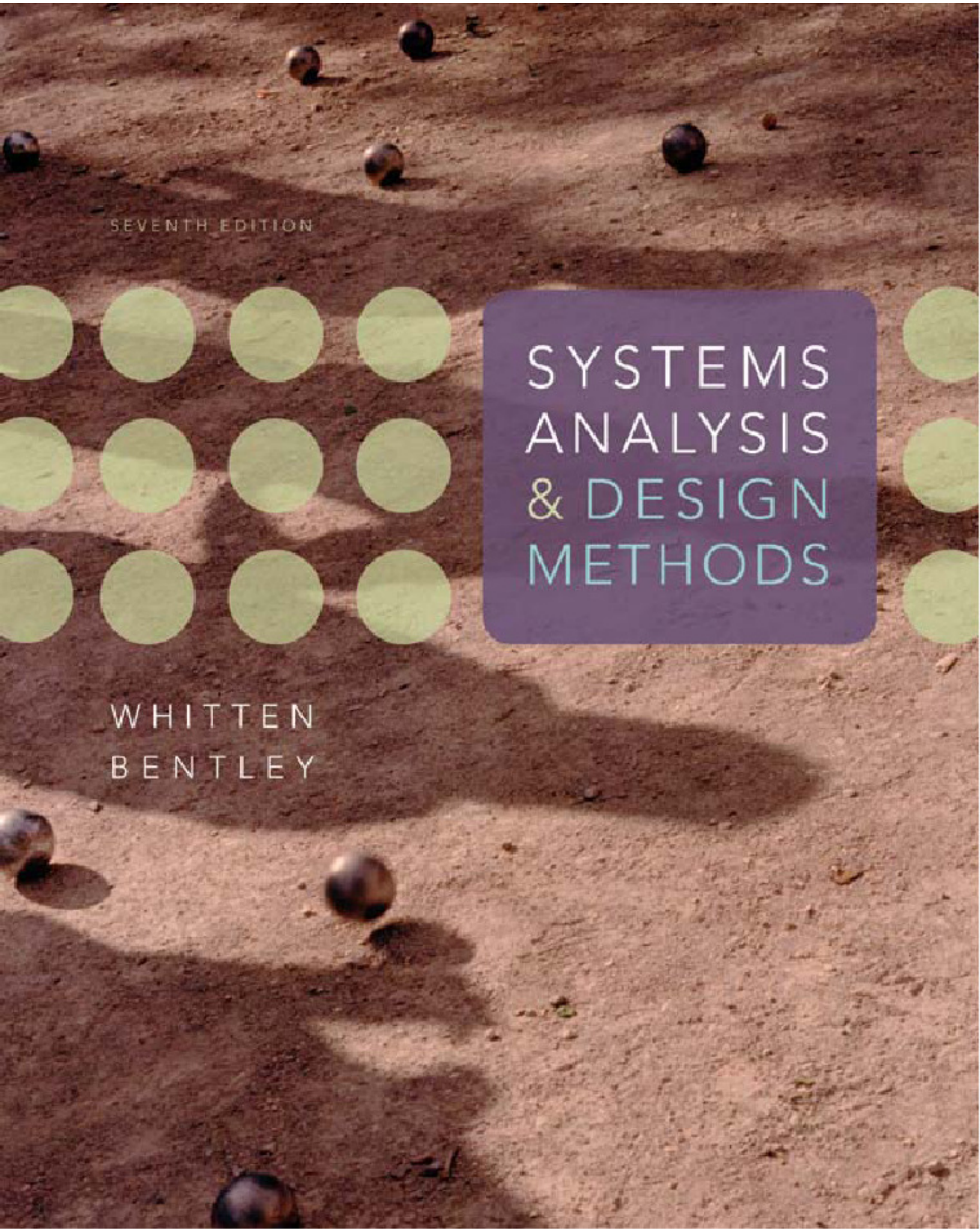
SEVENTH EDITION
SYSTEMS ANALYSIS & DESIGN METHODS
WHITTEN
BENTLEY

Systems Analysis and Design Methods

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Dedication

To my lovely wife Cheryl and my children Robert, Heath, and Coty. To my coauthor and good friend Jeff and our twenty years of writing side by side.

–Lonnie

To my father. You instilled in me the work ethic, perseverance, and curiosity for knowledge that has made this book possible.

–Jeff

Preface

> Intended Audience

Systems Analysis and Design Methods, seventh edition, is intended to support one or more practical courses in information systems development. These courses are normally taught to both information systems and business majors at the sophomore, junior, senior, or graduate level.

We recommend that students take a computer- and information systems–literacy course before using this text. While not required or assumed, a programming course can significantly 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, which 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 this book (1) to balance the coverage of concepts, tools, techniques, and their application, (2) to provide the most examples of system analysis and design deliverables available in any book, and (3) to balance the coverage of classic methods (such as *structured analysis* and *information engineering*) and emerging methods (e.g., *object-oriented analysis, agile development,* and *rapid application development*). Additionally, our goal is to serve the reader by providing a postcourse, professional reference for the best current practices.

We have written the book using a lively, conversational tone. This approach (and the numerous examples) delivers a comprehensive text that still connects with the student throughout the learning process.

