

SYSTEMS ANALYSIS AND DESIGN



Prentice-Hall International Editions

KENDALL
KENDALL

Systems Analysis and Design

Kenneth E. Kendall

George Mason University

Julie E. Kendall

George Mason University



Prentice-Hall International, Inc.

ISBN 0-13-881228-4

This edition may be sold only in those countries to which it is consigned by Prentice-Hall International. It is not to be re-exported and it is not for sale in the U.S.A., Mexico, or Canada.



© 1988 by Prentice-Hall, Inc.
A Division of Simon & Schuster
Englewood Cliffs, New Jersey 07632

All rights reserved. No part of this book may be reproduced, in any form or by any means, without permission in writing from the publisher.

Printed in the United States of America
10 9 8 7 6 5 4 3 2

ISBN 0-13-881228-4

Prentice-Hall of Australia Pty. Limited, Sydney
Prentice-Hall Canada Inc., Toronto
Prentice-Hall Hispanoamericana, S.A., Mexico
Prentice-Hall of India Private Limited, New Delhi
Prentice-Hall of Japan, Inc., Tokyo
Simon & Schuster Asia Pte. Ltd., Singapore
Editora Prentice-Hall do Brasil, Ltda., Rio de Janeiro
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

To our parents

COMPANY TRADEMARKS

Apple, Macintosh, and MacPaint are registered trademarks of Apple Computer, Inc. Beagle Bros. is a registered trademark of Beagle Bros. Micro Software. dBase III is a registered trademark of Ashton-Tate, Inc. Excelerator is a registered trademark of Index Technology Corporation. IBM PC/XT, IBM PC/AT, and PS/2 are registered trademarks of International Business Machines Corporation. Life-cycle productivity system is a registered trademark of American Management Systems, Inc. LOTUS, 1-2-3, HAL, and Freelance Plus are registered trademarks of Lotus Development Corporation. MTC 2000 is a registered trademark of Nastec. Paradox is a registered trademark of Ansa Software. Prokey is a registered trademark of Rosesoft. R:BASE System V is a registered trademark of Microrim Inc. Sidekick and Superkey are registered trademarks of Borland International, Inc. Softstrip is a registered trademark of Cauzin Systems, Inc. V-P Planner is a registered trademark of Paperback Software International. Word and Multiplan are registered trademarks of Microsoft Corporation. Wordperfect is a registered trademark of Wordperfect Corporation. Wordstar is a registered trademark of Micropro International Corporation.

Preface

The analysis and design of computerized information systems for organizations is an exciting and changing field. As the use of computers readily spreads within organizations, questions about using computers to improve productivity and attain organizational goals increase commensurately. Systems analysts, who often are challenged by these questions, must understand potential users as well as computers in order to put them together in the best possible way when designing an information system. Additionally, analysts must learn to develop and maintain working relationships with members of the systems analysis team.

Anyone making a career of analyzing and designing computerized information systems may apply the skills learned in this book. Since the work of systems analysts is shifting away from the application of purely technical expertise to the support of end users, systems analysts must not only understand people, but also how information is made meaningful to them for decision making. This book assists the reader by demonstrating how the systems analyst can best make this shift. In so doing, the book becomes a bridge between the old techniques and the new.

When we decided to write this book, we wanted to ensure comprehensive and innovative coverage of key systems analysis and design material, as well as pedagogical features to get students actively involved in applying what they are learning from the text.

Our book is unique in several regards. It includes extended coverage of data-gathering techniques (five chapters); an abundance of short “Consulting Opportunities” (over sixty) that get students involved by let-

ting them apply the knowledge they have gained to realistic, to-the-point minicases in every chapter; and chapters that discuss current ideas in systems analysis and design, such as prototyping, decision support systems (DSS), and computer-assisted software engineering (CASE) tools.

Since not all systems problems are huge two- to three-year projects, our book contains many Consulting Opportunities that can be solved quickly in twenty to thirty minutes of group discussion or individual writing. These minicases, written in a humorous manner to enliven the material, require students to synthesize what they have learned up to that point in the course, ask students to mature in their professional judgment, and expect students to articulate the reasoning behind their systems decisions.

