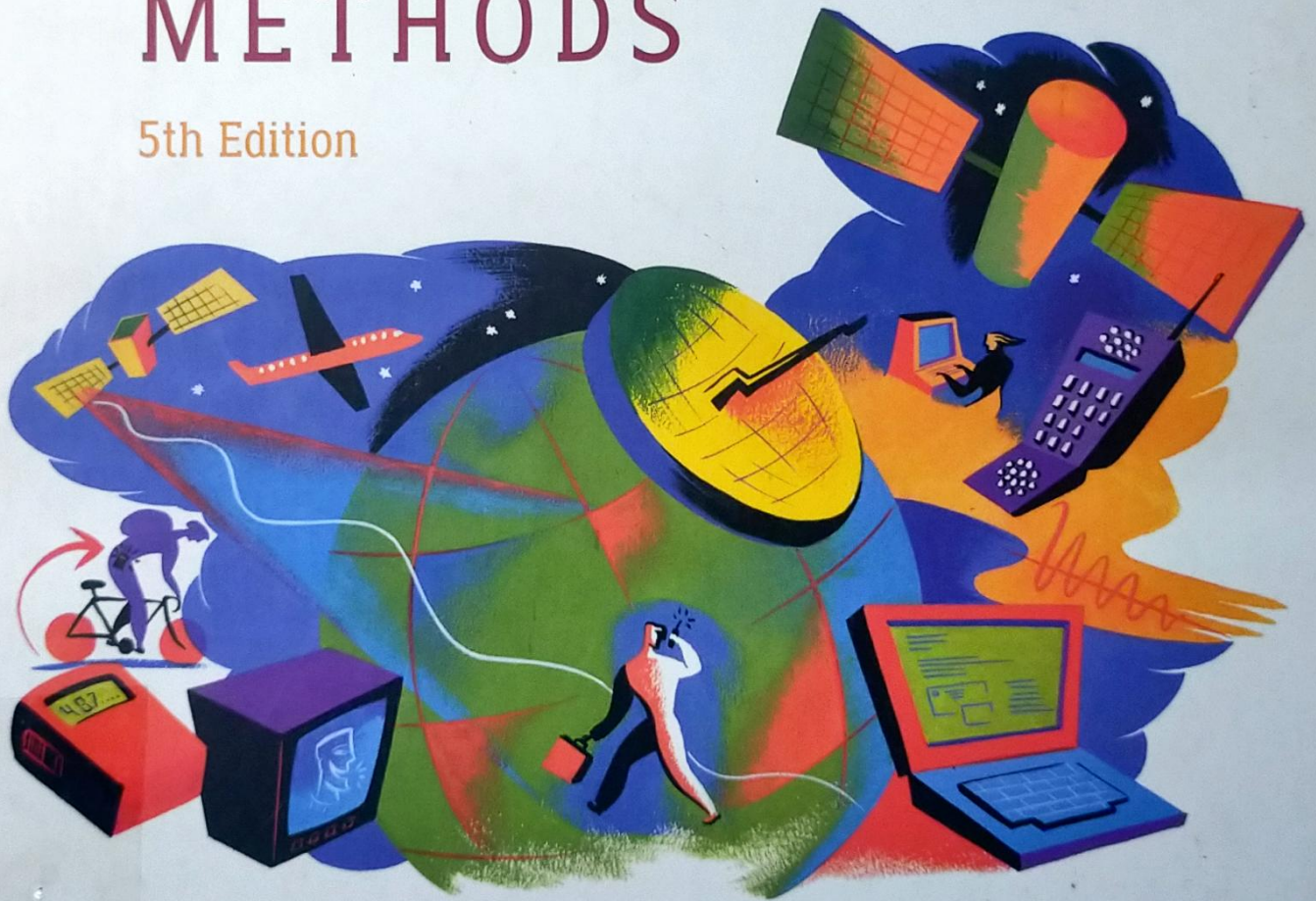


SYSTEMS ANALYSIS AND DESIGN METHODS

5th Edition



Jeffrey L. Whitten Lonnie D. Bentley Kevin C. Dittman

www.mhhe.com/whitten

FIFTH EDITION

SYSTEMS ANALYSIS AND DESIGN METHODS

JEFFREY L. WHITTEN

Professor

LONNIE D. BENTLEY

Professor

KEVIN C. DITTMAN

Assistant Professor

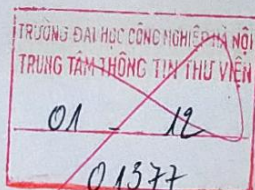
All at Purdue University

West Lafayette, IN



GIFT OF THE ASIA FOUNDATION
NOT FOR RE-SALE

QUÀ TẶNG CỦA QUỸ CHÂU Á
KHÔNG ĐƯỢC BÁN LẠI



**McGraw-Hill
Irwin**

Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis
Bangkok Bogotá Caracas Lisbon London Madrid
Mexico City Milan New Delhi Seoul Singapore Sydney Taipei Toronto

