THIRD EDITION

AUTOMATIC DATA PROCESSING

PRINCIPLES AND PROCEDURES

ELIAS M. AWAD

and

DATA PROCESSING MANAGEMENT ASSOCIATION

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

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Preface

Over the past two decades, computers have established a permanent place in business, government, and education. Their accelerated growth points out man's acceptance of the computer's role and his dependence on its capability to perform various tasks. Since the second edition of Automatic Data Processing was published in 1970, hundreds of business organizations have made commitments to new systems and a greater number of applications have been developed for special and general-purpose jobs. The "computers of the seventies" offer the user greater processing speed and versatility, and unique interactive features which allow him to "converse" with the system when needed.

This edition was prepared to reflect these and other developments. Like the previous two editions, it maintains lucidity, makes adequate use of illustrations, and presents a comprehensive coverage of the field. Among the key features of this revision are:

1. The addition of three chapters (9, 10, and 19) on Direct Data Entry Devices, Data Communication, and BASIC Programming.
2. A new approach in chapter 4 to the capabilities and elements of computer systems, chapter 5 on data representation, and chapter 26 on career opportunities and management's role.
3. Deletion of four chapters on punched card data processing. A two-page summary is presented in chapter 3.
4. A reworking of chapter 7, dealing with input preparation and entry, involving the use of the 80-column and 96-column card and their respective key punches.
5. Additional material in chapter 8 on input and output devices, including a section on computer-output microfilm.
6. A major update of chapter 11 on representative computer systems to include a section on minicomputer systems, brief coverage of IBM's system 3/ models 6 and 7 series, and an overview of the IBM 370 and the Burroughs 700 computer series.
7. Expansion of chapter 14 (control and the stored program) to include a section on operating systems and chapter 24 to cover the data-base concept.

8. Inclusion of Appendix C, presenting the current requirements for the Certificate in Data Processing.

This text is designed for use in an introductory one- or two-term course in data processing. Prior background in mathematics or experience in computer operation is not required, nor is the purchase or lease of computer equipment necessary to understand the topics covered in this edition. Instructors seeking additional supplementary material may wish to consider the workbook, *Problems and Exercises in Automatic Data Processing* written by Awad and DPMA or *Issues and Concepts in Computer Processing* (text-reader) by Awad. Details on the latter publication may be provided through the publisher upon request.

The authors are indebted to many individuals and organizations who directly or indirectly contributed to the preparation of this edition. Our thanks to Mr. William J. Horne, President of Spiras Systems Inc. for sharing the burden of editing and proofreading of the manuscript; to Jim Campise, consultant, Professor Joel W. Darrow, Pace College, and Dr. Melvin Morganstein, Nassau Community College, for their professional review and constructive comments that contributed to the final version of the revision; and to Donald J. MacPherson, Education Director, DPMA, for his instrumental role in securing technical literature and photographs from computer organizations and for his continuous support throughout the revision's preparation.

We also thank the computer manufacturers for permission to reproduce photographs of their systems and devices and for use of technical data to support this text.

Of the Prentice-Hall staff, we are especially indebted to Frederic K. Easter, Jr., Assistant Vice President, for activating the initial spark that culminated in the preparation of this edition and for his continued professional counsel on various aspects of the text; to Burton Gabriel, the computer series editor, for his encouragement and invaluable service in coordinating the details involved in the creation of a book of this magnitude; to Fred Dahl and Jim Bacci, production editors, for supervising the editorial and production work; and Pam Wilder and Barbara Cassel for their production assistance.

Elias M. Awad
and
Data Processing Management Association

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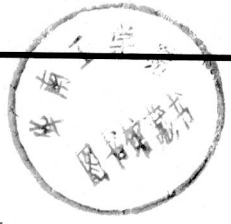

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DEVELOPMENTS IN DATA PROCESSING

The Development and Uses of Computers

THE PREAUTOMATED DATA-PROCESSING ERA

An Era of Transition

THE NEED FOR AND THE COST OF KEEPING BUSINESS RECORDS

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THE USES OF COMPUTERS

Basic Record-Keeping Applications

Payroll
Inventory Accounting
Production Scheduling
Customer Billing

Management Decision Making

Simulation
Linear Programming
Project Management
Management Games
Information Storage and Retrieval

The Management Information System
Education—Computer-Assisted Instruction
Medicine
Computer-Aided Design
Electronic Guidance and Process Control

Process Control System
Manned Space Flights

THE RAPID PACE of technological advances today makes it difficult to recognize that man's development toward progressively higher standards of living has been relatively slow and sometimes painful. It took man countless years just to learn how to use animals for transporting goods. Although the discovery of the wheel was revolutionary, it was many years before man applied his discovery to wagons and bicycles. Decades elapsed between his discovery of the use of steam as a source of power and its eventual use in propelling machinery.