A chapter is devoted to each of the data-gathering methods of sampling, interviewing, questionnaires, observation, and prototyping. This goes beyond other books that may offer a mere section of a chapter on each method. This treatment is an important innovation because it helps ensure that the student (who is training to become a systems analyst) is solving the correct problem when a systems project is proposed.

Chapter 11 discusses decision support systems (DSS) and goes well beyond competing texts in showing the importance of DSS to the work of systems analysts. Different types of decision-making style are discussed, as is the importance of incorporating multiple objective criteria into decision-making models for DSS.

Workbench technologies (also called CASE tools) in Chapter 21 introduce students to the new wave of automated system design. While automation of analysis and design tools is still too expensive for many schools, these productivity tools are the wave of the future for systems analysts. Students do not need to have access to the new tools to learn about them in a realistic way through the text.

The underlying philosophy of our book is that systems analysis and design is a process that integrates the use of many tools to accomplish systematically its goals of improving businesses through the implementation or modification of computerized information systems. The text is divided into five major parts: Systems Analysis Fundamentals (Part One), Information Requirements Analysis (Part Two), The Analysis Process (Part Three), The Essentials of Design (Part Four), and Software Engineering and Implementation (Part Five).

Part One (Chapters 1 through 3) stresses the basics that students need to know about what an analyst does; how organizations function and how information systems fit into them; how to determine whether a systems project is worthy of commitment; and how to manage a systems project. The three roles of the systems analyst as consultant, supporting expert, and change agent also are introduced and explained.

Part Two (Chapters 4 through 8) emphasizes the use of systematic and structured methodologies. Attention to analysis helps analysts ensure that

they are addressing the correct problem before designing the system. The presentation of each methodology (sampling, investigating hard data, interviewing, questionnaires, and observation) moves students closer to understanding what information users need and how needs can best be ascertained. Chapter 7 is especially innovative and goes well beyond the typical text in showing how to accomplish systematic observation of decision makers. Chapter 8 is also innovative in its treatment of prototyping as another data-gathering technique that enables the analyst to solve the right problem by getting users involved from the start.

Part Three details the analysis process (Chapters 9 through 13). It builds on the previous two parts to move students into analysis of data flows, as well as structured and semistructured decisions. It provides step-by-step detail on how to use structured techniques to draw data-flow diagrams, and how to diagram structured decisions with the use of structured English, decision tables, and decision trees. Students then progress to a consideration of semistructured decisions that are featured in decision support systems. Our book is unique due to its extensive coverage. After analysis of decisions is accomplished, students learn how to ascertain the hardware and software needs of the organization. In addition, students are taught several methods for forecasting costs and benefits, which is necessary to the discussion of software and hardware. Next, students are supplied with the quantitative and qualitative techniques needed to compare costs and benefits of a proposed system. Chapter 13 stresses the importance of a professionally prepared written and oral presentation of the systems proposal. The proposal is viewed as a persuasive document that is extremely important to the future acceptance and success of the system.

Part Four covers the essentials of design (Chapters 14 through 18). It begins with designing output, since many practitioners believe systems to be output driven. Particular attention is paid to relating output method to content, the effect of output on users, and designing good forms and screens. Input design stresses the importance of a systematic approach to the design of screens and forms and the influence of analysts in getting users to use the system. How the user interacts with the computer and how to design an appropriate interface are also covered. The importance of user feedback and correct ergonomic design of computer workstations are innovative topics in Part Four. How to design accurate data-entry procedures that take full advantage of computer and human capabilities to assure entry of quality data is the key here. Students are shown the relevance of database design for the overall usefulness of the system, and how users actually use databases.

Finally, Part Five (Chapters 19 through 21) introduces students to structured software engineering and documentation techniques as ways to implement a quality system. Here, we cover the most recent developments in structured techniques while also teaching students which techniques are appropriate for which situations. In addition, security, testing, audit-

ing, and maintenance of systems are covered in the context of total quality assurance. Part Five also introduces the student to some recent approaches to implementation including the establishment of an information center and implementing distributed systems. Both of these approaches require training users and choosing a conversion strategy and are discussed in a step-by-step way. Techniques for evaluating the completed information systems project are covered systematically as well. Finally, workbench technologies are introduced that provide students with a realistic introduction to the new automated tools that support the work of systems analysts. The text demonstrates how automated support can be useful to systems analysts as well as to their clients.