> Changes for the Seventh Edition

- **Reorganization for Better Clarity:** The object-oriented analysis chapter has become Chapter 10 to better position it alongside the structured analysis chapters (Chapters 8 and 9). Other chapters have been reorganized internally. For example, Chapter 9, in response to reviewer comments, has undergone extensive reorganization. Also, the discussion of sequential versus iterative development has been moved to Chapter 3 to place it with related methodology concepts.
- **Expanded Object-Oriented Coverage:** As object-oriented analysis and design grows in importance, coverage continues to increase. The seventh edition more fully explains the object-oriented approach and tracks both where it follows the same path as the traditional, structured approach and where the two approaches part ways. The object-oriented analysis chapter (Chapter 10) features expanded coverage of activity diagrams. New to this edition in Chapter 10 is coverage of system sequence diagrams. Chapter 18 features expanded coverage of object-oriented design. Persistence and system design classes are discussed as well as entity, controller, and interface design classes. The discussion of sequence diagrams and CRC cards has been expanded, and their role in the design process explained more fully. Coverage of design patterns has been greatly expanded with a discussion of the Gang of Four patterns and an examination of two of the patterns.
- **UML 2.0:** Both Chapter 10 and Chapter 18 have been revised to cover the UML 2.0 specification. Each UML 2.0 diagram is listed with an explanation of its purpose. In Chapters 7, 10, and 18, five of the thirteen UML 2.0 diagrams are developed in depth and three more are shown and discussed.
- **Expanded Discussion of Feasibility:** The discussion of feasibility now includes legal feasibility and cultural (or political) feasibility as well as our traditional four tests of feasibility (operational, economic, schedule, and technical).
- **Use of Context Diagrams:** Even as the move away from data flow diagrams and to UML diagrams continues, the context diagram continues to be important as a

tool for understanding system scope. It has been added to the tools used in Chapter 5 and can be employed in the classroom as a first modeling assignment.
- **Updated Technology References:** The extensive references to example technologies has been continued in the seventh edition and updated to reflect technological changes, version updates, and mergers and acquisitions of technology companies.
- **Revision of the SoundStage Running Case:** The SoundStage case has been condensed, changed from a dialogue format to a narrative format, and integrated into the opening of each chapter. Featuring the perspective of a just-graduated systems analyst in his first assignment, SoundStage briefly introduces the concepts taught in each chapter and underscores their importance in a real systems project.

> Pedagogical Use of Color

The seventh edition continues the use of color applied to an adaptation of Zachman's *Framework for Information Systems Architecture*. The color mappings are displayed in the inside front cover of the textbook.

The information systems building blocks matrix uses these colors to introduce recurring concepts. System models then reinforce those concepts with a consistent use of the same colors.

> Organization

Systems Analysis and Design Methods, seventh edition, is divided into four parts. The text's organization is flexible enough to allow instructors to omit and resequence chapters according to what 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.

Part One, "The Context of Systems Development Projects," presents the information systems development scenario and process. Chapters 1 through 4 introduce the student to systems analysts, other project team members (including users and management), information systems building blocks (based on the Zachman framework), a

Information Systems Framework
Color is used consistently throughout the text's framework to introduce recurring concepts.

represents methods

represents data and/or knowledge

represents process

represents communication/interface

represents people

contemporary systems development life cycle, and project management. Part One can be covered relatively quickly. Some readers may prefer to omit project management or delay it until the end of the book.

Part Two, "Systems Analysis Methods," covers the front-end life-cycle activities, tools, and techniques for analyzing business problems, specifying business requirements for an information system, and proposing a business and system solution. Coverage in Chapters 5 through 11 includes requirements gathering, use cases, data modeling with entity-relationship diagrams, process modeling with data flow diagrams, object-oriented analysis, and solution identification and the system proposal.

Part Three, "Systems Design Methods," covers the middle life-cycle activities, tools, and techniques. Chapters 12 through 18 include coverage of both general and detailed design, with a particular emphasis on application architecture, rapid development and prototyping, external design (inputs, outputs, and interfaces), internal design (e.g., database and software engineering), and object-oriented design.

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. Specifically, Chapters 19 and 20 examine system implementation, support, maintenance, and reengineering.

> Supplements and Instructional Resources

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

Web Site/OLC

A completely redesigned Web site provides easy-to-find resources for instructors and students.

For the Instructor

Web Site/OLC

The book's Web site at www.mhhe.com/whitten provides resources for instructors and students using the text. The Online Learning Center (OLC) builds on the book's pedagogy and features with self-assessment quizzes, extra material not found in the text, Web links, and other resources. The instructor side of the site offers a *secure* location for downloading the latest supplemental resources.

Instructor's Manual with PowerPoint Presentations

The instructor's manual is offered on the *Instructor's CD-ROM,* as well as on the book's Web site. This manual includes course planning materials, teaching guidelines and PowerPoint slides, templates, and answers to end-of-chapter problems, exercises, and minicases.

The PowerPoint presentations on the CD-ROM include over 400 slides. All slides are complete with instructor notes that provide teaching guidelines and tips. Instructors can (1) pick and choose the slides they wish to use, (2) customize slides to their own preferences, and (3) add new slides. Slides can be organized into electronic presentations or be printed as transparencies or transparency masters.

Test Bank

The *Instructor's CD-ROM* also includes an electronic test bank covering all the chapters. Computerized/Network Testing with Brownstone Diploma software is fully networkable for LAN test administration. Each chapter offers 75 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. A level-of-difficulty rating is also assigned to each question.

> Packages

Student Resource CD

Each text includes a student CD with two case projects, templates and forms for the projects, the same PowerPoint® slides provided to the instructor, and a 120-day evaluation copy of **Microsoft Project®** accompanied by a step-by-step tutorial.

