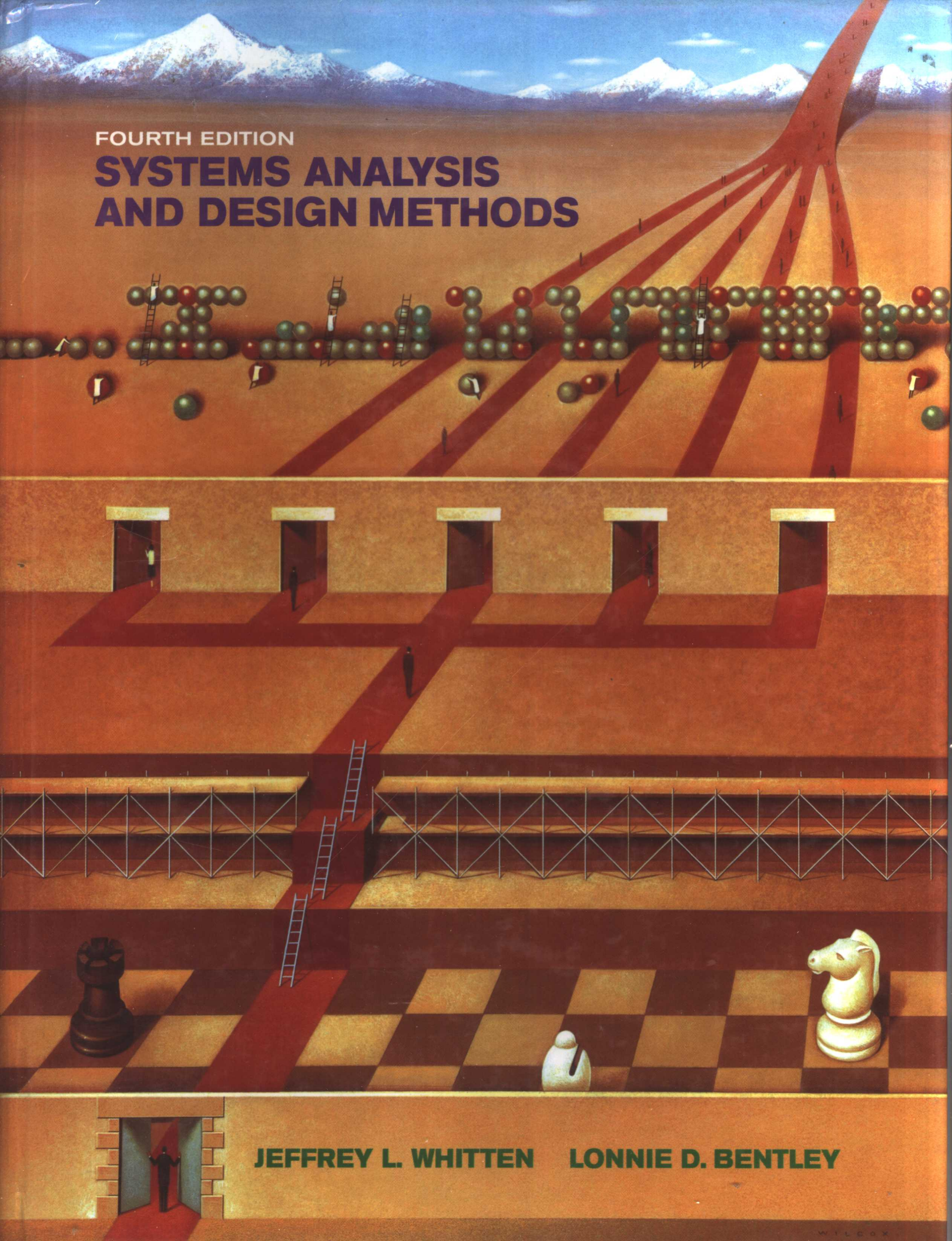


FOURTH EDITION

# SYSTEMS ANALYSIS AND DESIGN METHODS



JEFFREY L. WHITTEN

LONNIE D. BENTLEY

**FOURTH EDITION**

# **SYSTEMS ANALYSIS AND DESIGN METHODS**

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### **SYSTEMS ANALYSIS AND DESIGN METHODS**