Index Technology Corporation's software package, called *Excelerator*, is featured as one of the CASE tools in Chapter 21. The corporation offers an educational grant program to assist academic users with *Excelerator*. At the time of this writing, professors who can demonstrate that they are teaching systems analysis and design, and who have access to the necessary hardware to use *Excelerator* in class, are eligible to receive a free copy. Interested educators may apply to: Index Technology Corporation, 101 Main Street, Cambridge, Massachusetts, or may call the representative, Judith Vanderkay, at (617) 494-8200. We are also preparing a video tape that takes students through an actual *Excelerator* example step by step. This is available to instructors who adopt this book. For further information, contact Prentice Hall.

Systems analysis and design is taught in one or two semesters. Our book may be used in either situation. The text is appropriate for undergraduate (junior or senior) curriculum at a four-year university, graduate school, or community college. The level and length of the course can be varied and supplemented by using other materials, such as the casebook written to accompany this text.

Many colleges use one of two approaches for scheduling the course—the first is referred to as the ACM curriculum (Association for Computing Machinery), and the second as the DPMA curriculum (Data Processing Management Association). In the ACM curriculum, the course “IS5 Information Analysis” is covered by Chapters 1 through 8; the course designated “IS8 Systems Design” is covered by Chapters 9 through 21. For the DPMA curriculum, the course designated as “CIS/86-5 Systems Development Methodologies: A Survey” is covered by Chapters 1 through 21.

In addition to this book, ancillary materials are also offered. These include *Cases in Systems Analysis and Design* (Kendall & Kendall, Prentice Hall, 1988) and an instructor's manual. The casebook contains three major, integrated cases in systems analysis and design. The cases allow a student to perform a large systems development project over the length of a semester. Cases are coordinated with each chapter in this book.

The instructor's manual includes suggested solutions and additional background for the Consulting Opportunities, structure and suggested

solutions for the three cases in *Cases in Systems Analysis and Design*, answers to end-of-chapter review questions and problems, a test bank with multiple-choice questions and fill-in-the-blank questions, and overhead transparency masters.

Many people helped us in creating this book. Dennis Hogan of Prentice Hall has been wonderful. Our production editor, Susan Fisher, is the embodiment of professionalism, talent, and good will. Both lightened our task and made it more interesting.

We are also grateful to our dedicated word-processing staff at George Mason University, particularly to Mary Blackwell, who is in charge of Office Support Services, and Jean Berry, who was largely responsible for typing our manuscript.

The many graduate students and undergraduates who have attended our systems analysis and design classes over the years also deserve praise for their insightful comments and contributions. Our students, along with our many reviewers, helped strengthen this book. Our reviewers included Paul S. Licker, University of Calgary; John L. Eatman, University of North Carolina at Greensboro; Richard W. Lott, Bentley College; William E. Burrows, University of Washington; Robert Behling, Bryant College; Jane Fedorowicz, Boston University; and Laurence H. Levine, Baruch College.

Additionally, Gordon Davis of the University of Minnesota insisted that we adhere to our vision in writing this book, Hugh Watson of the University of Georgia provided much encouragement, and Bob Ashenurst of the University of Chicago offered useful suggestions along the way.

We would also like to thank our secretary, Glenda Cramer, in the Decision Sciences Department at George Mason for her support. Our thanks also go to Coleman Raphael, dean of the School of Business Administration at George Mason University, and to Berry Render, chairman of the Decision Sciences Department.

Special appreciation is deserved by James R. Buffington, Indiana State University, and Sangjin Yoo, Bowling Green State University, for their diligent and careful work on the instructor's manual to accompany our book. Merrill Warkentin, George Mason University, and Bret Michael, also warrant credit for helping out.

Finally, we thank our parents, Edward and Julia Kendall and Vernon and Emmy Tukua, who have provided much needed support and unending encouragement throughout this project. Their contribution is immeasurable.