System Architect Student Edition Version 8

An optional package combines the textbook, Student Resource CD, and a student version of System Architect. System Architect is a powerful, repository-based enterprise modeling tool which supports a comprehensive set of diagramming techniques and features, including all nine UML diagram types, business enterprise modeling, data modeling, business modeling with IDEFO and IDEF3 notations, plus many more.

Visible Analyst Workbench

Another optional package combines the textbook, Student Resource CD, and Visible Analyst Workbench. This tool integrates business function analysis, data modeling and database design, process modeling, and object modeling in one easy-to-use package. Print versions of each case can be ordered through McGraw-Hill's Custom Publishing group by visiting www.primiscontentcenter.com. A *build your own project* model is retained for instructors and students who want to maximize value by leveraging students' past and current work experience or for use with a live-client project.

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Primis Online

Print versions of projects and cases, as well as other MIS content, can be ordered through McGraw-Hill's Custom Publishing Group.

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To those of you who used our previous editions, thank you for your continued support. For those using the text for the first time, we hope you see a difference in this text. We eagerly await your reactions, comments, and suggestions.

Jeffrey L. Whitten
Lonnie D. Bentley

Brief Contents

Contents

Systems Analysis and Design Methods

Part One

The Context of Systems Development Projects

This is a practical book about information systems development methods. All businesses and organizations develop information systems. You can be assured that you will play some role in the systems analysis and design for those systems—either as a customer or user of those systems or as a developer of those systems. Systems analysis and design is about business problem solving and computer applications. The methods you will learn in this book can be applied to a wide variety of problem domains, not just those involving the computer.

Before we begin, we assume you've completed an introductory course in computer-based information systems. Many of you have also completed one or more programming courses (using technologies such as *Access, Java,* C/C++, or *Visual Basic*). That will prove helpful, since systems analysis and design precedes and/or integrates with those activities. But don't worry—we'll review all the necessary principles on which systems analysis and design is based.

Part One focuses on the big picture. Before you learn about specific activities, tools, techniques, methods, and technology, you need to understand this big picture. As you explore the context of systems analysis and design, we will introduce many ideas, tools, and techniques that are not explored in great detail until later in the book. Try to keep that in mind as you explore the big picture.

Systems development isn't magic. There are no secrets for success, no perfect tools, techniques, or methods. To be sure, there are skills that can be mastered. But the complete and consistent application of those skills is still an art.

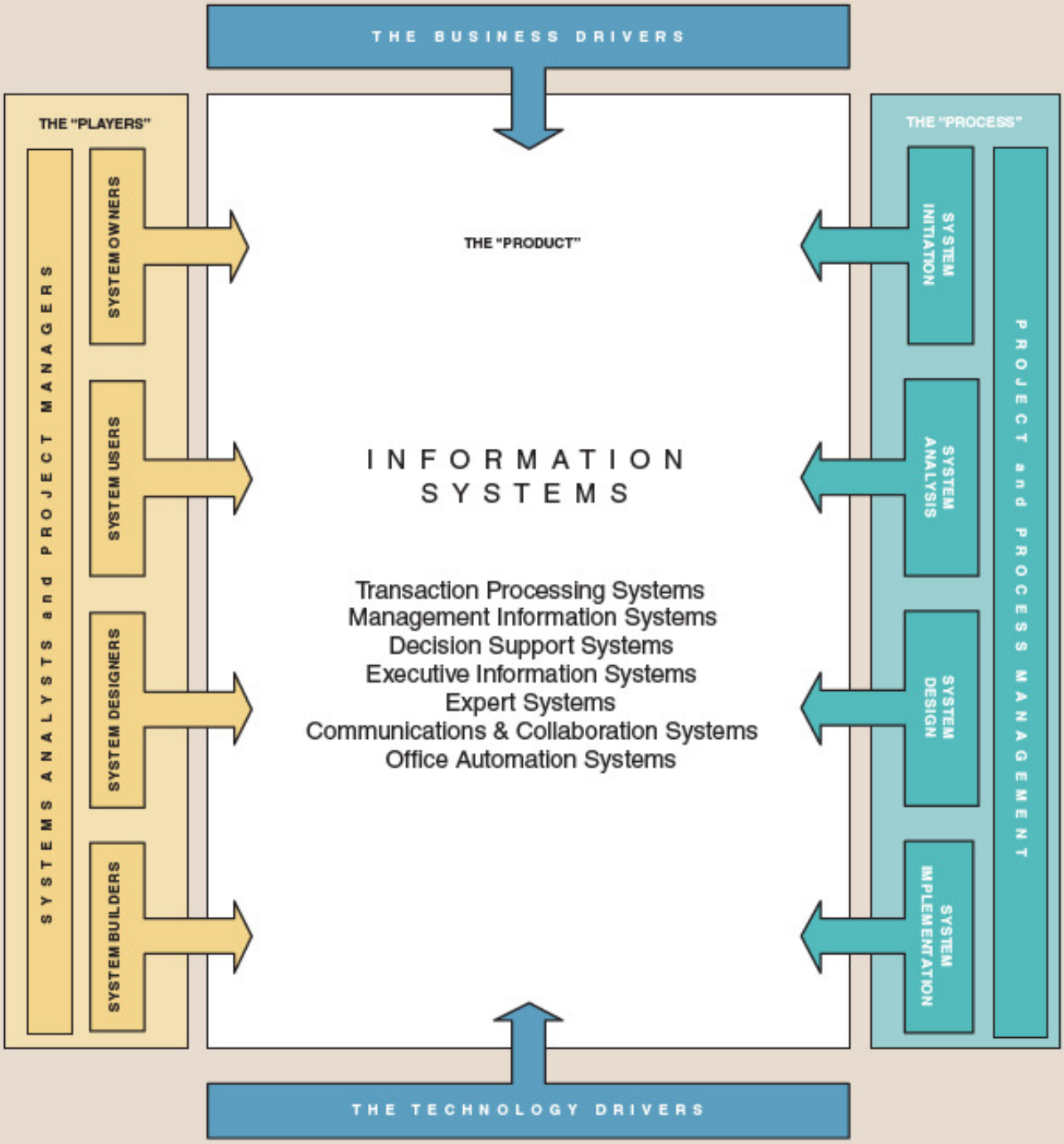
We start in Part One with fundamental concepts, philosophies, and trends that provide the context of systems analysis and design methods—in other words, the basics! If you understand these basics, you will be better able to apply, with confidence, the practical tools and techniques you will learn in Parts Two through Four. You will also be able to adapt to new situations and methods.