McGraw-Hill Higher Education

A Division of The McGraw-Hill Companies

SYSTEMS ANALYSIS AND DESIGN METHODS

Published by Irwin/McGraw-Hill, an imprint of The McGraw-Hill Companies, Inc. 1221 Avenue of the Americas, New York, NY, 10020. Copyright © 2000, 1998, 1994, 1989, 1986, by The McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc., including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

domestic 3 4 5 6 7 8 9 0 WCK/WCK 0 9 8 7 6 5 4 3 2
international 3 4 5 6 7 8 9 0 WCK/WCK 0 9 8 7 6 5 4 3 2

ISBN 0-07-231539-3

Vice President/Editor-in-chief: *Michael W. Junior*

Publisher: *David Kendrick Brake*

Senior sponsoring editor: *Rick Williamson*

Developmental editor: *Christine Wright*

Senior marketing manager: *Jeff Parr*

Senior project manager: *Susan Trentacosti*

Manager, new book production: *Melonte Salvati*

Senior designer: *Kiera Cunningham*

Senior supplement coordinator: *Marc Mattson*

Cover image: © *Linda Bleck/SIS*

Compositor: *GTS Graphics, Inc.*

Typeface: *10/12 Garamond Light*

Printer: *Quebecor World/Versailles*

Library of Congress Cataloging-in-Publication Data

Whitten, Jeffrey L.

Systems analysis and design methods / Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C.

Dittman. —5th ed.

p. cm.

ISBN 0-07-231539-3 (alk. paper)

1. System design. 2. System analysis. I. Bentley, Lonnie D. II. Dittman, Kevin C. III.

Title.

QA76.9.S88 W48 2001

004.2'1—dc21

00-040694

INTERNATIONAL EDITION ISBN 0-07-118070-2

Copyright © 2001. Exclusive rights by The McGraw-Hill Companies, Inc. for manufacture and export.

This book cannot be re-exported from the country to which it is sold by McGraw-Hill.

The International Edition is not available in North America.

www.mhhe.com

PART ONE THE CONTEXT OF SYSTEMS ANALYSIS AND DESIGN

1

CHAPTER 1

Players in the Systems Game 2

SoundStage Entertainment Club 4

How to Use the Demonstration Case 8

Why Study Systems Analysis and Design Methods? 8

Information Workers 9

System Owners 9

System Users 11

System Designers 12

System Builders 13

Systems Analysts 13

Information Technology Vendors and Consultants 13

The Modern Systems Analyst 13

Why Do Businesses Need Systems Analysts? 13

What Is a Systems Analyst? 14

What Does a Systems Analyst Do? 15

Where Do Systems Analysts Work? 15

Modern Business Trends and Implications 20

Total Quality Management 20

Business Process Redesign 20

Continuous Process Improvement 21

Globalization of the Economy 21

Information Technology Trends and Drivers 22

Preparing for a Career as a Systems Analyst 24

Working Knowledge of Information Technology 24

Computer Programming Experience and Expertise 24

General Business Knowledge 25

Problem-Solving Skills 25

Interpersonal Communication Skills 25

Interpersonal Relations Skills 26

Flexibility and Adaptability 27

Character and Ethics 27

Systems Analysis and Design Skills 28

The Next Generation 29

Career Prospects 29

Predictions 29

Where Do You Go from Here? 30

CHAPTER 2

Information System Building Blocks 36

SoundStage Entertainment Club 38

The Product—Information Systems 45

Transaction Processing Systems 46

Management Information Systems 47

Decision Support Systems 47

Expert Systems 48

Office Automation Systems 48

Putting It All Together 49

A Framework for Information Systems Architecture 51

DATA Building Blocks 52

PROCESS Building Blocks 56

INTERFACE Building Blocks 60

Using the Framework for Information Systems Architecture 63

Where Do You Go from Here? 66

CHAPTER 3

Information Systems Development 72

SoundStage Entertainment Club 74

The Process of Systems Development 75

The Capability Maturity Model 76

Systems Life Cycle versus Systems Development Methodologies 77

Underlying Principles for Systems Development 79

A Systems Development Methodology 84

Project Identification 84

Project Phases 86

Cross Life Cycle Activities 92

Alternative Routes and Methods 94

Model-Driven Development Route 94

Rapid Application Development Route 98

Commercial Off-the-Shelf Package Software Route 100

Hybrid Approaches 103

The Maintenance and Reengineering Route 105

Automated Tools and Technology	106
CASE—Computer-Aided Systems Engineering	107
Application Development Environments	109
Process and Project Managers	110
Where Do You Go from Here?	111