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To my wife, Deb. Your love and encouragement have given new significance to my every accomplishment. Also, to my mother and father. You have always been a source of inspiration.—*Jeff*

To my wife and best friend, Cheryl.  
And to my children, Coty, Robert, and Heath.  
God blessed me with a wonderful family.—*Lonnie*

To the students and alumni of the Computer Technology Department at Purdue University, West Lafayette, and Stateside Technology sites. May all your experiences be successful.—*Jeff and Lonnie*



## INTENDED AUDIENCE

*Systems Analysis and Design Methods*, fourth edition, is intended to support a practical course in information systems development. This course is normally taught at the sophomore, junior, senior, or graduate level. It is taught in vocational trade schools, junior colleges, colleges, and universities. The course is taught to both information systems and business majors. Previous editions have been used successfully in one-, two-, and three-semester and quarter-based systems.

The textbook can support a superset of the following courses from the *IS'95 Information Systems Model Curriculum* as jointly developed by the Association of Computing Machinery (ACM), the Association for Information Systems (AIS), and the Data Processing Management Association (DPMA):

- IS 95.7 Analysis and Logical Design
- IS 95.8 Physical Design and Implementation with DBMS
- IS 95.9 Physical Design and Implementation with a Programming Environment

We recommend that students should have taken a computer and information systems literacy course. While **not** required or assumed, a personal computing literacy course, and a programming course can enhance the learning experience provided by this textbook.

## WHY WE WROTE THIS BOOK

More than ever, today's students are "consumer-oriented," due in part to the changing world economy that promotes quality, competition, and professional currency. They expect to walk away from a course with more than a grade and a promise that they'll someday appreciate what they've learned. They want to "practice" the application of concepts, not just study applications of concepts. We wrote the previous editions of this book to deal with the following perceived problems:

- Some books were (and still are) *too conceptual*. Examples were too few, too late, or too loosely integrated to generate student interest.
- Some books were (and still are) *too mechanical*. They ignored concepts in favor of techniques. We continue to strive toward a balance of concepts, techniques, and applications.
- To our surprise, many books *still* perpetuate the myth that classical, structured, and modern techniques are mutually exclusive. Students need to develop an appreciation of the value added by continuously improving tools and techniques.
- Most books *still* lack sufficient examples and integrated cases to adequately demonstrate concepts and techniques.

Our goal was to write a textbook that overcomes these problems. Additionally, we wanted to write a textbook that would serve the reader as a post-course, professional reference for best current practices.

Consistent with the first three editions, we have written the book using a lively, conversational tone. Our experience suggests that the more traditional, academic tone detracts from student interest. Our conversational approach admittedly results in a somewhat longer text; however, the "talk with you—not at you" style seems to work well with a wider variety of students. We hope that our style does not offend or patronize any specific audience. We apologize if it does.

## CHANGES FOR FOURTH EDITION

We believe that we have preserved all of the features you liked in the previous editions. And in the spirit of continuous improvement we have made the following changes:

- The fourth edition returns to the legacy of its namesake, *systems analysis and design methods*. The coverage of systems planning, systems implementation, and systems support is downsized, and primarily serves to place those peripheral subjects into the context of systems analysis and design. The basic philosophical change was that, "if we want to teach anything worthwhile, we must not try to teach everything." In order to maintain currency in analysis and design, we elected to summarize all other phases.