Four chapters make up this part. Chapter 1, "The Context of Systems Analysis and Design Methods," introduces you to the *participants* in systems analysis and design with special emphasis on the modern systems analyst as the facilitator of systems work. You'll also learn about the relationships between systems analysts, end users, managers, and other information systems professionals. Finally, you'll learn to prepare yourself for a career as an analyst (if that is your goal). Regardless, you will understand how you will interact with this important professional.

Chapter 2, "Information System Building Blocks," introduces the *product* we will teach you how to build—*information systems.* Specifically, you will learn to examine information systems in terms of common building blocks, KNOWLEDGE, PROCESSES, and COMMUNICATIONS—each from the perspective of different participants or stakeholders. A visual matrix framework will help you organize these building blocks so that you can see them applied in the subsequent chapters.

Chapter 3, "Information Systems Development," introduces a high-level (meaning general) process for information systems development. This is called a *systems development life cycle.* We will present the life cycle in a form in which most of you will experience it—a *systems development methodology.* This methodology will be the context in which you will learn to use and apply the systems analysis and design methods taught in the remainder of the book.

Chapter 4, "Project Management," introduces project management techniques. All systems projects are dependent on the principles that are surveyed. This chapter introduces two modeling techniques for project management: *Gantt* and *PERT.* These tools help you schedule activities, evaluate progress, and adjust schedules.



CHAPTER 1 HOME PAGE Each chapter in this book begins with a "home page" similar to the one above. The home page is something of a chapter map, a visual framework for systems thinking applicable to that chapter. Chapter 1 focuses on (1) the players in the systems game, (2) business drivers of interest to business players, (3) technology drivers and enablers of interest to the technical players, and (4) the process used to develop systems. We will also examine the critical role played by systems analysts in facilitating an understanding of how all four perspectives must come together.

1 The Context of Systems Analysis and Design Methods

Chapter Preview and Objectives

This is a book about systems analysis and design as applied to information systems and computer applications. No matter what your chosen occupation or position in any business, you will likely participate in systems analysis and design. Some of you will become *systems analysts,* the key players in systems analysis and design activities. The rest of you will work *with* systems analysts as projects come and go in your organizations. This chapter introduces you to information systems from four different perspectives. You will understand the context for systems analysis and design methods when you can:

- Define *information system* and name seven types of information system applications.
- Identify different types of *stakeholders* who use or develop information systems, and give examples of each.
- Define the unique role of *systems analysts* in the development of information systems.
- Identify those *skills* needed to successfully function as an information systems analyst.
- Describe current *business drivers* that influence information systems development.
- Describe current *technology drivers* that influence information systems development.
- Briefly describe a simple *process* for developing information systems.

Introduction

It is Bob Martinez's first week at work as an analyst/programmer. Fresh out of college with a degree in computer information systems technology, Bob is eager to work with information systems in the real world. His employer is SoundStage Entertainment Club, one of the fastest-growing music and video clubs in America. SoundStage is just beginning systems analysis and design work on a reengineering of their member services information system. Bob has been appointed to the project team.

This morning was the kickoff meeting for the project, a meeting that included the vice president of member services, director of the audio club, director of the game club, director of marketing, director of customer services, and director of warehouse operations. With that lineup Bob was glad to mainly keep silent at the meeting and rely on his boss, Sandra Shepherd, a senior systems analyst. He was amazed at how well Sandra was able to speak the language of each of the participants and to explain the plans for the new information system in terms they could understand and with benefits they could appreciate. Bob had thought that being just out of college he would know more about cutting-edge technology than most of his co-workers. But Sandra seemed to understand everything about e-commerce and using mobile technologies plus many things of which Bob was only vaguely aware. He made a note to read up on ERP systems as that had come up in the discussion. By the end of the meeting Bob had a new appreciation for the job of systems analyst and of all the things he had yet to learn.

system a group of interrelated components that function together to achieve a desired result.

A Framework for Systems Analysis and Design

information system (IS) an arrangement of people, data, processes, and **information technology** that interact to collect, process, store, and provide as output the information needed to support an organization.

information technology (IT) a contemporary term that describes the combination of computer technology (hardware and software) with telecommunications technology (data, image, and voice networks).

transaction processing system (TPS) an information system that captures and processes data about business transactions.

management information system (MIS) an information system that provides for management-oriented reporting based on transaction processing and operations of the organization.

