about an *event* from its origin, through files, to output. This *event-chain* approach opens up the opportunity to use processors for analyzing the *actual flow* of data in an existing system and the *planned flow* in a proposed system. Thus it is both a systems-analysis and a systems-design technique at the data-flow level.

Decision tables are used to relate conditions and actions in a tabular form for the various rules that are applicable. Decision tables facilitate careful statement of conditions and actions, aid in developing correct and complete program logic, point up ambiguities and inconsistencies, and serve as a documentation device. Tables are a promising alternative to detailed flow-charting in both the design and programming-coding phases of systems development.

Programming is treated in this book in both problem-oriented and machine-oriented languages. COBOL-1, a simplified version of COBOL-61 (Common Business Oriented Language, 1961 edition), is covered first to bring out the fundamentals of processing business files. COBOL-1 is presented with the intricacies and options of COBOL-61 stripped away. It is more important, we think, to develop the concepts and drive home the fundamental points than it is to give encyclopedic but hasty sketches of the numerous features of programming. The coverage of COBOL-1 in Chapters 8 and 9 introduces many features of problem-oriented languages. COBOL-1 is a real programming language, compatible with COBOL-61. Instructions for compiling and running COBOL-1 programs on one processor serve as a guide for compiling and running programs on other processors. COBOL-1 programs can be run on any processor for which the manufacturer has prepared a COBOL-61 compiler.

Programming in machine-oriented language, covered in Chapters 10 and 11, is discussed in terms of a fixed-word-length processor, WORDCOM, which is representative of this widely used class of machines. FIELDCOM, a "field" or variable-word-length machine, is also covered to show the features of this class of machines. COBOL-1, WORDCOM, and FIELDCOM programming are covered at the introductory level to offer the reader some choice of where he wants to start. The sequence used here, and the one we recommend, is to study COBOL-1 first in order to learn programming fundamentals with the fewest embellishments. Then the

reader is ready, we think, to go to the machine-oriented languages of WORDCOM and FIELDCOM.

Although this book is written for those who are new to systems work, it is also intended for those experienced with electronic data processing and, therefore, it can be used in several ways. The reader may find the detailed summaries at the end of each chapter helpful in setting up his own reading program. Readers familiar with equipment and programming can profitably begin with Part V (Principles of Processing Systems). Management personnel might read Parts III (Systems Design), V, and VI (Equipment Acquisition and Utilization), since these sections discuss how to make informed decisions on systems design, proposed applications, and equipment selection. Systems analysts experienced in other processing methods may want to start with Part V; they may then find the earlier sections on equipment and processing more useful. Parts III and VI are especially appropriate for analysts because they deal with the effect of new processing techniques on systems analysis. At some point, and perhaps at the beginning, most readers will want to study Parts II (Automatic Equipment) and IV (Programming and Processing Procedures).

Automatic Data-Processing Systems is designed as a full semester or one-year text for a basic course. Appendix I contains numerous questions and problems (graduated in difficulty) designed to emphasize the important points in the chapter and to encourage methodical thinking about the problems of data-information systems. Appendix II is a glossary of terms common to the field of electronic data processing; it includes all terms given a new meaning in this book. Appendix III is a brief guide to literature useful in the field of business data-processing systems.

The idea for this text was suggested by members of the Office, Chief of Ordnance, U. S. Army Ordnance Corps, which supported the preparation of an earlier text for its own educational purposes; this version led to the first edition of *Automatic Data-Processing Systems*. We are indebted to Herbert Bryer for the basic tables in Chapter 5, to O. T. Gatto for the material on AUTOSATE in Chapter 6, and to Solomon Pollack for the material on DETAB-X in Chapter 7 and for many helpful suggestions. We owe much to our many friends and colleagues who have, in one way or another, contributed to this volume and especially to our readers and friendly critics in universities, government, and business: Arthur Carlson, Edward Chappelear, Richard W. Conway, James Gibbons, Howard C. Holland, Elmer F. Judge, and Robert Schlosser. We are also

grateful to Mary Cole, who guided the book through typing and cheerfully did much of the work, and to our illustrator, Willard Harriss.

Robert H. Gregory
Richard L. Van Horn

Contents

III
SYSTEMS DESIGN

IV
PROGRAMMING AND PROCESSING PROCEDURES

PART I
ORIENTATION

1

The Why and How of Business Data Processing

Substantial changes in business activity during recent years have encouraged the creation of new data-processing systems. Conversely, changes in data-processing equipment and methods are suggesting new methods of doing business. Electronic data processing, operations research, and other new scientific and engineering developments are fast becoming a part of common business practice. And it is probable that data-processing and management-control methods will change more rapidly during the next decade than they have in recent years.

This progress will not make manual data processing and conventional control techniques completely obsolete, but it will make knowledge of automatic data processing invaluable for business managers, data-processing personnel, and systems and procedures analysts. All people who rely on facts for performing or managing business operations—people who need facts for answering questions and making reports—have a vital interest in the origination and processing of data.

WHY PROCESS DATA?

Data about business events are gathered, stored, processed, and reported for various reasons. Some of the more important reasons are to keep detailed *facts* about individual transactions; to produce routine *operating documents,* such as paychecks and purchase orders; to summarize masses of facts into useful, *informative reports,* such as reports on sales in given areas and on costs of production; and to make *analyses* of business problems, such as finding locations for factories and warehouses that will give minimum transportation costs.

