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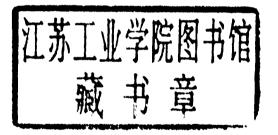
Introduction to

SYSTEMS ANALYSIS AND DESIGN

SECOND EDITION

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University of Technology, Sydney





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Introduction to

SYSTEMS ANALYSIS AND DESIGN

Preface

The second edition builds on the ideas and structure of the first edition. Like the first edition, it stresses the ideas of contemporary structured analysis and uses modeling techniques to describe systems. It also distinguishes between physical and logical design, and emphasises the structured way of moving from a description of user needs to a working system.

Most of the changes in this edition concentrate on improving or expanding the explanation of some principles and on updating the text of the first edition. The underlying philosophy of the book remains the same: to introduce the techniques in the sequence required in practice. The techniques described in the book include all those commonly used in practice. One important set of techniques is known as structured systems analysis, which concentrates on modeling data flows, deriving data structure and identifying system functions from these flows. Another set of techniques concentrates on data, developing data models and using data analysis methods to construct these models. Process flows are then defined around the data model. Data analysis techniques include relational analysis and a variety of semantic modeling techniques. A further set of techniques concentrates on functional analysis to describe how data is used and changed in the system.

Since the first edition, however, some of these design methodologies have evolved and matured. The second edition includes changes and updates to reflect these developments. It thus places greater emphasis on the integration of dataflow techniques with entity-relationship modeling. The chapters dealing with design methodologies and CASE tools have also been updated to reflect the rapid evolution of these design tools. This edition has also improved and expanded explanations of some areas. Thus relational analysis has been explained in more detail and interviewing has been expanded.

Systems analysis and design techniques are still introduced in the sequence required for systems analysis and design. The book begins by outlining the steps followed in analysis and design and then describes each step in detail, introducing the techniques to be used at that point. It then discusses techniques for describing how data, process and flow can be integrated and how models developed during analysis can be converted to working systems during design.

There is, however, one change to the sequence of presenting techniques. Relational analysis is now included as a separate chapter in the design area rather than the analysis. This appears to be the trend in most methodologies, where entity-relationship analysis is used to define the data during system analysis and then relational analysis is used during design to normalise the data prior to database design.

The book continues to be a text for beginners and does not assume any knowledge of systems analysis and design, although it still assumes that the readers have some basic knowledge about computers. For example, readers should know that data is stored on computer disks which are

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controlled by a processor. Readers should also know that data can be input into a computer through devices such as cards or through terminals, and that outputs can then be obtained on the terminal screen or output printer. Readers should also know that computers can communicate between themselves or remote devices via communications links. Some knowledge of programming and algorithms is also useful but not essential.

Finally, to assist students' understanding, more problems have been added to the large number of examples provided in the first edition. As before, each chapter is followed by discussion questions and problems to illustrate the techniques described, and more discussion questions have been added — especially to the early chapters. Three text cases are used throughout the book to illustrate how the techniques can be applied to each step.

Igor Hawryszkiewycz

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1

The system design environment

INTRODUCTION

This book is about building computer-based information systems. It describes methods that are used to analyze systems, design them and build them.

The terms analyze, design and build are placed in this sequence because, in practice, this is the sequence of steps used to construct computer-based information systems. Analysis is used to gain an understanding of an existing system and what is required of it. At the conclusion of analysis, there is a system description and a set of requirements for a new system. If there is no existing system, then analysis defines only the requirements. Design, which follows, proposes the new system that meets these requirements. This new system may be built afresh or by changing the existing system. Once the design is approved, the system is built.

This sequence of activities is described in detail in Chapter 3, and Chapter 4 then describes how to gather information about the system. The book then continues by describing methods used in systems analysis and design. It begins with analysis and describes analysis techniques in Chapters 5 through to 10. Contemporary systems analysis is centered on building models of existing systems. These models describe the system processes, data and flows. System models are used to gain precision and to avoid the ambiguities often found in natural language system descriptions. Modeling techniques used in systems analysis avoid ambiguity by using precise modeling constructs and process descriptions. They also assist analysts to define precisely the requirements of the new system. Systems analysis is now often supported by software

2 Chapter 1

tools that help analysts in their work. These tools store the models developed during analysis and some can even convert these models to trial designs. In practice, many modeling methods are used, some to describe data, some to describe processes and others to describe information flows in systems. There is a trend to integrate process, data and flow modeling methods into practical methodologies. This book addresses this trend and describes modeling methods for processes, data and flows and how they can be integrated.