As its title suggests, this is a book about *systems analysis and design methods.* In this chapter, we will introduce the subject using a simple but comprehensive visual framework. Each chapter in this book begins with a *home page* (see page 4) that quickly and visually shows which aspects of the total framework we will be discussing in the chapter. We'll build this visual framework slowly over the first four chapters to avoid overwhelming you with too much detail too early. Thereafter, each chapter will highlight those aspects of the full framework that are being taught in greater detail in that chapter.

Ultimately, this is a book about "analyzing" business requirements for information systems and "designing" *information systems* that fulfill those business requirements. In other words, the *product* of systems analysis and design is an information system. That product is visually represented in the visual framework as the large rectangle in the center of the picture.

A **system** is a group of interrelated components that function together to achieve a desired result. For instance, you may own a home theater system made up of a DVD player, receiver, speakers, and display monitor.

Information systems (IS) in organizations capture and manage data to produce useful information that supports an organization and its employees, customers, suppliers, and partners. Many organizations consider information systems to be essential to their ability to compete or gain competitive advantage. Most organizations have come to realize that *all* workers need to participate in the development of information systems. Therefore, information systems development is a relevant subject to you regardless of whether or not you are studying to become an information systems professional.

Information systems come in all shapes and sizes. They are so interwoven into the fabric of the business systems they support that it is often difficult to distinguish between business systems and their support information systems. Suffice it to say that information systems can be classified according to the functions they serve. **Transaction processing systems (TPSs)** process business transactions such as orders, time cards, payments, and reservations. **Management information systems (MISs)** use the transaction data to produce information needed by managers to run the business.

Decision support systems (DSSs) help various decision makers identify and choose between options or decisions. **Executive information systems (EISs)** are tailored to the unique information needs of executives who plan for the business and assess performance against those plans. **Expert systems** capture and reproduce the knowledge of an expert problem solver or decision maker and then simulate the "thinking" of that expert. **Communication and collaboration systems** enhance communication and collaboration between people, both internal and external to the organization. Finally, **office automation systems** help employees create and share documents that support day-to-day office activities.

decision support system (DSS) an information system that either helps to identify decision-making opportunities or provides information to help make decisions.

executive information system (EIS) an information system that supports the planning and assessment needs of executive managers.

As illustrated in the chapter home page, information systems can be viewed from various perspectives, including:

- The players in the information system (the "team").
- The business drivers influencing the information system.
- The technology drivers used by the information system.
- The process used to develop the information system.

Let's examine each of these perspectives in the remaining sections of the chapter.

The Players—System Stakeholders

Let's assume you are in a position to help build an information system. Who are the **stakeholders** in this system? Stakeholders for information systems can be broadly classified into the five groups shown on the left-hand side of Figure 1-1. Notice that each stakeholder group has a different perspective of the same information system. The *systems analyst* is a unique stakeholder in Figure 1-1. The systems analyst serves as a facilitator or coach, bridging the communications gap that can naturally develop between the nontechnical system owners and users and the technical system designers and builders.

expert system an information system that captures the expertise of workers and then simulates that expertise to the benefit of nonexperts.

All the above stakeholders have one thing in common—they are what the U.S. Department of Labor calls **information workers.** The livelihoods of information workers depend on decisions made based on information. Today, more than 60 percent of the U.S. labor force is involved in producing, distributing, and using information. Let's examine the five groups of information workers in greater detail.

communications and collaboration system an information system that enables more effective communications between workers, partners, customers, and suppliers to enhance their ability to collaborate.

Let's briefly examine the perspectives of each group. But before we do so, we should point out that these groups actually define "roles" played in systems development. In practice, any individual person may play more than one of these roles. For example, a system owner might also be a system user. Similarly, a systems analyst may also be a system designer, and a system designer might also be a system builder. Any combination may work.

office automation system an information system that supports the wide range of business office activities that provide for improved work flow between workers.

> Systems Owners

For any information system, large or small, there will be one or more **system owners.** System owners usually come from the ranks of management. For medium to large information systems, system owners are usually middle or executive managers. For smaller systems, system owners may be middle managers or supervisors. System owners tend to be interested in the bottom line—how much will the system cost? How much value or what benefits will the system return to the business? Value and benefits can be measured in different ways, as noted in the margin checklist.

stakeholder any person who has an interest in an existing or proposed information system. Stakeholders may include both technical and nontechnical workers. They may also include both internal and external workers.

> Systems Users

System users make up the vast majority of the information workers in any information system. Unlike system owners, system users tend to be less concerned with costs and benefits of the system. Instead, as illustrated in Figure 1-1, they are concerned with the functionality the system provides to their jobs and the system's ease of learning and ease of use. Although users have become more technology-literate over the years,

information worker any person whose job involves creating, collecting, processing, distributing, and using information.