Data Availability

Facts are the raw material of data processing. Initially, the collection of facts may be restricted to the minimum immediately required; but supplemental facts are often obtained at first in order to anticipate probable or possible demands for them in the future.

Often the solution of a problem has to be postponed until necessary facts are obtained. An efficient scheme for obtaining facts depends on balancing the *cost* of having them available—either too many or too few—against the *benefits* of having the necessary facts when they are wanted. The point is that it is usually impossible to obtain just the right set of facts about events "today." One must choose between trying to search out and reconstruct facts about yesterday, or waiting for tomorrow and gathering facts about events as they occur.

Document Production

The preparation of readable documents is an important phase of data processing. Documents are still a common means of communication among companies, and they are widely used within companies that have manual data-processing systems.

Where data collection is done by people and the output from processing goes to people, it is usually taken for granted that readable documents are required. This need is reduced, or even eliminated, when equipment is used for gathering and processing data. The output of machines at one stage—whether punched tape, cards, magnetic tape, or machine-readable printed characters—can be used as input at the next stage of processing, in either the same or a different company. The use of readable documents is sometimes restricted to small-volume operations where mechanization at the next stage is not feasible. Readable documents that are distributed to a wide audience—bills to customers and reports to managers—will continue to be used for many years.

Management Information

An important reason for developing elaborate data-processing schemes is to supply the management organization with the critical facts needed to control operations. The word *data* might be used to cover *all* the facts obtained; the term *information* is useful for denoting the *particular* facts management wants to know.

Although information derives from raw data, information has certain qualities that can serve as a guide in processing data. A

manager in a company is interested in getting facts about operations he is responsible for. He wants these facts to be accurate, timely, and related to problems he can solve by his decisions. Furthermore, he is more interested in learning about unpredictable than about predictable developments. He has no need to be told repeatedly something he already knows. In short, the information given him should be accurate, have an element of newness or novelty about it, focus on a selected area, and deal with the unexpected.

Some examples will help distinguish *data* from *information*. Newspapers are bought for information. Someone who feels that a particular issue has little news to offer, either because so little is happening or because too many other editions are published, will not buy it. To stimulate their sluggish circulation, newspapers often try to create an air of bright novelty around the humdrum, or revive interest in old mysteries; the Loch Ness monster, for instance, is said to be a summertime phenomenon that obligingly reappears for the benefit of Scottish newspapers. Likewise, reports to management about unexpected or undesirable events, such as the costs of production jobs exceeding their standard, select and emphasize items to increase the reader's attention. The costs of jobs not exceeding standard may be included in reports for completeness or omitted for brevity, according to the reader's immediate interests or his needs for later reference to the whole picture.

The difference between a mass of facts and a few critical facts is illustrated by the plight of a businessman who furnished 1350 pounds of records to a tax collector. He was brought to court by the collector, who wanted five additional books, weighing only 10 or 20 pounds, that he considered critical. Every day businessmen are given pounds of reports when they want only a few critical facts. Managers do not really care about source reports, documents, and data, however useful they may be elsewhere in the organization.

The nature of information can be described, but it is difficult to measure information itself as a quantity. Whether a new system will produce better information than the old system did is difficult to determine, and will be even after the new system is introduced. Information production and the related areas of management control, including automatic decision-making, are challenging and profitable areas of study.

HOW DATA ARE PROCESSED

The basic functions of processing data are well established. Managers and operating personnel in business, government, and

other enterprises have long been accustomed to processing data to obtain facts about operations and information for their control.

The basic operations in processing data are (1) to originate data, (2) to manipulate, according to some plan, the new data and files prepared in an earlier cycle, and (3) to report results.

Origination of Data

The origination of data in a form suitable for processing includes three necessary stages—collection, conversion, and verification.

Data Collection. Data collection captures facts when they are available; they may be processed later, when needed. For example, the time an employee starts or stops work on a particular job may be recorded in *writing* by a timekeeper, *stamped* in numerals by a time clock, or *punched* into a card. A storekeeper identifies and counts any material received in the stockroom in order to write a receiving report. Requisitions for material, on the other hand, specify desired quantities and serve as the original records of issuance. Employees of utility companies record customer meter readings by marking cards that are later run through equipment that "senses" the marks and punches them.

Data collection often starts with the *manual operation* of keyboards that punch cards or paper tape, or that record data on magnetic tape. Several devices recently developed for business use are capable of automatically collecting data in *machine-processable* form, though one class of these devices yields data in a machine-processable form that people cannot read. Examples of devices producing machine-readable media are point-of-sale recorders, transaction recorders, and time clocks that punch tape or cards. Another class of automatic data-collection devices produces numerals and letters on paper or cards in a form readable by both machines and people. Character-reading machines "read" the characters and convert them to a form suitable for automatic processing.

Other important techniques for data collection are pre-preparation of constant data, by-product preparation as a part of other operations, and duplication from card, plastic, or metal plates. A simple time clock records the basic facts for a transaction; a more complex clock might record all the facts—worker, time, job involved, and units produced—and thereby deserve the name "automatic transaction recorder."

New input data may be only a small part of the total data han-