SYSTEMS ANALYSIS FOR BUSINESS DATA PROCESSING

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REVISED EDITION

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PREFACE

The usage of computers, in all their variants, now permeates all aspects of commercial, industrial, and administrative procedures. No company or government department–local or national–is unaffected by this development; and significant numbers of these organizations are totally dependent upon the power of the computer for their continuing operation. The past decade has seen data transmission become amalgamated with computer-based data processing, with the result that the computer industry has become more correctly identified as the communications industry.

This revised edition is intended for prospective systems analysts and students of systems analysis and data processing. With the latter in mind, problems have been added at the end of each chapter together with suggested solutions. These are intended not only as intellectual exercises but also as supplementary information about the pertinent topics. The reader is therefore advised to study each problem and its solution, even if he is disinclined to attempt the problems for intellectual motives.

It is preferable for the reader to have had either a few years of experience of business methodology or some previous education in that field. Those persons coming completely fresh to the subject are advised to acquire a basic knowledge of accountancy and computer hardware and software before tackling this text.

Accountants and business managers wishing to understand data processing and systems analysis will find sufficient information to meet their needs; for these people, the more technical aspects in Chapters 5 to 8 can be omitted.

University and college students reading business studies and computer science will find that this book contributes considerable material to their courses. Preferably, this text should be studied in conjunction with the case studies from the companion volume, *Data Processing Systems Design.*

Computer programmers who wish to become systems analysts will have no difficulty in merging the information herein with their existing knowledge.

Every effort has been made to eliminate unnecessary technical jargon from the text, and increasing emphasis has been placed on financial and human considerations. The terminology employed is, for the most part, that already encountered by United States computer users.

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CONTENTS

CHAPTER 1

INTRODUCTION

1.1 MEANING AND SIGNIFICANCE OF DATA PROCESSING

An absolutely watertight definition of the term "data processing" is a somewhat ambitious and difficult aim in today's rapidly changing world. We can, however, regard data processing as being the means of obtaining control of business and administration through the provision of timely information of a high quality. Hence, as an alternative, we could refer to "Business Information Systems" because this name in many ways is more meaningful as applied to this subject.

Data can be regarded as being raw facts that are in some way recordable and from which useful inferences can be eventually drawn. Within the general framework of business, the word "data" pertains to the identification and measurement of objects, events, and people. Therefore, it is apparent that data is created continuously by all types of business activity and, in fact, by life in general.

The word "processing" refers to any series of actions and operations that enables useful information to be distilled and extracted from raw data. The implication here is that the latter is not in itself useful. This is true to the extent that raw data does not normally provide sufficient information to initiate direct action. When data is processed, the outcome is information upon which decisions regarding future activities and policies can be based.

What is it, then, that makes data processing so new or so different? When all is said and done, data has been around for a long time, and man has been using it to make inferences ever since his evolution as an intelligent thinker. Men also provided themselves with usable information long before the advent of electronic machines. Since accounts clerks, corporation presidents, factory

storemen, and corner shopkeepers have always used data, they are justified in asking, "What is special about data processing from my viewpoint?" These people, along with many others, have long been involved with processed data in the course of their everyday jobs. A corporation president is not in a position to present his firm's financial status until a very considerable amount of data has been processed. A shopkeeper, checking his bills, hardly sees himself in the role of data processor, but, as part of his job, that is sometimes his function.

We must avoid thinking of data processing as merely financial procedures; data can apply to the characteristics of events, persons, and things as authentically as it does to money. Data subjected to processing may be drawn from many spheres of activity, and it includes items such as road accident details, examination marks, share prices, and seat reservations. In the broad sense, data processing involves all basic facts from which useful information can result, and this applies in the business world especially to information that enables management to make far-reaching decisions.

The essence of data processing lies in the ability of modern computing systems to transmit and digest vast amounts of raw data at very high speed. The business methodologies now being employed were inconceivable before the days of electronic computation, magnetic storage, and high-quality telecommunications. This new power is based not so much on the computer's ability to perform complicated calculations as upon its capacity to organize data, i.e., to sort, store, and compare numbers and names. The storage devices now forming part of a computer configuration facilitate the rapid scanning and updating of large files of records, known as the system "data base." This means that more data than ever before can be taken into consideration when preparing information for management so that it can control the organization's day-to-day activities.

The compactness and accessibility of magnetically recorded files, combined with high-speed telecommunications, engender the centralization of the firm's records of all types within the data processing department. As a consequence of this, integration of the firm's planning and control activities becomes possible.

The creation of an integrated data processing system necessitates systems investigation and design of the highest order. This work is of a higher level than "organization and methods," involving not only a complete reappraisal of the organization's methods for achieving its objectives, but also the reassessment by top management of its information requirements for present and future control of the organization. Data processing systems are now being designed with a much more flexible nature to meet management requirements. When desirable, they can be arranged to allow managers to participate directly in obtaining selected information.