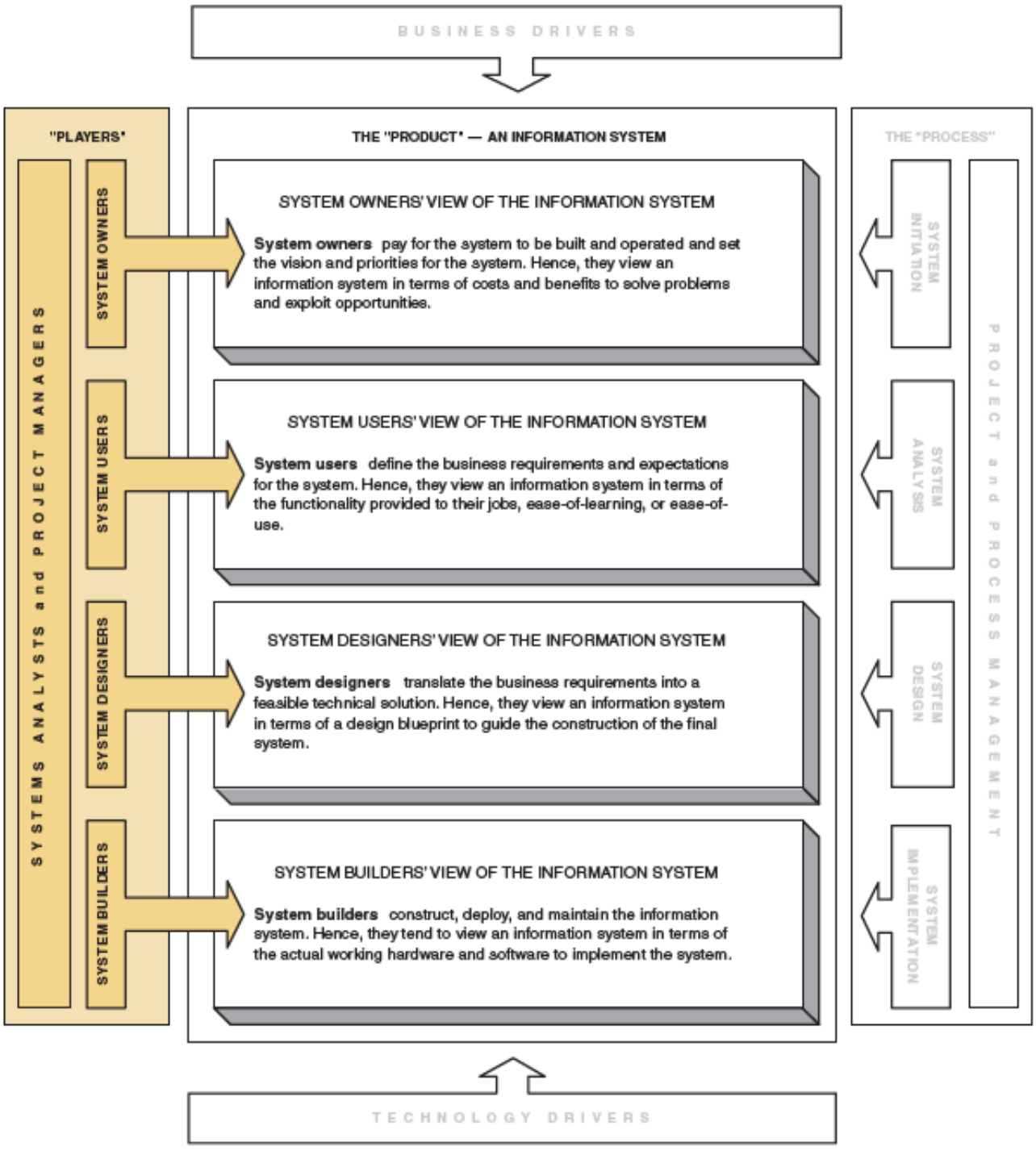


FIGURE 1-1 Stakeholders' Perspective of an Information System

system owner an information system's sponsor and executive advocate, usually responsible for funding the project of developing, operating, and maintaining the information system.

their primary concern is to get the job done. Consequently, discussions with most users need to be kept at the business requirements level as opposed to the technical requirements level. Much of this book is dedicated to teaching you how to effectively identify and communicate business requirements for an information system.

There are many classes of system users. Each class should be directly involved in any information system development project that affects them. Let's briefly examine these classes.

Internal System Users Internal system users are employees of the businesses for which most information systems are built. Internal users make up the largest percentage of information system users in most businesses. Examples include:

- *Clerical and service workers*—perform most of the day-to-day transaction processing in the average business. They process orders, invoices, payments, and the like. They type and file correspondence. They fill orders in the warehouse. And they manufacture goods on the shop floor. Most of the fundamental data in any business is captured or created by these workers, many of whom perform manual labor in addition to processing data. Information systems that target these workers tend to focus on transaction processing speed and accuracy.
- *Technical and professional staff*—consists largely of business and industrial specialists who perform highly skilled and specialized work. Examples include lawyers, accountants, engineers, scientists, market analysts, advertising designers, and statisticians. Because their work is based on well-defined bodies of knowledge, they are sometimes called **knowledge workers.** Information systems that target technical and professional staff focus on data analysis as well as generating timely information for problem solving.
- *Supervisors, middle managers, and executive managers*—are the decision makers. Supervisors tend to focus on day-to-day problem solving and decision making. Middle managers are more concerned with tactical (short-term) operational problems and decision making. Executive managers are concerned with strategic (long-term) planning and decision making. Information systems for managers tend to focus entirely on information access. Managers need the right information at the right time to identify and solve problems and make good decisions.