The book then describes techniques used in system design. Design begins by defining a model of the new system and continues by converting this model to a new working system. The model of the new system shows what the new system must do to satisfy the requirements. Chapter 11 describes how the new model is developed. The methods used to convert the model of the proposed system into a computer specification are then described. This book describes such conversions in Chapters 12 through to 15. Chapter 12 describes how models of data flows are converted to user procedures, Chapters 13 and 14 describe how data models are converted to a database, and Chapter 15 describes the conversion of process descriptions to programs. Precision is again emphasized in design. We need to convert precisely the proposed model to a working system and not go through a process of interpretation, where we would lose some precision. Chapter 16 then outlines some practical methodologies that integrate analysis and design.

The book concludes by describing some important issues in systems analysis. First, alternative steps for system development are described in Chapter 17. That chapter describes how systems can be developed gradually rather than by one pass of the three steps of analysis, design and build. Such system development procedures are known as prototyping and evolutionary design. Then project management is described in Chapter 18, which covers issues such as resource allocation, team structures and monitoring project progress. Chapter 19 then discusses strategic planning and its role in determining the sequence in which applications are developed in an organization.

Before beginning a detailed description of systems analysis and design techniques, the kinds of systems that are built using these techniques are outlined. Some typical computer-based information systems are described in this chapter and in Chapter 2. From this you will see how complex some of these systems are and what must be done to build them. You will also see why a book about analyzing, designing and building systems is needed.

WHAT IS A SYSTEM?

One question people often ask when discussing system analysis and design is, what is a system? What is it that we are generally analyzing and designing? There are several ways of answering this question, and the answer usually depends on the general approach that is being used in design.

One view of the system is that shown in Figure 1.1. It simply shows the system as a computer system and the components that make up a computer system. The system in

Figure 1.1 The computer as a system

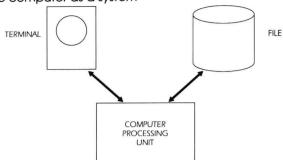
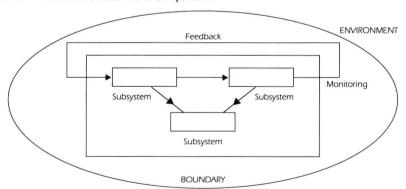


Figure 1.1 is made up of three components: a computer, a file and a terminal. Figure 1.1 also shows the connections between these three components.

The view of the system shown in Figure 1.1 is too constraining for what we are doing in this book. It simply describes computers and not how they are used. What we will do here is study systems that use computers to solve problems for users. We will not use the view in Figure 1.1 in this book because we are considering systems with wider scope than simply computers. We will study systems that include computers to solve some wider problem.

Another way to view systems is shown in Figure 1.2. This is more a theoretical view that concerns the fundamental systems issues.

Figure 1.2 A theoretical view of systems



Theoretical approaches to systems have introduced many generalized principles. *Goal setting* is one such principle. It defines what exactly the system is supposed to do. Then there are principles concerned with system structure and behavior. One such principle is the *system boundary*. This defines the components that make up the system. Anything outside the system boundary is known as the system *environment*. Then a system can be made up of any number of *subsystems*. Each subsystem carries out part of the system function. Subsystems are important because they can help to handle systems complexity and thus improve the understanding of a system. Each subsystem carries out some part of the system goal. The subsystems communicate by passing messages between themselves. A good system will be made up of highly independent subsystems with minimal

4 Chapter 1

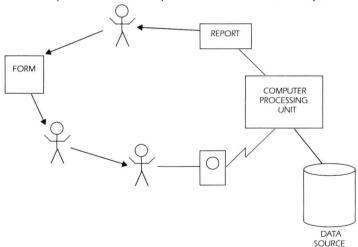
flows between them. Minimizing flows minimizes, in turn, complexity and simplifies the system.