CHAPTER 4

Project Management	120
SoundStage Entertainment Club	122
What Is Project Management?	123
The Causes of Failed Projects	125
The Project Management Body of Knowledge	126
The Project Management Life Cycle	132
Activity 1—Negotiate Scope	133
Activity 2—Identify Tasks	134

Activity 3—Estimate Task Durations	136
Activity 4—Specify Intertask Dependencies	137
Activity 5—Assign Resources	139
Activity 6—Direct the Team Effort	143
Activity 7—Monitor and Control Progress	144
Activity 8—Assess Project Results and Experiences	154
Where Do You Go from Here?	154

PART TWO SYSTEMS ANALYSIS METHODS

CHAPTER 5

Systems Analysis	162
SoundStage Entertainment Club	164
What Is Systems Analysis?	165
Systems Analysis Approaches	167
Model-Driven Analysis Approaches	167
Accelerated Analysis Approaches	171
Requirements Discovery Methods	172
Business Process Redesign Methods	173
FAST Systems Analysis Strategies	174
The Preliminary Investigation Phase	174
Task 1.1—List Problems, Opportunities, and Directives	176
Task 1.2—Negotiate Preliminary Scope	178
Task 1.3—Assess Project Worth	179
Task 1.4—Plan the Project	179
Task 1.5—Present the Project and Plan	180
The Problem Analysis Phase	181
Task 2.1—Study the Problem Domain	183
Task 2.2—Analyze Problems and Opportunities	185
Task 2.3—Analyze Business Processes	186

Task 2.4—Establish System Improvement Objectives	187
Task 2.5—Update the Project Plan	188
Task 2.6—Present Findings and Recommendations	188
The Requirements Analysis Phase	189
Task 3.1—Define Requirements	192
Task 3.2—Analyze Functional Requirements	193
Task 3.3—Trace and Complete Requirements	195
Task 3.4—Prioritize Requirements	196
Task 3.5—Update the Project Plan	196
Ongoing Requirements Management	197
The Decision Analysis Phase	197
Task 4.1—Identify Candidate Solutions	199
Task 4.2—Analyze Candidate Solutions	200
Task 4.3—Compare Candidate Solutions	202
Task 4.4—Update the Project Plan	202
Task 4.5—Recommend a Solution	202
The Next Generation of Systems Analysis	203
Where Do You Go from Here?	205

CHAPTER 6

Requirements Discovery	212
SoundStage Entertainment Club	214
An Introduction to Requirements Discovery	215
The Process of Requirements Discovery	218
Problem Discovery and Analysis	218
Requirements Discovery	219
Documenting and Analyzing Requirements	221
Requirements Management	223
Requirements Discovery Methods	223
Sampling of Existing Documentation, Forms, and Files	223
Research and Site Visits	225
Observation of the Work Environment	226
Questionnaires	228
Interviews	230
How to Conduct an Interview	232
Discovery Prototyping	237
Joint Requirements Planning (JRP)	238
A Fact-Finding Strategy	243
Documenting Requirements Methods	244
Use Cases	244
How to Document a Use Case	245

Decision Tables	247
Requirements Tables	247
Where Do You Go from Here?	249

CHAPTER 7

Data Modeling and Analysis	254
SoundStage Entertainment Club	256
An Introduction to Systems Modeling	257
System Concepts for Data Modeling	260
Entities	260
Attributes	261
Relationships	264
The Process of Logical Data Modeling	273
Strategic Data Modeling	273
Data Modeling during Systems Analysis	275
Looking Ahead to Systems Design	276
Automated Tools for Data Modeling	277
How to Construct Data Models	277
Entity Discovery	277
The Context Data Model	279
The Key-Based Data Model	281
Generalized Hierarchies	284
The Fully Attributed Data Model	284
Analyzing the Data Model	286
What Is a Good Data Model?	286
Data Analysis	288
Normalization Example	288
Mapping Data Requirements to Locations	297
Where Do You Go from Here?	298