Kenneth E. Kendall
Julie E. Kendall

Contents

Preface xxv



Part One

Systems Analysis Fundamentals

1

Assuming the Role of the Systems Analyst 1

INFORMATION AS AN ORGANIZATIONAL RESOURCE 1

Managing Information as a Resource 1

Managing Computer-Generated Information 1

SYSTEMS ANALYSIS AND DESIGN CONCEPTS 2

Data-Processing Systems 2

Management Information Systems 3

Decisions Support Systems 3

Expert Systems and Artificial Intelligence 3

Need for Systems Analysis and Design 5

Types of Systems Users 5

ROLES OF THE SYSTEMS ANALYST 6

Systems Analysts as a Consultant 7

Systems Analyst as Supporting Expert	7
Systems Analyst as Change Agent	7
Qualities of the Systems Analyst	8
THE SYSTEMS DEVELOPMENT LIFE CYCLE	8
Identifying Problems, Opportunities, and Objectives	9
Determining Information Requirements	10
Analyzing System Needs	10
Designing the Recommended System	11
Developing and Documenting Software	11
Testing and Maintaining the System	12
Implementing and Evaluating the System	12
SUMMARY	13
KEYWORDS AND PHRASES	14
REVIEW QUESTIONS	14

2

Understanding Organizational Style and Its Impact on Information Systems 16

ORGANIZATIONAL FUNDAMENTALS	16
ORGANIZATIONS AS SYSTEMS	17
Interrelatedness and Interdependence of Systems	18
Organizational Boundaries	18
System Feedback for Planning and Control	19
Environments for Organizational Systems	20
Openness and Closedness in Organizations	20
Taking a Systems Perspective	21
Systems and the Entity-Relationship Model	24
LEVELS OF MANAGEMENT	28
Operations Management	28
Middle Management	29
Strategic Management	29
Implications for Information Systems Development	30
ORGANIZATIONAL DESIGN	33
Hierarchy	35
Project Structures	36
Matrix Structures	37
Information Processing Model	38
Implications for Information Systems Development	39
OTHER ORGANIZATIONAL FACTORS	42
Leadership Style	42
Technological Considerations	44
Organizational Culture	45
Human Relationships in Organizations	47

SUMMARY	47
KEYWORDS AND PHRASES	48
REVIEW QUESTIONS	49
PROBLEMS	49

3

Determining Feasibility and Managing Analysis and Design Activities 52

PROJECT FUNDAMENTALS	52
PROJECT INITIATION	52
Problems within the Organization	53
Opportunities for Improvement	55
Selection of Projects	55
DETERMINING FEASIBILITY	57
Defining Objectives	58
Determining Resources	58
Judging Feasibility	60
ACTIVITY PLANNING AND CONTROL	60
Estimating Time Required	62
Using Gantt Charts for Project Scheduling	64
Using PERT Diagrams	66
Expediting	73
MANAGING ANALYSIS AND DESIGN ACTIVITIES	76
Communication Strategies for Managing Teams	76
Setting Project Productivity Goals	79
Motivating Project Team Members	81
Avoiding Project Failures	82
SUMMARY	83
KEYWORDS AND PHRASES	84
REVIEW QUESTIONS	84
PROBLEMS	85



Part Two Information Requirements Analysis

4

Sampling and Investigating Hard Data 90

SAMPLING	90
The Need for Sampling	90

- Sampling Design 92
- The Sample Size Decision 95
- KINDS OF INFORMATION SOUGHT IN INVESTIGATION 101
 - Types of Hard Data 103
 - Abstracting Data from Archival Documents 115
- SUMMARY 118
- KEYWORDS AND PHRASES 118
- REVIEW QUESTIONS 119
- PROBLEMS 120

5

Interviewing 125

- KINDS OF INFORMATION SOUGHT 125
- PLANNING THE INTERVIEW 126
 - Five Steps in Interview Preparation 127
 - Question Types 130
 - Question Pitfalls 134
 - Arranging Questions in a Logical Sequence 135
 - Structured Versus Unstructured Interviews 138
 - Making a Record of the Interview 140
 - Before the Interview 142
- CONDUCTING THE ACTUAL INTERVIEW 142
 - Beginning the Interview 142
 - Troubleshooting During the Interview 143
 - Closing the Interview 148
- WRITING THE INTERVIEW REPORT 148
- SUMMARY 148
- KEYWORDS AND PHRASES 151
- REVIEW QUESTIONS 151
- PROBLEMS 152

6

Using Questionnaires 156

- KINDS OF INFORMATION SOUGHT 156
- PLANNING FOR THE USE OF QUESTIONNAIRES 157
 - Writing Questions 158
- USING SCALES IN QUESTIONNAIRES 163
 - Scaling Fundamentals 164
 - Constructing Scales 166