Then there are also a number of principles concerned with system behavior. One such important principle is *feedback*. Feedback is the idea of monitoring the current system output and comparing it to the system goal. Any variations from the goal are then fed back into the system and used to adjust it to ensure that it meets its goal. To do this it is necessary to *monitor* the system and see if it is meeting its goal.

We will not emphasize the theoretical approach in the book but will nevertheless use many principles from it. For example, the idea of subsystems is very important. Any information system contains many subsystems. Some may be computers, others organizational units and so on. Goals are also important in information systems. Each such system has some purpose and must work towards this purpose. Feedback also comes up in information systems. It provides the outputs that are used in monitor system performance and possibly changes some activities in the system.

In this book we place greater emphasis on the components that make up a computer-based information system, but at the same time we use the general ideas about systems. Our approach, however, goes beyond the simple system shown in Figure 1.1 and includes people as well as procedures.

Figure 1.3 Components of a computer-based information system



Thus the general view of the system used in this book is shown in Figure 1.3. Figure 1.3 views systems as collections of *people*, *equipment* and *procedures*.

People, of course, are an essential component of any information system. Information is produced and used by people in an organization. People use this information in their everyday activities to make decisions on what is to be done. Such decisions may be routine; for example, a bank teller may use the computer to check the account balance before allowing a withdrawal. There may also be more complex decisions; for example, what shares to include in a share portfolio or what supplier to select given a mix of parts and prices.

Information systems must support all these kinds of user activities. To do this they

must establish *procedures* ensuring that the right people receive the right data at the right time. These procedures determine what is to be done with data as it enters and passes through the system. For example, what do we do when a customer order arrives? There must be a procedure to tell us what is to be done with that order. This procedure will tell us who to send the order to and what that person will do with it.

Finally, there is the *equipment* that is used to store the data, move it around the organization and process it. The equipment includes the computers themselves, their disk drives, input devices, interfaces to computer users and any communication devices that may send data to computers from remote places or send data between two computers. There are of course other kinds of equipment used in information systems, such as filing cabinets and drawers or microfiche, but in this book these are of secondary interest only. A system like the one shown in Figure 1.3 has many of the characteristics of the system in Figure 1.2. It has a boundary and interacts with its environment. It has many components including equipment and people. It also has flows between these components. There is also feedback because outputs from the system can influence its operation.

The goal of analysis and design is to build computer-based information systems that meet some organizational goal. This goal may be to improve an organization's accounting system to produce new reports. It may be to speed up the processing of orders. Analysts must then study the system to see how such goals can be met. This does not always mean putting in a computer system. It can sometimes simply require changes to existing procedures, rearranging work flows in an office or making forms more understandable. Sometimes a new computer system may be needed. However, it is important to keep in mind that the goal of systems analysis and design is not simply to put in a computer but to improve the system as a whole.

Some examples

Computer-based information systems can take many forms. Computers in such systems store data about organizations and make this data available to the organization's personnel. Computer-based information systems may be very simple systems like the one in Figure 1.4. Here a person has a small computer and enters data into it. The data may consist of simple records such as daily sales. One entry is made for each sale. The entry states the item sold (e.g. a hammer), the quantity of items sold (e.g. 30) and the sale price (e.g. \$95). Each entry is stored as a record on a file on the computer disk. At the end of the day, the computer can generate reports from the stored file showing total sales and sales trends. The user can use this information to make decisions about what items to stock or to plan future advertising campaigns. Designers of such systems must decide how to store the needed data in the computer and to design the software that will allow users to use this data.

Most systems, however, are more complex than the one shown in Figure 1.4. Typically, organizations have more than one computer system, as shown in Figure 1.5. The computer-based information system in Figure 1.5 is made up of two computer systems. Computer system 1 supports financial and inventory functions whereas computer system 2 supports sales and production. People can have access to these