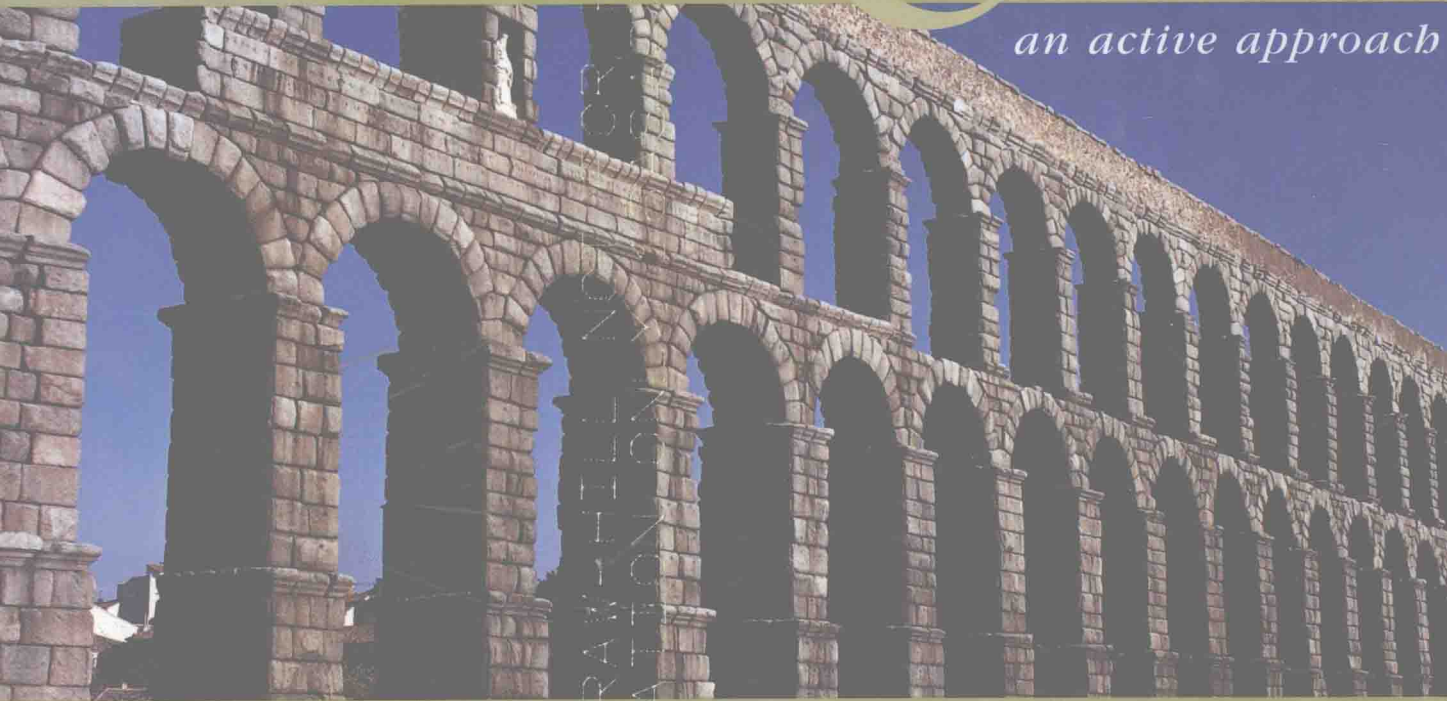


Systems Analysis & Design

an active approach



Second Edition

George M. Marakas

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George M. Marakas

*Professor of Information Systems
University of Kansas*



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Systems Analysis & Design

An Active Approach

This book is dedicated to my wonderful daughter
Stephanie:

Always teach from your heart and
your students will always keep you in theirs.

About the Author

George M. Marakas is a professor of information systems in the Accounting and Information Systems Department at the University of Kansas. His teaching expertise includes systems analysis and design, technology-assisted decision making, electronic commerce, managing IS resources, behavioral IS research methods, and data visualization and decision support. In addition, he is an active researcher in the areas of systems analysis methods, data mining and visualization, creativity enhancement, conceptual data modeling, and computer self-efficacy. He is the recipient of the Center for Teaching Excellence–Lilly Teaching Fellowship and the highly prestigious Krowe Foundation Award for Innovation Excellence in Teaching. His research has appeared in the top journals in his field, including *Management Science*, *Information Systems Research*, *International Journal of Human–Computer Studies*, and *European Journal of Information Systems*. In addition, Dr. Marakas is the author of the top-selling textbook *Decision Support in the 21st Century*.