- The *pyramid* model for conceptual foundations has served us well for three editions, but now gives way to a *matrix* model that more clearly reinforces the concepts of information systems and their development. The *Zachman Framework for Information Systems Architecture* continues to organize the subject's conceptual foundations. The "network" column of the third edition and Zachman's framework has been renamed "geography" to avoid any confusion with "computer networking and technology." Finally, an "interface" column has been added to reflect both the emergence of the graphical user interface and the importance of systems integration.
- This edition further emphasizes systems analysis and design techniques for developing *client/server* or *distributed computing applications*. The mainframe is considered just another server.
- The fundamentals unit (Part One) has been downsized from five chapters to three as a direct response to adopters' requests to accelerate the path into the skill units and chapters.
- The opening chapter (1) relates the overall subject matter to current business and information strategies such as *information strategy planning*, *total quality management*, *business process redesign*, and *continuous process improvement*.
- The *information systems building blocks* chapter (2) has been downsized at the request of third edition adopters. Its sole intent in this edition is to introduce the Zachman framework that will organize the concepts, tools, and techniques taught in the course.
- The *systems development life cycle* and *methodology* chapters have been integrated—yet simplified. Life cycle/methodology coverage has been modernized; however, it returns to a derivative of the second edition life cycle that offered a simpler and cleaner "problem-solving approach" to the subject. Details about the phases are deferred to the analysis, design, and implementation chapters that introduce (or conclude) their respective units.
- The *CASE* chapter has been deleted from the fundamentals unit; however, CASE is introduced early and reinforced often throughout the text.
- This edition replaces DOS-based CASE tools with *Windows*-based equivalents. Popkin's *System Architect* provides an inexpensive upper-CASE environment that supports *both* structured and object-oriented methods. Microsoft's *Visual Basic* provides a popular lower-CASE, object-based, rapid application development (RAD) environment that supports design and prototyping. Very similar functionality can be achieved with *Delphi*, *Powerbuilder*, and other visual programming environments.
- The *data modeling* chapter (5) now uses the more popular Martin-style entity relationship diagrams that are common to information engineering.
- The *process modeling* chapter (6) has undergone significant revisions for the first time since the first edition. The top-down approach to DFDs is replaced by the more modern event-driven approach as recommended by McMenamin, Palmer, Yourdon, and many information engineering-based methodologies.
- The *network modeling* (as in data and process distribution) chapter (7) is improved by the incorporation of association matrices from information engineering.
- Object-oriented analysis and design are truly emerging. In the previous edition, we retreated from extensive coverage because we did not sense that any one OO paradigm had developed the requisite industry following. *Object modeling* (Chapter 8) is formally taught in this edition as an *alternative* to data and process modeling. After studying competing methods and paradigms, we have elected to synthesize concepts from several methodologies, but present them within the context of Rumbaugh's *object modeling technique (OMT)* that had a wider industry acceptance than either the Booch or Coad/Yourdon techniques. We also incorporated elements from the very popular use case techniques as developed by Jacobson.  
Like many others, we greatly anticipate the arrival of the so-called unified *Object Modeling Language* that is being developed through the collaboration of Rumbaugh, Jacobson, and Booch. Even Ed Yourdon (of the Coad/Yourdon technique fame) has conceded in his newsletters that the unified language will probably prevail.
- The *project repository* chapter from the third edition has been effectively merged into the data, process, network, and object modeling chapters.
- The design unit (Part Three) pervasively applies a *rapid application development (RAD)* technique using Microsoft's *Visual Basic* for design prototyping. The conceptual framework for this approach is also compatible with other RAD technologies such as Powersoft's *Powerbuilder* and Borland's *Delphi*.
- The *analysis-to-design transition* coverage from third edition has been modified to better support distributed computing client/server environments. The chapter title has been changed to *Application Architecture and Process Design* (Chapter 10).
- The *database design* chapter (11) more adequately addresses modern *distributed database technology* (using *Oracle* as an example) and *data distribution* techniques that are becoming commonplace in client/server computing environments.

- *Input and output design* has been split into separate chapters (12 and 13). Each chapter has been significantly modernized to reflect newer, pervasive technologies and paperless design techniques.
- The *user interface design* chapter (14) has been completely modernized to focus on GUI design strategies and techniques using the popular *Windows* client as an example. Examples of such GUI designs are provided through *Visual Basic*, but they apply to almost any GUI-based development environment.
- The *structured design* chapter (15) has been both simplified and modernized to better teach transition from data flow models to structure charts using a relatively simple and elegant algorithm.
- An *object-oriented design* chapter (16), using the aforementioned OMT technique, has been added to complement the object modeling chapter (8) in the analysis unit (Part Two). It is reasonable to expect that object methods will eventually replace structured methods, but that may not happen until the fifth or sixth edition.
- The *project management* module (A) has received its first-ever complete revision. The revision is based on computer-based project management using Microsoft *Project* tools and techniques.
- An entire module (D) has been added to teach *joint requirements planning/joint application development* (JRP/JAD) techniques as they apply to systems analysis and design.