External System Users The Internet has allowed traditional information system boundaries to be extended to include other businesses or direct consumers as system users. These external system users make up an increasingly large percentage of system users for modern information systems. Examples include:

- *Customers*—any organizations or individuals that purchase our products and services. Today, our customers can become direct users of our information systems when they can directly execute orders and sales transactions that used to require intervention by an internal user. For example, if you purchased a company's product via the Internet, you became an external user of that business's sales information system. (There was no need for a separate internal user of the business to input your order.)
- *Suppliers*—any organizations from which our company may purchase supplies and raw materials. Today, these suppliers can interact directly with our company's information systems to determine our supply needs and automatically create orders to fill those needs. There is no longer always a need for an internal user to initiate those orders to a supplier.
- *Partners*—any organizations from which our company purchases services or with which it partners. Most modern businesses contract or outsource a number of basic services such as grounds maintenance, network management, and many others. And businesses have learned to partner with other businesses to more quickly leverage strengths to build better products more rapidly.
- *Employees*—those employees who work on the road or who work from home. For example, sales representatives usually spend much of their time on the road. Also, many businesses permit workers to telecommute (meaning "work from home") to reduce costs and improve productivity. As mobile or remote users, these employees require access to the same information systems as those needed by internal users.

POSSIBLE VALUES AND BENEFITS OF INFORMATION SYSTEMS

Increased Business Profit
Reduced Business Costs
Costs and Benefits of the System
Increased Market Share
Improved Customer Relations
Increased Efficiency
Improved Decision Making
Better Compliance with Regulations
Fewer Mistakes
Improved Security
Greater Capacity

system user a "customer" who will use or is affected by an information system on a regular basis—capturing, validating, entering, responding to, storing, and exchanging data and information.

knowledge worker any worker whose responsibilities are based on a specialized body of knowledge.

remote user a user who is not physically located on the premises but who still requires access to information systems.

mobile user a user whose location is constantly changing but who requires access to information systems from any location.

External system users are increasingly referred to as **remote users** and **mobile users.** They connect to our information systems through laptop computers, handheld computers, and smart phones—either wired or wireless. Designing information systems for these devices presents some of the most contemporary of challenges that we will address in this book.

> Systems Designers

System designers are technology specialists for information systems. As Figure 1-1 shows, system designers are interested in information technology choices and in the design of systems that use chosen technologies. Today's system designers tend to focus on technical specialties. Some of you may be educating yourselves to specialize in one of these technical specialties, such as:

system designer a technical specialist who translates system users' business requirements and constraints into technical solutions. She or he designs the computer databases, inputs, outputs, screens, networks, and software that will meet the system users' requirements.

- *Database administrators*—specialists in database technologies who design and coordinate changes to corporate databases.
- *Network architects*—specialists in networking and telecommunications technologies who design, install, configure, optimize, and support local and wide area networks, including connections to the Internet and other external networks.
- *Web architects*—specialists who design complex Web sites for organizations, including public Web sites for the Internet, internal Web sites for organizations (called *intranets*), and private business-to-business Web sites (called *extranets*).
- *Graphic artists*—relatively new in today's IT worker mix, specialists in graphics technology and methods used to design and construct compelling and easy-to-use interfaces to systems, including interfaces for PCs, the Web, handhelds, and smart phones.
- *Security experts*—specialists in the technology and methods used to ensure data and network security (and privacy).
- *Technology specialists*—experts in the application of specific technologies that will be used in a system (e.g., a specific commercial software package or a specific type of hardware).

> Systems Builders

system builder a technical specialist who constructs information systems and components based on the design specifications generated by the system designers.

System builders (again, see Figure 1-1) are another category of technology specialists for information systems. Their role is to construct the system according to the system designers' specifications. In small organizations or with small information systems, systems designers and systems builders are often the same people. But in large organizations and information systems they are often separate jobs. Some of you may be educating yourselves to specialize in one of their technical specialties, such as:

- *Applications programmers*—specialists who convert business requirements and statements of problems and procedures into computer languages. They develop and test computer programs to capture and store data and to locate and retrieve data for computer applications.
- *Systems programmers*—specialists who develop, test, and implement operating systems–level software, utilities, and services. Increasingly, they also develop reusable software "components" for use by applications programmers (above).
- *Database programmers*—specialists in database languages and technology who build, modify, and test database structures and the programs that use and maintain them.
- *Network administrators*—specialists who design, install, troubleshoot, and optimize computer networks.
- *Security administrators*—specialists who design, implement, troubleshoot, and manage security and privacy controls in a network.

- *Webmasters*—specialists who code and maintain Web servers.
- *Software integrators*—specialists who integrate software packages with hardware, networks, and other software packages.

Although this book is not directly intended to educate the system builder, it is intended to teach system designers how to better communicate design specifications to system builders.

> Systems Analysts

As you have seen, system owners, users, designers, and builders often have very different perspectives on any information system to be built and used. Some are interested in generalities, while others focus on details. Some are nontechnical, while others are very technical. This presents a communications gap that has always existed between those who need computer-based business solutions and those who understand information technology. The **systems analyst** bridges that gap. You can (and probably will) play a role as either a systems analyst or someone who works with systems analysts.

systems analyst a specialist who studies the problems and needs of an organization to determine how people, data, processes, and information technology can best accomplish improvements for the business.

As illustrated in Figure 1-1, their role intentionally overlaps the roles of all the other stakeholders. For the system owners and users, systems analysts identify and validate business problems and needs. For the system designers and builders, systems analysts ensure that the technical solution fulfills the business needs and integrate the technical solution into the business. In other words, systems analysts *facilitate* the development of information systems through interaction with the other stakeholders.

There are several legitimate, but often confusing, variations on the job title we are calling "systems analyst." A *programmer/analyst* (or *analyst/programmer*) includes the responsibilities of both the computer programmer and the systems analyst. A *business analyst* focuses on only the nontechnical aspects of systems analysis and design. Other synonyms for "systems analyst" are systems consultant, business analyst, systems architect, systems engineer, information engineer, information analyst, and systems integrator.