Prior to his academic career, Dr. Marakas enjoyed a successful career as an analyst and systems designer in both the banking and the real estate industries. As a result, Dr. Marakas is an active consultant to a number of organizations, including Citibank–Asia, Nokia Corporation, United Information Systems, Federal National Mortgage Association, Central Intelligence Agency, U.S. Department of the Treasury, National Institute of Drug Abuse, Burger King Corporation, Lotus Development Corporation, and British-American Tobacco, among many others. In addition, Dr. Marakas is considered a leading expert in the area of e-business global strategy, and he travels the planet lecturing and consulting on e-business issues for large, multinational corporations.

Dr. Marakas is an avid musician and songwriter and enjoys tinkering in his recording studio whenever time permits. He is also an active member of a number of professional IS organizations and is an avid golfer, a PADI master scuba diver trainer, and a member of Pi Kappa Alpha fraternity.

Preface

Twenty-five or thirty years ago, a conference called the “CEO in the Wired World” would not have been possible. And twenty years from now, it will not be necessary.

—Peter Drucker, *Excerpt from Keynote Address at the First CEO Technology Retreat in 1994*

We are witnessing the early, turbulent days of a revolution as significant as any other in human history. A new medium of human communication is emerging—one that may surpass the printing press, telephone, and television in its impact on our economic and social lives. Interactive multimedia and the information highway are creating a new economy based on the networking of human intelligence.

—Donald Tapscott, *The Digital Economy*

These two epigraphs, when combined in message, serve to define the role of the systems analyst in the 21st century. Anything that can become digital will become digital, and this means that all organizations will ultimately become irreversibly dependent on their information and automation systems and the people who design, develop, and maintain them. The core competencies for the information systems (IS) professional in this wired world are built on an understanding of the process by which a business problem or economic opportunity is identified and a successful solution is crafted.

This is exactly what this textbook is about—the core competency for the 21st-century IS professional—systems analysis and design (SAD). As organizations increase both their awareness of ISs as strategic tools and their dependency on them, they are also embracing the structured techniques, developed and refined over the last four decades, used to design and implement those systems. In this new economy, the age-old role of programmer as designer is being replaced by the professional Business Technologist, written with a capital *B* and a capital *T*. Organizations need IS professionals who both understand the intricacies of their business and can skillfully apply a technological solution to their complex problems and strategic initiatives. Although the names and the activities have changed over the last 40 years, such a person has been, and will continue to be, the professional systems analyst.

In the coming decades, no stone will be left unturned with regard to the design and deployment of information technologies to capture the narrow windows of economic opportunities that present themselves to wired organizations. For the most part, these “stones” will be turned over by systems analysts who have been trained in structured problem-solving approaches and the crafting of holistic, technology-based solutions. No company of any measurable size will be able to function without a highly valued cadre of systems analysts who are always at the center of their information initiatives. A recent conversation with a bright MBA student of mine may help to make this point. We will call him Jim.

“Professor Marakas,” said Jim. “I am really struggling with where to focus my energies in getting a job when I graduate. It just seems like the really hot technology companies are in such demand that everyone is aiming for them, and I am worried that I will not be able to compete with the rest of the computer geeks.”

“This is quite a surprise to me, Jim,” I said. “I was under the impression that you received a rather substantial offer from United Parcel Service just last week.”

Jim’s expression was clearly one of disappointment. “Oh yeah,” he said. “The offer from UPS was great, but I was counting on working for a company that was really driven by technology so that I could get involved in some cutting-edge stuff. I really do not want to work for someone that delivers boxes all day.”

It was clear to me that Jim had missed the most important aspect of the job offer. “Jim, what business do you think UPS is really in?” I queried.

Jim quickly informed me that “UPS delivers boxes.”

The point of this anecdote is that the world is wired and, regardless of the product or service that a company offers, it is most certainly highly dependent on an IS. UPS is in more than a box delivery business; it is also a manager, provider, and procurer of reliable information about its deliveries. In a larger sense, everything it does is information—the numbers and letters written on the packages and swirling in the organization’s electronic soup are just as critical to achieving the company’s mission as the jets and vans that actually transport the packages. All of this information is managed by the team of IS professionals, including a large army of systems analysts, employed at UPS—a company, by the way, that has one of the largest IS budgets in the world!