DESIGNING AND ADMINISTERING THE QUESTIONNAIRE	170
Designing the Questionnaire	170
Administering the Questionnaire	177
USING Q-SORTS	179
The Q-sort Technique	180
Advantages of the Q-sort Technique	180
Guidelines for Using the Q-sort Technique	182
SUMMARY	184
KEYWORDS AND PHRASES	185
REVIEW QUESTIONS	185
PROBLEMS	186

7

Observing Decision-Maker Behavior and Office Environment 190

KINDS OF INFORMATION SOUGHT	190
OBSERVING A DECISION MAKER'S BEHAVIOR	191
Observing a Typical Manager's Decision-Making Activities	192
Time and Event Sampling	192
Observing a Decision Maker's Body Language	193
Recording Behavior	196
OBSERVING THE PHYSICAL ENVIRONMENT	202
Structured Observation of the Environment	202
SUMMARY	214
KEYWORDS AND PHRASES	215
REVIEW QUESTIONS	216
PROBLEMS	216

8

Prototyping 219

KINDS OF INFORMATION SOUGHT	219
Initial User Reactions	219
User Suggestions	220
Innovations	221
Revision Plans	221
APPROACHES TO PROTOTYPING	221
Kinds of Prototypes	221

- Prototyping as an Alternative to the Systems Development Life Cycle 225
- Prototyping as Augmenting the Systems Development Life Cycle 227
- DEVELOPING A PROTOTYPE 229
 - Guidelines for Developing a Prototype 231
 - Disadvantages of Prototyping 235
 - Advantages of Prototyping 236
- USERS' ROLES IN PROTOTYPING 238
 - Interaction with the Prototype 238
- SUMMARY 242
- KEYWORDS AND PHRASES 243
- REVIEW QUESTIONS 243
- PROBLEMS 243



Part Three The Analysis Process

9

Analyzing Data-Oriented Systems 247

- METHODS AVAILABLE 247
- THE DATA FLOW APPROACH TO REQUIREMENTS DETERMINATION 248
 - Advantages of the Data Flow Approach 248
 - Conventions Used in Data Flow Diagrams 249
 - Other Conventions Used in the Data Flow Approach 253
 - A Data Flow Diagram Example 254
 - Developing Data Flow Diagrams 259
 - Using Data Flow Diagrams 261
- THE DATA DICTIONARY 262
 - Need for Understanding the Data Dictionary 262
 - Data Contained in the Data Dictionary 262
 - Building a Data Dictionary 266
 - Using the Data Dictionary 274
- SUMMARY 275
- KEYWORDS AND PHRASES 276
- REVIEW QUESTIONS 277
- PROBLEMS 277

10

Analyzing Structured Decision Systems 282

- METHODS AVAILABLE 282
- OVERVIEW OF STRUCTURED DECISIONS 282
 - Semistructured and Structured Decisions 283
 - Information Required for Structured Decisions 285
- STRUCTURED ENGLISH 288
 - Writing Structured English 289
- DECISION TABLES 292
 - Developing Decision Tables 295
 - Checking for Completeness and Accuracy 298
 - More Advanced Decision Tables 301
- DECISION TREES 303
 - Drawing Decision Trees 304
- CHOOSING A STRUCTURED DECISION-ANALYSIS TECHNIQUE 309
- SUMMARY 310
- KEYWORDS AND PHRASES 310
- REVIEW QUESTIONS 311
- PROBLEMS 311

11

Analyzing Semistructured Decision Support Systems 315

- METHODS AVAILABLE 315
- DECISION SUPPORT SYSTEMS 316
 - Characteristics of a Decision Support System 316
 - Decision Support System Users 317
- DECISION-MAKING CONCEPTS RELEVANT TO DSS 319
 - Decision Making Under Risk 319
 - Decision-Making Style 320
 - Problem-Solving Phases 324
- SEMISTRUCTURED DECISIONS 324
 - Dimensions of Semistructured Decisions 325
 - Semi-structured Decisions in Intelligence, Design, and Choice 328
- MULTIPLE-CRITERIA DECISION MAKING 332
 - Using a Tradeoff Process 333
 - Using Weighting Methods 334