As man discovered new ways to harness the forces of nature to aid him in his work, his ingenuity for devising adaptations of these basic discoveries also increased. Thus the step from the first airplane flight to the development of the jet airplane is shorter than the one from "foot power" to "animal power." Once the principles behind jet flight were understood and applied, the transition to manned space flights was imminent. In fact, man has become so ingenious and imaginative in his inventive powers that it sometimes seems as if "miracles" can be performed overnight. This progress is especially evident in the field of automation—the use of mechanical devices to perform routine tasks with minimum human assistance.

Data processing—whether manual or automatic, business or scientific—involves collecting, recording, and manipulating the necessary information to achieve a given result. It is a means to an end, not an end in itself.

THE PREAUTOMATED DATA-PROCESSING ERA

There always has been a need for man to "calculate." In early times, he had to count his family, his flock, and the number of his enemies. As a farmer or a breeder, he found it necessary to keep track of the seasons, and therefore he developed a calendar. Tying knots in thongs or cutting notches in sticks helped him keep track of such data.

In the early days of banking, notches in a stick were used to keep the borrower and the banker honest. The notches represented the amount of the loan, and the stick was cut in half lengthwise through the notches. The bank kept half the stick and the borrower held the matching half. The half held by the banker was known as the "stock"; hence, the banker became known as the "stockholder.' Other early calculations were recorded by making scratches in the dust.

Although notches in sticks and straight-line scratches in clay tablets were adequate for man's early needs, it later became necessary for him to create written numerals. Greek and Roman numerals served the purpose of representing numbers but were cumbersome. It was not until Hindu and Arabic numerals were invented that man had a truly workable system of written numbers.

Each number system had its own symbols, beginning with "zero" and progressing through "nine." The use of digits made it possible to use the "decimal place" system, in which the position of a given digit indicated its value (that is, ones, tens, hundreds, thousands, and so on).

So we can see that man was forced to create better calculating devices as his paperwork expanded. In Charles Dickens' story *A Christmas Carol,* Bob Cratchit is pictured sitting on a high stool working on Mr. Scrooge's books. At that period in history, this was the approved method of calculating and recording. It is quite a contrast to today's bookkeeper, who has adding machines, calculators, and other devices at his disposal. The "green-eyeshade" bookkeeper is almost a thing of the past.

An Era of Transition

During the late nineteenth and the early twentieth centuries, man progressed beyond these primitive methods of data recording and processing. He was forced to find better ways of doing things because business was expanding, demand for better products was increasing, and consequently the recording, reporting, and manipulation of data began to present a greater problem. Business went through a transition from the one-man firm, where records were negligible and the need for recording data was slight, to firms owned by many people, employing many hundreds or thousands of workers. It became necessary to maintain an endless variety of business records involving the sale of goods, the receipt and disbursement of cash, and the periodical preparation of payroll. These and other functions, then, revealed a need for a gradual transition from the use of relatively inadequate tools to a more efficient system; and this need resulted in the utilization of the automatic data-processing system.

THE NEED FOR AND THE COST OF KEEPING BUSINESS RECORDS

If we analyze the needs of a business firm for obtaining accurate and adequate information, we find several areas of business activity that must be controlled. Just as an early shepherd had to keep track of the sheep in his flock, a businessman must keep track of the things he owns. This is known as keeping an inventory. When a businessman's inventory falls below a safe minimum, he must know how many units to reorder and how long it will take to replace his stock, so that he may continue to carry on his business activities without interruption.

Large or small, a business firm needs records. An automobile is equipped with an oil pressure gauge to indicate whether the engine is receiving proper lubrication. Without this device, it is likely that the driver would be unaware of a lubrication failure until serious trouble developed. Likewise, a business firm needs "gauges" to determine its operating performance. These "gauges" of business are its accounting records.

Payroll must be prepared regularly. This process involves the preparation of a paycheck for each employee, as well as the maintenance of information regarding his earnings and deductions for the year. The firm must have ready cash to pay creditors, such as suppliers, the landlord or mortgage holder, and the advertising agency.

All accounts-receivable and accounts-payable information must be recorded. City, state, and federal governments require more records and reports from business firms each year. These reports and others of a similar nature must be prepared, and numerous workers often are required to get the job done.

In relation to the total number of workers in a firm, the number of clerical employees is quite high. Clerical requirements have continued to grow each year, creating higher costs of doing business. A higher and higher percentage of a firm's capital and personnel is required for recording, classifying, summarizing, and filing masses of vital business data. If it were possible to total the annual cost of creating and maintaining business records, the sum would be staggering.

To keep these costs down, business firms are always looking for better and cheaper methods of keeping their records. Economy is not the only factor to consider, however. Speed is equally important. Timing is critical in decision making, and to aid the executive in arriving at a decision, business data must be available as soon as possible. Management may speed up the processing of business data by increasing the clerical force, of course, but this would only mean increased clerical costs.

Not only are the volume of data and the need for data increasing, but as businesses become more complex, the distance between a manager and the activity he is to control is also increasing. When the manager becomes farther removed from operations, decisions that previously could be made on the basis of personal knowledge and experience must now be based on "second-hand" information. It is important, then, that this information be accurate and on time to be of use. Effective management control requires the "feedback" of information in time to affect important decisions. If infor-

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