## PEDAGOGICAL USE OF COLOR

The fourth edition continues the use of full color applied to an adaptation of Zachman's *Framework for Information Systems Architecture*. Based on adopter feedback, we have reduced the number of base colors to four (with a fifth color used only in the two object-oriented chapters). The color mappings are as follows:

- Indicates something to do with "data"
- Indicates something to do with "processes"
- Indicates something to do with "geography"
- Indicates something to do with "interface"
- Indicates something to do with "objects" (only applicable to Chapters 8 and 16)

The Information Systems Architecture matrix uses these colors to associate concepts with the model.

## ORGANIZATION

*Systems Analysis and Design Methods*, fourth edition, is divided into five parts. Past experience indicates that instructors can omit and resequence chapters as they

feel is important to their audience. Every effort has been made to decouple chapters from one another as much as possible to assist in resequencing the material—even to the extent of reintroducing selected concepts and terminology. The Instructor's Edition and the Instructor's Guide should clearly indicate any exceptions to this general rule.

Part One, "The Context of Systems Analysis and Design Methods," presents the information systems development situation and environment. The chapters introduce the student to systems analysts and the systems development team, information systems building blocks, and a contemporary systems development methodology. Part One has been redesigned so that it can be covered more quickly.

Part Two, "Systems Analysis Methods," covers the front-end life cycle activities, tools, and techniques for analyzing business requirements for an improved system. Coverage can be restricted to either structured or object-oriented techniques, but both are recommended since industry is caught in what should prove to be a lengthy transition from structured methods to object-oriented methods. The network modeling chapter (7) is optional, but recommended in light of client/server application trends that will distribute data, processes, and objects throughout a distributed computing network.

Part Three, "Systems Design and Construction Methods," covers the middle life cycle activities, tools, and techniques. It includes coverage of both general and detailed design with a particular emphasis on design decision making, human factors, and rapid application development.

Part Four, "Beyond Systems Analysis and Design," is a capstone unit that places systems analysis and design into perspective by surveying the back-end life cycle activities. The systems implementation and support chapters (17 and 18) are intended primarily to bridge this textbook's systems analysis and design coverage with the students' prior programming experiences.

Part Five, "Cross Life Cycle Activities and Skills," introduces material that spans multiple phases of systems development. Chapters are replaced by modules that can be interwoven into the course at various points in time (or assigned as supplemental reading). The modules include project and process management (A), fact-finding and information gathering (B), feasibility analysis and cost-benefit analysis (C), joint application development (D), and interpersonal skills and communications (E). The Instructor's Edition provides threads in appropriate chapters that might be enhanced by introducing material from these modules.

See the Instructor's Annotated Edition or the Instructor's Guide for more information on how to use this book in a variety of course formats and sequences.

## SUPPLEMENTS

It has always been our intent to provide our adopters with a complete course, not just a textbook. We are especially excited about this edition's comprehensive support package. It includes software and instructional bundles for both the student and instructor. The supplements for this edition include the following components.

### For the Instructor

**Instructor's Edition.** Once again, an Instructor's Edition of the textbook is available. For each chapter, it provides an instructor's overview, chapter-to-course sequencing (new!), summary of changes for the fourth edition, and a topical/sentence outline (new!).

**Instructor's Guide.** For those instructors more comfortable with a separate instructor supplement, an Instructor's Guide is available. It provides the same front- and back-matter as the Instructor's Edition, but also provides instructional notes embedded within a "notes pages" printout of complete Microsoft *PowerPoint* presentations. The electronic versions of these presentations will either be available through your McGraw-Hill sales representative, or downloadable from the textbook's World Wide Web site.

**Test Bank.** A written Test Bank covering all the chapters and modules includes more than 3,000 questions. Each chapter and module has questions in the following formats: true/false, multiple choice, sentence completion, and matching. The test bank and answers are cross referenced to the page numbers in the textbook. An electronic version of the test bank is available for the creation of customized exams.

**Laboratory CASE Tools.** Popkin Software & Systems, Inc. is making available a *University Edition* program for their CASE product, *System Architect*. *System Architect* provides *Windows*-based CASE tools for all of the techniques taught in this edition, inclusive of object-oriented analysis and design. The *University Edition* software provides identical functionality to the commercial product to support large student projects, at a nominal cost. This software requires a network. To obtain the software, contact:

University Edition Program Manager  
Popkin Software  
11 Park Place  
New York, NY 10007  
(212) 571-3434

Academic grant programs are available for other CASE tools including Visible Systems' *Visible Analyst Workbench*. Your McGraw-Hill representative can provide further details.

