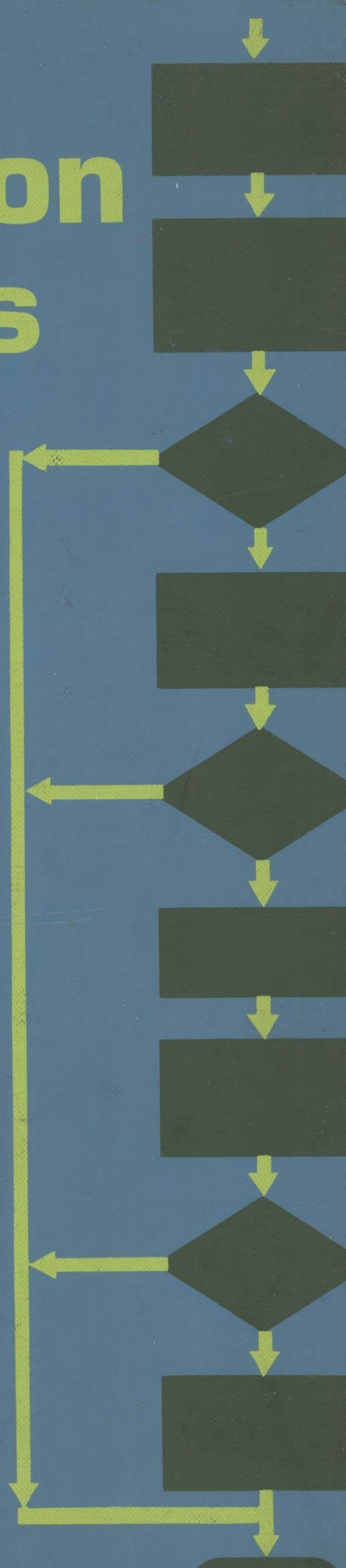
Information Systems



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Information Systems

To Margaret

Preface

With the proliferation of books in the area of data processing and information systems, one should have a good reason for adding to the list. It is hoped that the users of this book will agree that I did, indeed, have some objectives different from those of other authors in the field.

First of all, I think it is important that information processing students have an opportunity to work on projects in which data are processed in a realistic manner as soon as possible. This is important to their appreciation of the "finer points" that come later in the course. Second, an appreciation of hardware is of limited value at this stage of the students' education. It is more important to emphasize the logic and methodology of gathering and processing data and of then reporting the results to management. When data processors use hardware to implement their software, they are justified in depending on it to function properly. They need concern themselves, in detail, only with those facets of the hardware design and operation that interact with the design and efficiency of their software and systems. In my opinion, extensive study of numbering systems, adding schemes, card readers, and similar equipment details, is obsolete. It is not to be found in this book.

The flow of the book is as follows. First, there is a discussion of the firm as a system and how it must therefore be controlled (Chapter 1). Then follows a discussion of data sources, the generalities of file updating, and of report presentation (Chapters 2 and 3). Batch sequential processing (with examples) is then presented (Chapters 4 and 5), followed by an introduction to in-line and on-line processing (Chapter 6). Then there is Chapter 7 on computer configurations and operating systems, referenced back to the materials in Chapters 4 through 6. In Chapter 8 some programming aids are presented (structured programming and decision tables). The essentials of systems analysis for sequential systems are presented in Chapter 9.

Since two of the primary aspects of sequential and on-line processing are sorting and searching, respectively, each one is discussed at some length (Chapters 10 and 11). Chapter 12 is devoted to a discussion of the data base and data management. Chapter 13 explores the reliability of an information system. A more complete discussion of on-line systems is presented in Chapter 14.

The whole forms an integrated approach to the subject. Students should understand data processing to the extent that they can design simple systems and even get a data processing procedure running on the computer. The processing examples in the book are necessarily simplistic.

A hypothetical company in the upholstered furniture manufacturing industry is discussed in Appendix A, following which some processing applications and subsystems are suggested for development as projects. The description of the firm and the suggested procedures are deliberately nondetailed so that students can specify many factors themselves and thus participate in the system design. Instructors should insist that student teams follow a good design cycle in setting the system requirements, specifications, and design data and then follow through with careful system development. The projects can terminate at the flow chart stage or can go all the way to complete debugging on the computer, depending on the resources available and the purpose of the particular course. Even though there are many short problems at the ends of the chapters to aid students in mastering many of the details of the subject, the accomplishment of the complete design, development, and implementation cycle of an application is the glue that cements the whole course together and makes the effort worthwhile.

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ONE

Introduction

1-1 Data Processing and Management

Data processing in industry and business is the collection, manipulation, filing, and reporting of data concerning events which happen in the organization. Data processing is a service undertaken to assist management and it must, therefore, be developed to accomplish that objective.

In most instances managements have several goals. The existence of more than one objective is the reason that optimization of the firm's performance on a global basis is not possible. Hence, it is not proper to speak of *optimal data processing* or of processing data for *optimal firm performance*. It is instructive to consider a few of the purposes of management, however, and see if such a consideration will shed light on what is and what is not efficient data processing.

1. The most fundamental purpose of management is undoubtedly the assurance of the survival of the firm. Truly, no more damaging evidence could ever be found of poor management than the failure and bankruptcy of a firm.

2. On a more positive side, most managements aspire to lead their companies to better performances in all directions: higher sales, higher productivity, and greater profitability.
3. Most managements also wish to build their firms' reputations for providing the best in products, in service, and in value.
4. For longer than many people today realize, most managements have taken seriously their responsibilities to lead their firms to good corporate citizenship. This means avoiding economic fluctuations that disrupt the local economy, minimizing pollution and other ecological problems, and participating in the social and political life of the community.