CONCEPT AND PURPOSE

Teaching systems analysis poses several challenges to the modern business school. Most notably, systems analysis is not something you *know*; it is something you *do*. Because of this, learning how to *do* systems analysis cannot be easily accomplished simply by reading a book. This would be analogous to learning how to paint by reading a book and never touching a brush. This text and its accompanying curriculum resources were developed using the guiding principle that when students are *doing* systems analysis they develop a richer understanding of the concepts, activities, tools, and techniques that are used daily by the professional systems analyst. Further, given the fierce competition for jobs at the undergraduate and MBA levels, those students, when interviewing, who can say “I have done that” or “I have used that analysis tool” will fare much better than the student who can say only “I have read about that” or “We learned about that tool in our systems class.” This is the essence of this book—an *active approach to systems analysis and design*.

WHO SHOULD USE THIS BOOK

This book is directed to business school students who aspire to a career in ISs and who want to be an integral part of the strategic initiatives of their organization. The primary targets for this text are upper-level undergraduate or MBA SAD requisites or electives. These types of courses are regularly offered at both four-year universities and many community colleges. Ideally, students should have completed an introductory MIS program and, most likely, a semester of structured programming before moving toward a focus on SAD. In addition, the chapter content and organization assume that the student has already completed, or is concurrently completing, a database design course. Finally, the further the student is in his or her business curriculum, the more relevant the structured problem-solving perspective of the text becomes. The chapters in this text are written so as to provide a good reference for both students and practitioners to use throughout the course of their daily analysis and design activities.

ELEMENTS OF PEDAGOGY

This text employs a variety of pedagogical techniques intended to create a rich, realistic environment in which the student can actively pursue an understanding of the world of SAD. The combination of the various approaches to learning used in this program of study is

also intended to accommodate the widest possible range of cognitive styles for both the instructor and the students.

Chapter Learning Objectives

A statement of learning objectives for each chapter is presented in both performance and behavioral terms. In other words, the objectives state what the student should be capable of *understanding* and *doing* as a result of reading the chapter.

Figures and Tables

Clear and carefully designed figures and tables have been included to aid in the student's understanding of the material. Wherever possible, the diagrams contained in each chapter not only are referenced in the body of the text but are positioned such that they can serve as a repeated visual reference for the detailed explanation that follows.

Key Terminology

Immediately following each chapter summary is an alphabetical glossary of the key terms presented in the chapter. This section can aid the student in reviewing the material contained in the chapter in preparation for either class discussion or examination. In addition, each of the key terms in the book has been used to create matching questions in the supplemental test bank.

Questions for Review

Each chapter contains a list of 15 to 20 questions intended to allow students to test their retention and understanding of the material contained in the chapter. Each question is phrased such that the answer can be readily found in the chapter and that a detailed and precise answer can be provided. Sample responses to each question are provided in the *Instructor's Manual* supplement to this text.

For Further Discussion

Following the review questions, several additional questions are provided at the end of each chapter that expand on the material presented. These questions are intended to allow the student to engage in a richer thought process and discussion than would occur using only the review questions. Each of the discussion questions can be used to engage students in an open class discussion, and many of them easily can be expanded into individual or team mini-projects. Sample responses to each question are provided in the *Instructor's Manual* supplement to this text.

Role-Play Case Scenarios

One of the most unique aspects of this approach to *doing* SAD is the use of multimedia-supported role-playing scenarios. Through the use of the access-controlled nomasweb.com Web site available to adopters and students using this text, the students engage in a series of team-oriented, role-play case studies that are intended to simulate the activities, episodes, and encounters typically experienced during the various phases of the systems development life cycle (SDLC). Each case and its associated role-play presentation is designed to create a realistic simulation of the technical, organizational, social, cultural, and behavioral aspects of business problem identification and solving.

Role-play as a pedagogical approach brings with it a number of benefits unavailable in other learning approaches:

- It allows students to empathize with others in the various roles commonly found in a social setting.

- Students can experience responsibilities and burdens associated with the role of the expert.
- The scenarios require that students select, sort, retrieve, link, and prioritize information.
- The ambiguity of the role-playing scenarios requires that the participants form hypotheses and generalizations from specific evidence.
- The role-play presentations to the “client” participants require that the students verbally and visually summarize issues relevant to the specific stage of the process.
- The students are able to reflect on how, what, and why they are learning.
- The participants are able to experience, firsthand, the chronological order of analysis and design events.
- The students develop their skills with regard to listening for meaning, purpose, innuendo, and tone as a means of garnering additional information from dialogue.
- Most important, the students learn to work meaningfully in groups, as a whole class, and individually.