1.2 EVOLUTION OF DATA PROCESSING

Business organizations have had key-operated accounting machines of various types at their disposal for over half a century. These machines have been developed from simple mechanical adding devices into today's sophisticated electronic accounting machines and visible record "computers." Their means of output are now not only printed documents but also *paper tape* and *magnetically striped cards.* The latter give them the ability to record *carried-forward data* in a form that is easily re-input to the machine; this, together with an *internally stored program of instructions,* provides a limited degree of automatic operation.

A parallel but quite separate development was that of punched card machines. Punched cards, originally designed for special purposes such as the analysis of census statistics, were in use for over 40 years in business and government departments. Punched card machines were originally somewhat crude electromechanical devices, and in view of their large size, capable of doing surprisingly little in the way of business tasks. The mainstay of the system was the sorter; this machine, although very slow by modern sorting standards, was unsurpassed when it came to sorting large volumes of data.

When the printing tabulator appeared in the early 1930s, the first move had been made toward an automatic data processing machine. Never before had an accounting machine been able to run continuously without human control. Accompanying the printing tabulator came various machines for automatically arranging and punching cards. Examples were the collator for matching and merging groups of cards, the interpreter for printing the contents on the card itself (now done by card punches instead), the reproducer for copying the contents of cards into other cards, and the gang summary punch for automatically punching summarized results from the tabulator. Collators and reproducers are still in use to some extent as ancillary machines in data processing departments.

Not until the mid-1950s did punched card equipment make use of electronics, at which time its range was increased by the introduction of electronic calculators. These were able to do multiplication, division, and simple comparisons under the control of a wired program of instructions. Later, more advanced types of calculators were able to carry out quite complex calculations; and so much so that some were employed to do scientific calculations in the fields of atomic research and aircraft design. The employment of punched card machines in business organizations was generally only for the straightforward aspects of payroll, costing, stock control, and accounting—and then only for the larger companies and local authorities with sufficient volumes of data to justify the use of these machines in view of their restricted capabilities.

What, then, are the disadvantages of these two streams of equipment as compared with modern computers? The key-operated machines are geared inherently to the human operator. This has the advantage of versatility in that a wide range of tasks can be carried out with little time spent in preparation; but it has the disadvantages of comparatively low speed of throughput and of human fallibility in operation. The punched card machines, on the other hand, after being set up by the insertion of wired panels, were free from human error and were much faster in operation than the key-operated machines. They suffered, however, from the disadvantage of being inflexible, their functions being too rigid and narrow to allow for their use as management tools in a changeable situation.

A third and distinct development took place in the early 1950s in connection with scientific computing. Because of the tremendous increase in the complexity of scientifically designed plant and machines (such as atomic power stations, aircraft and weapon systems), the demand for computing power surged. This demand was largely met by the introduction of new models of computers, small by today's standards but of advanced concept and design for that period. Unfortunately these machines had limited printing capacity and this, together with the absence at that time of high-speed mass-storage media, meant that they were generally unsuitable as business computers, although a few were in fact used in this way.

The manufacturers of punched card machines also developed small computers based on the coupling of tabulators and gang punches to electronic units (e.g., IBM 650). In common with the scientific computers, these were controlled by internally stored instructions, and this feature gave them considerably more power than the punched card machines for planning and analysis purposes. Nevertheless, their speeds of input and output were geared to those of tabulators, and their only means of mass storage was punched card files. These limitations and the difficulty of programming made them unacceptable for most business applications. Another reason for their lack of success was the inability of both the business community and the manufacturers' salesmen to comprehend the potential of computers.

The first significant line of computers was introduced around 1960 by IBM, known as the 1400 series. During the years that followed, a large number of established punched card users were won over to this line, and of course this was facilitated by the compatibility of their existing cards. Similar computers followed from other manufacturers, and these so-called second-generation computers possessed three main advantages over their predecessors: first, higher data input/output speeds; second, means of storing mass data and processing it at high speed (i.e., magnetic tape); and third, higher-level languages to ease the programming burden.

The mid-1960s saw the introduction of the so-called third-generation computers, and among the present leaders of this field are the ICL 1900 series and the IBM system 360-370. The principal characteristics of third-generation computers that distinguish them from their forerunners are extensibility and compatibility. Extensibility, as the name suggests, means that the user can make his computer grow by replacing or adding to its units (known as hardware). A small computer can thus be gradually transformed into a large one without at any one time replacing the computer as a whole, thereby minimizing the disturbance of changing over. Compatibility implies the ability of a given range of variously sized computers to accept both each other's programs and those from a standard range (software). Also, any selection from existing or future peripherals (hardware) can be attached at will.

During the late 1960s, the principal developments were in the field of peripheral equipment, arising from the compatibility aspect of the third-generation computers. A considerable number of companies, some quite small, entered the data processing market with a wide range of peripheral units such as disk storage devices, visual display units, and on-line input keyboards; also available is microfilm equipment for use with computers. Thus, although the mainframe suppliers have been reduced in number owing to takeovers and mergers, the overall number of firms in the data processing business has increased considerably.