CHAPTER 8

Process Modeling	304
SoundStage Entertainment Club	306
An Introduction to Systems Modeling	307
System Concepts for Process Modeling	310
Process Concepts	310
Data Flows	321
External Agents	329
Data Stores	330
The Process of Logical Process Modeling	331
Strategic Systems Planning	331
Process Modeling for Business Process Redesign	332
Process Modeling during Systems Analysis	332
Looking Ahead to Systems Design	332
Fact-Finding and Information Gathering for Process Modeling	334
Computer-Aided Systems Engineering (CASE) for Process Modeling	334
How to Construct Process Models	336
The Context Data Flow Diagram	336
The Functional Decomposition Diagram	337
The Event-Response or Use Case List	339
Event Decomposition Diagrams	340
Event Diagrams	340
The System Diagram(s)	345
Primitive Diagrams	347
Completing the Specification	347
Synchronizing of System Models	351
Data and Process Model Synchronization	351

Process Distribution	352
The Next Generation	353
Where Do You Go from Here?	355

CHAPTER 9

Feasibility Analysis and the System Proposal	362
SoundStage Entertainment Club	364
Feasibility Analysis and the System Proposal	364
Feasibility Analysis—A Creeping Commitment Approach	365
Systems Analysis—Preliminary Investigation Checkpoint	365
Systems Analysis—Problem Analysis Checkpoint	365
Systems Design—Decision Analysis Checkpoint	367
Four Tests for Feasibility	367
Operational Feasibility	367
Technical Feasibility	369
Schedule Feasibility	369
Economic Feasibility	370
The Bottom Line	370
Cost-Benefit Analysis Techniques	370
How Much Will the System Cost?	370
What Benefits Will the System Provide?	371
Is the Proposed System Cost-Effective?	373
Feasibility Analysis of Candidate Systems	377
Candidate Systems Matrix	377
Feasibility Analysis Matrix	378
The System Proposal	380
Written Report	380
Formal Presentation	383

PART THREE SYSTEMS DESIGN METHODS 391**CHAPTER 10**

Systems Design	392
SoundStage Entertainment Club	394

What Is Systems Design?	394
Systems Design Approaches	395
Model-Driven Approaches	395

Rapid Application Development (RAD)	401
FAST Systems Design Strategies	401

Systems Design for In-house Development—The “Build” Solution	401
Task 5.1—Design the Application Architecture	403
Task 5.2—Design the System Database(s)	405
Task 5.3—Design the System Interface	405
Task 5.4—Package Design Specifications	407
Task 5.5—Update the Project Plan	408
Systems Design for Integrating Commercial Software—The “Buy” Solution	408
Task 4.1—Research Technical Criteria and Options	408
Task 4.2—Solicit Proposals (or Quotes) from Vendors	411
Task 5A.1—Validate Vendor Claims and Performances	413
Task 5A.2—Evaluate and Rank Vendor Proposals	413
Task 5A.3—Award (or Let) Contract and Debrief Vendors	414
Impact of Buy Decisions on Remaining Life Cycle Phases	414
Where Do You Go from Here?	415

CHAPTER 11

Application Architecture and Modeling	420
SoundStage Entertainment Club	422
Application Architecture	423
Physical Data Flow Diagrams	424
Physical Processes	425
Physical Data Flows	428
Physical External Agents	430
Physical Data Stores	430
Information Technology Architecture	430
Distributed Systems	432
DATA Architectures—Distributed Relational Databases	443
INTERFACE Architectures—Inputs, Outputs, and Middleware	445
PROCESS Architecture—The Software Development Environment	449

Application Architecture Strategies for Systems Design	452
The Enterprise Application Architecture Strategy	452
The Tactical Application Architecture Strategy	452
Modeling the Application Architecture of an Information System	453
Drawing Physical Data Flow Diagrams	453
Prerequisites	454
The Network Architecture	454
DATA Distribution and Technology Assignments	456
PROCESS Distribution and Technology Assignments	456
The Person/Machine Boundaries	458
Where Do You Go from Here?	458

CHAPTER 12

Database Design	466
SoundStage Entertainment Club	468
Conventional Files versus the Database	470
The Pros and Cons of Conventional Files	470
The Pros and Cons of Database	472
Database Concepts for the Systems Analyst	473
Fields	473
Records	473
Files and Tables	474
Databases	475
Prerequisite for Database Design—Normalization	481
What Is a Good Data Model?	481
Conventional File Design	482
Modern Database Design	482
Goals and Prerequisites to Database Design	483
The Database Schema	483
Data and Referential Integrity	488
Roles	489
Database Distribution and Replication	491
Database Prototypes	492
Database Capacity Planning	492