**RAD Tools.** Academic grants or educational discounts are widely available for RAD software development

environments such as *Visual Basic*, *Powerbuilder*, and *Delphi*. All of these development environments support visual construction of graphical user interfaces and various degrees of database connectivity and rapid application development.

### For the Student

**Application Cases Workbook.** The application cases workbook has been rewritten by Professor Kevin C. Dittman under our direct review. The new format provides for multiple minicases that are cross-referenced for use in specific chapters and modules. Additionally, the workbook provides three challenging case studies suitable for a term project with milestones. Also, the *Build Your Own Case* option has been further refined for this edition.

**CASE Tools.** We recognize that greater numbers of students own their own PCs. Now they can install CASE technology on those PCs. Popkin Software is providing a *Student Edition* of *System Architect (Book Mode)*. It supports all of the diagrams covered in the textbook, and it is restricted to 10 diagrams, 300 symbols, and 400 definitions per encyclopedia. That should be more than sufficient to support homework and subsets of project work. (If the adopting school purchases the networked *University Edition*, students can directly upgrade to the *Student Edition (Lab Mode)*, which triples these limits.) The diagrams developed in both *Student Editions* can be exported to, and imported from, the full-function *University Edition* of *System Architect*. The software is packaged with a tutorial written by our colleague, Professor Kevin C. Dittman. It is available only through McGraw-Hill and your local bookstore.

In addition, Visible Systems' *Visible Analyst Workbench (Student Edition)* can be packaged with the text. It has similar functionality to *System Architect's Student Edition*.

## ACKNOWLEDGMENTS

We are indebted to many individuals who have contributed to the development of four editions of this textbook. First, we wish to thank Susan Solomon, Larry Alexander, and Rick Williamson who in succession managed the editorial development of the first three editions. These individuals each contributed support to their management for what, at the time, must have seemed to be unusual author demands for subject matter content, format, and strategy. We owe a debt of gratitude for all those times they supported our ideas to top management! Thanks for believing! We also thank their colleagues and staffs who contributed to the success of the prior editions.

We would also like thank our colleague Kevin Dittman who wrote several modules, collaborated with us on the



object-oriented chapters, and wrote many of the supplements. We look forward to Kevin's increased role in the future editions of this book.

We would also like to thank our colleague Carlin R. Smith who developed database and screen prototypes for this edition. His detailed understanding of the *Visual Basic* and *SQL Server* client/server environments added value in the form of technical currency.

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Your patience and constructive criticism were essential and appreciated. As you might guess, opinions from different individuals were varied. We have incorporated as many as possible into this edition. And as usual, we have already started a file for fifth edition—after we catch our breath, of course.

Special thanks are offered to Dorothy Jane Miller and JoAnne Anderson, our secretaries, who provided special assistance throughout the project. Not a single edition would have ever seen the light of day without their support and service.

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We also thank our students and alumni. Your future is our incentive. You make teaching a worthwhile experience. We truly grow through your successes!

Finally, we acknowledge the contributions, encouragement, and patience of the staff of Irwin/McGraw-Hill. For aspiring authors, you can't do any better than these folks! For this edition, special thanks to Rick Williamson for never losing his cool in the wake of deadlines we missed; to Christine Wright, our developmental editor; to Susan Trentacosti, who as production editor for two editions has established the benchmark of excellence in that role. We also thank Bob Lange, Charlene Perez, Heidi Baughman, Keith McPherson, Keri Johnson, and Jim Rogers.

We hope we haven't forgotten anyone. And we assume full responsibility for any inadequacies or errors in this text. We eagerly await your reactions and willingly provide the following Internet forums for your comments and suggestions:

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To those who used our previous three editions, thank you for your continued support. And for new adopters, we hope you'll see a difference in this text. We hope you enjoy using the textbook as much as we have enjoyed writing it. And until the *fifth edition*, go forth and teach . . . there is no nobler profession!

Jeffrey L. Whitten  
 Lonnie D. Bentley

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