Most would agree that it is not possible to teach SAD experiences. However, students can learn the theories that underlie good analysis and design practice. If they are then given the opportunity to apply these theories to real situations (but without the pressures of failure in an actual work environment), the students can learn how the theories apply in practice. When students are given immediate feedback, asked to reflect on that feedback, and provided with an opportunity to put their revised thoughts into practice, they most certainly improve their individual skills in business problem identification and the technology-based crafting of appropriate solutions.

There is a significant amount of empirical evidence in support of the role-play approach to learning found in the academic literature. Kolb’s model of experiential learning (Kolb, 1984) provides the educational validity of this approach. The Teach and Govahi (1993) survey found that role-plays were the most effective method of developing conflict resolution and communication skills. Van Ments (1983) identifies negotiation, a common activity in SAD, as one of the specific areas in which role-play is most effective. Petranek, Corey, and Black (1992) provide further advice on how to best use role-plays in higher education.¹

Interactive Multimedia Web Site: www.nomasweb.com

All of the materials necessary to conduct the role-playing case studies are delivered and managed through the accompanying Web-based course management system. The Web site contains the case study materials; streaming-audio interview sessions with the client; various software-based analysis tools; a complete course management system, including presentation scheduling, time-released case documents, course material distribution, a team document upload repository, an automated peer evaluation system for grading the role-play presentations by each team, and several evaluation and grade book functions to facilitate the delivery of this course. A demo of the entire NOMAS system is available at www.nomasweb.com. Details of the setup and use of the Web-based course management system can be found on instructor-accessible sections of this site. The instructor-accessible sections of the site are password-protected. To receive your user name and password, please contact your local McGraw-Hill/Irwin representative.

¹Kolb, D. 1984. *Experiential Learning: Experience as the Source of Learning and Development*. Upper Saddle River, NJ: Prentice Hall.

Petranek, C., S. Corey, and R. Black. 1992. “Three Levels of Learning in Simulations: Participation, Debriefing, and Journal Writing.” *Simulation and Gaming* 23(2): 174–185.

Teach, R., and G. Govahi. 1993. “The Role of Classroom Techniques in Teaching Management Skills,” *Simulation and Gaming* 24(4): 429–445.

Van Ments, M. 1983. *The Effective Use of Role-Play*. London: Kogan Page.

CHAPTER DESCRIPTIONS

Chapter 1—The Systems Development Environment

The opening chapter provides an overview of the environment of the modern systems analyst, as well as a conceptual understanding of the state of the art. We identify the various roles within the software development process, outline the basic skill set necessary to pursue a career in SAD, and present an initial understanding of the phased development approach.

Chapter 2—So What Is the Problem?

Chapter 2 focuses on developing an understanding of the concepts of problem recognition and problem definition. We present initial problem categorization tools, such as Ishikawa charts and Wetherbe's PIECES framework. Finally, we explain in detail the individual phases of the SDLC, along with the expected activities and deliverables from each.

Chapter 3—Identification and Selection of Development Projects

Chapter 3 acquaints the student with the processes by which organizations identify and select IS projects. In addition, we present the concept of an IS steering committee and discuss the various roles. Finally, this chapter introduces the logical versus physical building blocks of a modern IS.

Chapter 4—System Requirements Determination

The activities associated with gathering and organizing end users' requirements are the focus of Chapter 4. Students are introduced to the various traditional and modern data-gathering methods, along with examples of when each may be appropriately applied.

Chapter 5—Modeling the Processes and Logic

Chapter 5 covers the concepts, tools, and techniques associated with the construction of both process and logic models. We introduce the data flow diagram (DFD) and several logic modeling tools, including structured English, decision trees and tables, and state-transition diagrams.

Chapter 6—Modeling the Data: Conceptual and Logical Data Modeling

In Chapter 6, we turn our attention to the tools and techniques associated with data modeling by introducing the entity-relationship diagram (ERD). To ensure that these concepts are well engrained in the students' understanding, we present in review form several building blocks from their database course, including cardinality, relationship degree, and optionality.