1.3 EMPLOYMENT OF COMPUTERS IN BUSINESS

Computers are nowadays an accepted part of business and governmental machinery; this is evidenced by the disappearance from the press of colorful accounts of computer applications and their replacement by discussions of the sociological problems brought about by computers. The amount of mundane but necessary work being done by computers is far greater than is generally realized, and in many cases it would be impossible to return to manual methods. Clerical work, in the old-fashioned sense, is a dying occupation but the replacement of men will not be by machines but by different kinds of men—be they the original men in other guises or a newer breed. It is the particular job, not the man, that is at stake. Tomorrow's clerk will have at his disposal a million-dollar computer, which he will command but probably never see. The complexity of modern planning and the rate of change of many business situations are so great that they cannot really be coped with except by means of a man-machine relationship. Provided men can adjust their attitudes so as to assert their intelligence superiority over the computer, this relationship will be harmonious and rewarding.

Business Applications and Recent Developments

Computers are currently in use in very many companies and organizations; their application runs the gamut of conventional business and administrative activities. It is interesting to identify a few examples from the extremely wide range of existing applications; from them, one can perceive the computer's versatility and potential.

Road accident recording and analysis.
Registration of shares.
Electronic injury surveillance.
Airline seat reservation.
Passenger transport surveys.
Blood donor administration.
Selection of shipping facilities.
Land-use surveys.
Tote betting accounting.
Election result forecasting.
Examination administration.
Portfolio evaluation.
Crime recording and statistics.
Retrieval of legal information.
Parking ticket accounting.

The preceding list is by no means comprehensive, but it is sufficient to demonstrate that a considerable amount of talent has been employed in making these applications realizable on computers. There was a considerable degree of fortuity in their implementation, their selection having arisen mainly because of the vision of the first user of the application. Now data processing power has become more readily available, and people are accustomed to having it on tap, the fortuitous and visionary aspects have disappeared. Developments have removed the barriers between the "ordinary" man and the computer; a brief mention of several developments in this direction is worthwhile at this point.

The bigger the computer, the better the value for money. It is therefore generally more economic to use a small amount of time on a big computer than a large amount of time on a small computer. The former aim can be achieved in one of two ways—either by renting time on a large computer and using the machine fully during that time, or by "time sharing" simultaneously with other users. Time sharing involves the installation of terminal hardware and the provision of data transmission facilities, but it has an advantage over renting time in that the exact time of usage does not normally have to be preallocated.

Another aspect of man/computer communication is the formation of modes of expression common to both. This is seen in an elementary form in the employment of stylized printing on documents; this is recognizable by machines and men, and is known as optical character recognition (OCR), or magnetic ink character recognition (MICR).

A more sophisticated form of common expression is the system known as "conversational mode."* This brings the human and electronic counterparts into contact by permitting a pseudo-conversation to take place between them. The computer is programmed to respond to the user in such a way as to make it appear that it understands his instructions. At the same time, the computer is able to lead the user along the correct path toward obtaining his requirements. A simple version of conversational mode is the use of "computer utilities"; with these, the user is in contact with the computer via a keyboard and a printer or visual display unit at his terminal. The job in hand is preplanned to be done by an interplay of the user and the computer, thus giving a degree of flexibility more akin to keyboard machines than conventional computers, but at the same time preserving the computer's calculating and organizing power.

Allied with the developments mentioned above is the increased employment of visual methods and, to a lesser degree, audio input and output. The main visual technology is the cathode-ray unit, arranged to provide a display of figures or graphs and able to accept modifications to the data by means of a light pen or similar device. The business application of this equipment has resulted in a much closer contact between the manager and his files, the rapid speed of display enabling large amounts of data to be shown without delay, and thus facilitating the interrogation of files from the manager's desk. Similarly, the input of data such as customer's orders is brought closer to its source and is also brought into closer contact with the master files. These features provide for more stringent vetting of the input data and easier subsequent correction of the errors thus detected.

Why Analyze Systems?

An inspection of the short list of less well-known applications given previously reveals the fact that they are mostly isolated or occasional applications. For these specialized applications this is generally of no consequence, but even with more conventional computer applications there is an underlying tendency for this to be the case. It is far easier to build a house in the country than to rebuild a town; similarly, companies that have successfully implemented isolated computer jobs have failed when attempting to integrate them to form a total system. Without stretching the analogy too far, a

*Martin, *Design of Man-Computer Dialogues*, Prentice-Hall, 1973.

town can arise from uncoordinated construction projects, but only after makeshift alterations can it be made to function as an entity.

The fragmented implementation of computer work can cause similar problems; it is dangerous to allow each department to specify its requirements in isolation and then to design a system to provide these quite separately. The requirements of department A may conflict with those of department B; alternatively they may coincide, but in any event it is better that they are considered together. Only through a painstaking investigation and analysis of the overall situation within the organization can a comprehensive plan evolve.

This is not to suggest that all applications must be implemented simultaneously, nor that it is absolutely imperative that every application is invariably included in the data processing system. The main objectives of systems analysis are (1) to study in depth the aims and problems of existing work, and (2) to design a system that is "open ended" so that further applications can be welded to it without duplication of work or records.