In order to be able to carry out these and other objectives that particular firms may have, it is necessary for management to be in control of the firm and all of its activities. This does not necessarily imply a dictatorial sort of control, for the management of a firm may consist of a large management team. In fact, modern corporations tend to diffuse control of the firm over as many people and to the lowest management level possible. But even a large team may find that events command it rather than it commanding events. For example, in the field of government, has the inflation of the last few decades resulted from actions by the "government management team" to induce inflation or did events get beyond the control of that team?

1-2 Control Through Negative Feedback

To appreciate the control problem, one should consider the industrial or commercial firm as a large servo-mechanism. In fact, this is the approach of a simulation method known as *Systems* or *Industrial Dynamics.* In Systems Dynamics, models of firms and their immediate environments are constructed to portray faithfully the feedback nature of the real-life organizations. These are then operated in a simulation mode on a digital computer and a simulated history of the firm is obtained. Developing the Systems Dynamics approach is beyond the scope of this book, however.

Figure 1-1 shows a simple feedback system with but a single feedback loop. The device f converts the input (e_i) into an output (e_o); F represents a second converter which produces a correction or modification (e_c) to the input from a measure of the output. The quantities e_i, e_o, and e_c can be considered as signals or attributes of their devices. For example, they could be voltages and the devices f and F could be units that produce output voltages which are functions of their respective input voltages. The outputs may be larger than, smaller than, or related in a more complicated

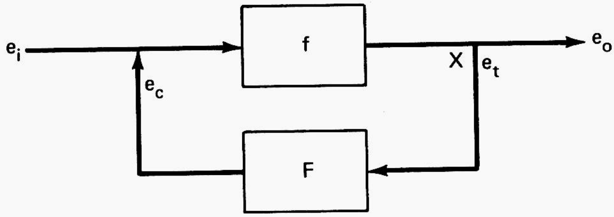

Figure 1-1 A feedback loop.

way to the inputs. The main point is that there must be only one possible output for each possible input. In addition, we will assume, for the moment, that $f(e)$ has the same sign as e, where e is the input to f and $f(e)$ is the output, and that $f(0) = 0$. The same relations hold for e' and $F(e')$.

Considering device f first, we see that its input in Figure 1-1 is $e_i + e_c$. Hence, we may write

$$e_o = f(e_i + e_c)$$

Considering device F next, we will assume that its input is produced by a sensor at X and that this input is given by $e_o - e_t$, the latter being the *target* or *desired* output. Hence e_c is given by

$$e_c = F(e_o - e_t)$$

Substituting the second expression into the first, we have

$$e_o = f\{e_i + F(e_o - e_t)\}$$

If $e_o = e_t$, e_c must equal zero. Now suppose that e_o is made *slightly* larger than e_t. Since $F(e_o - e_t)$ has the same sign as $e_o - e_t$, e_c will soon be positive also, causing e_o, and hence $e_o - e_t$, to increase as well. With e_c increasing e_o and the latter increasing e_c, the result is an explosive growth in e_o. Suppose that during this rapid growth some accident caused e_i to be suddenly reduced. If the drop in e_i is great enough, e_o will be decreased to a level below its target which will cause e_c to decrease in value and e_o will now *diminish* with great speed. If e_o is a voltage, it can decrease beyond zero, becoming large but with a polarity opposite to what it had originally. Obviously, such a system is highly unstable. It will soon cease to function because its variables will quickly surpass hardware limitations.

The system described is an example of *positive feedback*. A deviation from the desired condition, when sensed by the monitoring device, is sent to the control unit which sends a "correction" signal which causes the error to increase. Few real systems are of this type because they are self-destructive. In order to devise a system of more permanence and greater stability, it is necessary that device F produce a correction signal which is opposite in sign to that of $e_o - e_t$, its input. Thus, if e_o becomes "too large," for any reason at all, the correction signal, e_c, will be negative so that e_c subtracts from e_i and the output decreases toward its target. If the correction signal (e_c) is so strong that e_o drops below e_t, e_c will then become positive and bring e_o up closer to e_t. In other words, if the correction overshoots its mark, the correction process automatically changes direction and, if the system is well designed, the oscillations will soon die away, leaving e_o very close to its target. Poorly designed systems may oscillate a long time; long repetitions of these oscillations with little decrease in amplitude is called *hunting*.

The requirement that F produce an output signal with a sign opposite to that of its input has caused this type of feedback to be called *negative feedback*. Negative feedback tends toward stability much as positive feedback tends toward instability. The devices f and F can be made to conform to many desired input/output patterns. It is the task of a control engineer, when working with physical systems, to design equipment that will cause the output to remain close to the desired value at all times, consistent with the importance of close agreement between these factors and the cost of attaining it.

In nature, negative feedback is common. It is used in many ways in the human body to control blood acidity, body temperature, the amount of fluids in the tissues, and so on. An apparent exception is population growth. If survival conditions are good, all species can produce enough offspring to produce growth in their numbers. Man, for example, has steadily increased his numbers despite wars, famines, and plagues. But negative feedback elements are certain to become stronger as the human population approaches its limits at current levels of technology. It is likely that many readers of this book will live to experience the gradual change from positive to negative feedback in this system as crowding, resource exhaustion, and pollution increase the strength of the negative feedback components. The process promises to be painful unless great ingenuity and cooperation are also prevalent during this period.

1-3 System Complexities

Two additional ideas must be added to the material of the preceding section. The first is that the target output may be a variable. For that purpose, another way of introducing the target output is often shown. This is illustrated in Figure 1-2. It shows the target signal being fed