Chapter 7—CASE Tools and Joint and Rapid Application Development

Chapter 7 provides an overview of the evolution of modern CASE tools, as well as coverage of the advantages and disadvantages associated with their deployment in an organization. In addition, we present the process of joint application development in conjunction with an overview of rapid application development as it compares and contrasts to the traditional SDLC approach.

Chapter 8—Moving from Analysis to Design

Chapter 8 begins the shift of focus from the logical design of a system to the physical specifications. We present the various categories of feasibility assessment and economic justification in this chapter.

Chapter 9—Designing Systems for Diverse Environments

Chapter 9 is intended to allow the student to gain an appreciation of the diversity of design and development environments faced by the modern analyst. We discuss design issues related to centralized versus distributed systems, various network topologies, and unique characteristics of systems operating in enterprise resource planning (ERP), data warehouse, collaborative, and intranet environments.

Chapter 10—Designing the Files and Databases

The conversion of the logical data models to physical databases and files is presented in Chapter 10. This chapter also serves as a review of the basic concepts taught in the typical database design course.

Chapter 11—Designing the System Output

In Chapter 11, we present the basic characteristics of high-quality system output and the processes and techniques commonly employed to create such output. In addition, the student is introduced to the concepts associated with the development of control strategies to manage the various types of outputs generated by IS. Finally, we present an overview of various backup and retention strategies.

Chapter 12—Designing the Inputs and User Interface

Chapter 12 covers the various types of common user interfaces and focuses the student on the importance of proper application and design of the interface. We present guidelines for effective interface design, and we continue, from an input control perspective, the presentation of control design issues that began in Chapter 11.

Chapter 13—Designing the System Internals

The concepts of structured and modular design are presented in Chapter 13. Here, the focus is on the design of high-quality program code modules. We present and discuss several concepts, including factoring, coupling, cohesions, and module size.

Chapter 14—Implementing and Maintaining the System

The final chapter of the text allows students to explore the issues and constraints often associated with the activities performed during the implementation and maintenance of a new IS. Topics include selection of an appropriate test strategy, conversion planning and approaches, and development and delivery of various system documentation elements.

Appendix A—Project Management: Process, Techniques, and Tools

Appendix A is intended to be used as a refresher for those students who have had previous training or experience in cross-life-cycle activities related to project management. If such training is not a normal part of the curriculum, Appendix A can be taught as a separate module within the SAD course.

Appendix B—Object-Oriented Analysis and Design

Appendix B provides an overview of the object-oriented approach to analysis and design. It can be used as a reference, overview, or precursor to a more detailed discussion of the object-oriented methods.

INSTRUCTOR SUPPORT MATERIALS

The instructor's resources feature the following support materials:

- *Instructor's Manual*, by George M. Marakas—contains an overview of each chapter, teaching suggestions, and answers to both the review and discussion questions.
- *NOMAS Instructor's Manual*, by George M. Marakas—contains a detailed explanation of the conduct of each of the 10 NOMAS cases, along with sample solutions and deliverables. This supplement is available in the Faculty Resource section of the nomasweb.com Web site.
- *Test Item File*, by Nathan Stout and Geoffrey G. McGregor—includes true/false, multiple choice, fill-in-the blank, matching, and essay questions covering the key issues for every chapter.
- *PowerPoint Slides*, by George Marakas—feature key concepts and diagrams from the book.

Acknowledgments

Having lived through the humbling, sometimes arduous, but inevitably satisfying experience of writing my first textbook, I vowed never to do it again. As evidenced by this text, that vow was both short-lived and quickly forgotten. This was, to a large extent, due to my desire to make a positive contribution to the careers of the next generation of systems professionals. It was also due to the unending support and encouragement of my family. I never realized how much can be accomplished.

No project of this magnitude can be accomplished without the constant help of a large number of devoted people. Some were charged with correcting my mistakes, others with answering my questions, several with contributing to the vast amount of required labor, and all with reassuring me in the myriad times of self-doubt and frustration. Without them, I do not believe this book would have come to pass. What follows is a brief, but nonetheless heartfelt, expression of my deepest gratitude and dedication to those people who were instrumental in the development of this project.

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To my daughter, Stephanie, who is enjoying her own successful career as an educator, I also express my thanks. Stephanie has never been shy about expressing her pride in me, and I want it on record that I am proud of her devotion to shaping the future through teaching. I am also just plain proud of her, too!

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To my mentors, Dan Robey and Joyce Elam: You have given of yourselves to teach me how to teach others. Without your wisdom and guidance I would be lost.

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George M. Marakas

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