Database Structure Generation	492
The Next Generation of Database Design	493
Where Do You Go from Here?	495

CHAPTER 13

Output Design and Prototyping	502
SoundStage Entertainment Club	504
Output Design Concepts and Guidelines	505
Distribution and Audience of Outputs	505
Implementation Methods for Outputs	509
How to Design and Prototype Outputs	513
Automated Tools for Output Design and Prototyping	513
Output Design Guidelines	515
The Output Design Process	517
Web-Based Outputs and E-Business	525
Where Do You Go from Here?	528

CHAPTER 14

Input Design and Prototyping	534
SoundStage Entertainment Club	536
Input Design Concepts and Guidelines	537
Data Capture, Data Entry, and Data Processing	537
Input Methods and Implementation	540
System User Issues for Input Design	543
Internal Controls—Data Editing for Inputs	544
GUI Controls for Input Design	546
Common GUI Controls for Inputs	546
Advanced Input Controls	552
How to Design and Prototype Inputs	552
Automated Tools for Input Design and Prototyping	554

The Input Design Process	554	Types of Computer Users	571	Windows and Frames	577
Web-Based Inputs and E-Business	560	Human Factors	572	Menu-Driven Interfaces	577
Where Do You Go from Here?	560	Human Engineering Guidelines	573	Instruction-Driven Interfaces	584
		Dialogue Tone and Terminology	574	Question-Answer Dialogues	586
CHAPTER 15		User Interface Technology	575	Special Considerations for User Interface Design	587
User Interface Design	568	Operating Systems and Web Browsers	575	How to Design and Prototype a User Interface	590
SoundStage Entertainment Club	570	Display Monitor	575	Automated Tools for User Interface Design and Prototyping	590
User Interface Design Concepts and Guidelines	571	Keyboards and Pointers	576	The User Interface Design Process	592
		Graphical User Interface Styles and Considerations	577	Where Do You Go from Here?	597

PART FOUR BEYOND SYSTEMS ANALYSIS AND DESIGN

603

CHAPTER 16

Systems Construction and Implementation 604

SoundStage Entertainment Club	606
What Is Systems Construction and Implementation?	607
The Construction Phase	607
Task 6.1—Build and Test Networks (If Necessary)	607
Task 6.2—Build and Test Databases	609
Task 6.3—Install and Test New Software Packages (If Necessary)	609
Task 6.4—Write and Test New Programs	609
The Implementation Phase	611

Task 7.1—Conduct System Test	612	System Maintenance	628
Task 7.2—Prepare Conversion Plan	612	Task 8.1.1—Validate the Problem	629
Task 7.3—Install Databases	615	Task 8.1.2—Benchmark Program	630
Task 7.4—Train Users	615	Task 8.1.3—Study and Debug the Program	631
Task 7.5—Convert to New System	616	Task 8.1.4—Test the Program	631
Where Do You Go from Here?	617	System Recovery	632
		Technical Support	633
		System Obsolescence	633
		Task 8.4.1—Analyze Enhancement Request	635
		Task 8.4.2—Make the Quick Fix	635
		Task 8.4.3—Recover Existing Physical System	636
		System Enhancement	638
		Where Do You Go from Here?	638

CHAPTER 17

Systems Operations and Support 622

SoundStage Entertainment Club	624
The Context of Systems Operation and Support	625

PART FIVE ADVANCED ANALYSIS AND DESIGN METHODS

643

MODULE A

Object-Oriented Analysis and Modeling 644

An Introduction to Object Modeling	646
System Concepts for Object Modeling	647
Objects, Attributes, Methods, and Encapsulation	647
Classes, Generalization, and Specialization	649

Object/Class Relationships	651	Modeling the Behavior of the Objects	668
Messages	654	Where Do You Go from Here?	668
Polymorphism	654		
The UML Diagrams	655		
The Process of Object Modeling	656		
Modeling the Functional Description of the System	656	MODULE B	
Finding and Identifying the Business Objects	659	Object-Oriented Design and Modeling	674
Organizing the Objects and Identifying Their Associations	661	An Introduction to Object-Oriented Design	676

Design Objects	676	Modeling Object Interactions and Behaviors that Support the Use-Case Scenario	679	Additional UML Design and Implementation Diagrams	687
Object Responsibilities	677			Where Do You Go from Here?	692
Object Reusability	677				
The Process of Object-Oriented Design	678	Updating the Object Model to Reflect the Implementation Environment	687	Glossary/Index	695
Refining the Use-Case Model to Reflect the Implementation Environment	678				