Some of you will become systems analysts. The rest of you will routinely work with systems analysts who will help you solve your business and industrial problems by creating and improving your access to the data and information needed to do your job. Let's take a closer look at systems analysts as the key facilitators of information systems development.

The Role of the Systems Analyst Systems analysts understand both business and computing. They study business problems and opportunities and then transform business and information requirements into specifications for information systems that will be implemented by various technical specialists including computer programmers. Computers and information systems are of value to a business only if they help solve problems or effect improvements.

Systems analysts initiate *change* within an organization. Every new system changes the business. Increasingly, the very best systems analysts literally change their organizations—providing information that can be used for competitive advantage, finding new markets and services, and even dramatically changing and improving the way the organization does business.

The systems analyst is basically a *problem solver.* Throughout this book, the term *problem* will be used to describe many situations, including:

- Problems, either real or anticipated, that require corrective action.
- Opportunities to improve a situation despite the absence of complaints.
- Directives to change a situation regardless of whether anyone has complained about the current situation.

The systems analyst's job presents a fascinating and exciting challenge to many individuals. It offers high management visibility and opportunities for important

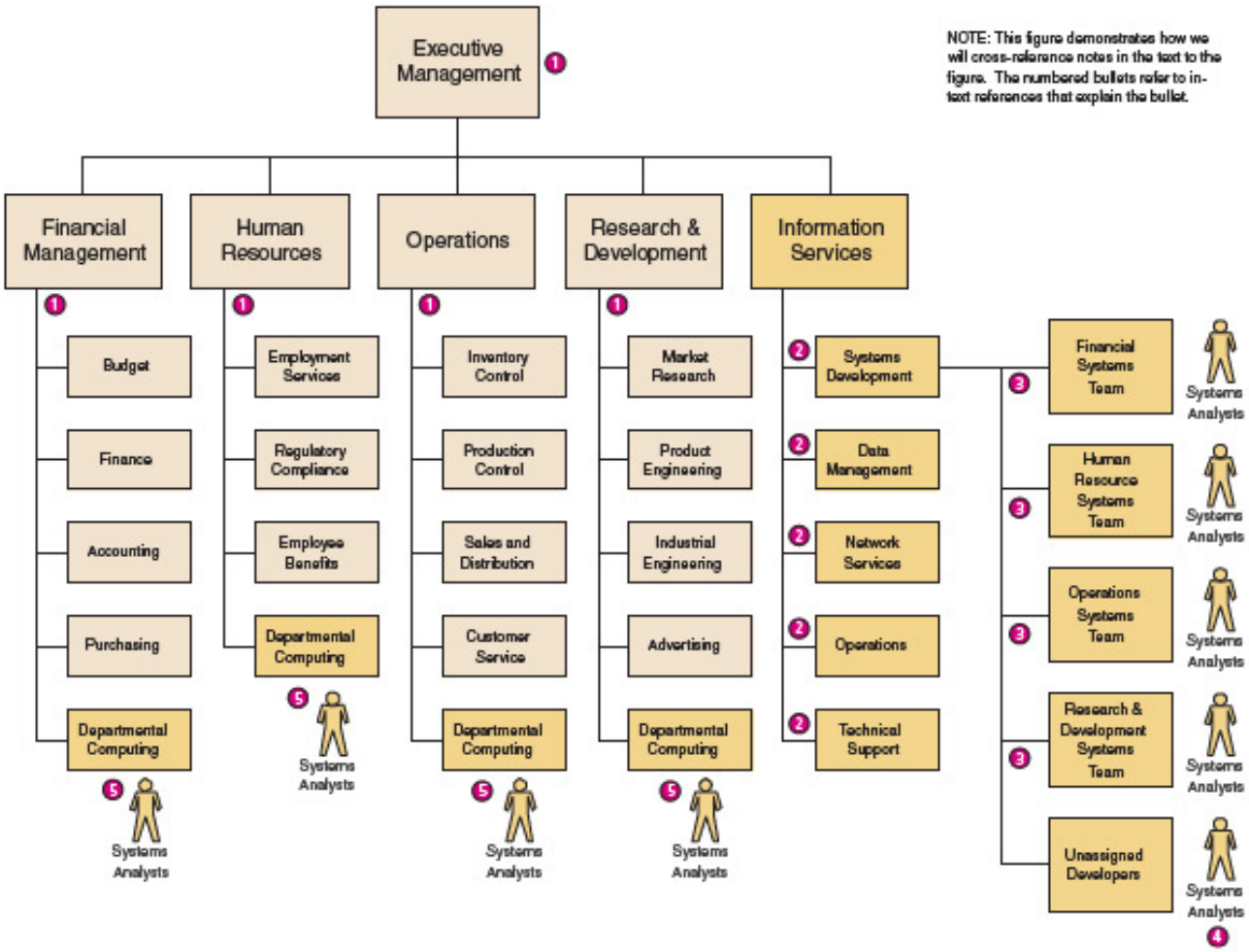


FIGURE 1-2 Systems Analysts in a Typical Organization

decision making and creativity that may affect an entire organization. Furthermore, this job can offer these benefits relatively early in your career (compared to other entry-level jobs and careers).

Where Do Systems Analysts Work? Every business organizes itself uniquely. But certain patterns of organization seem to reoccur. Figure 1-2 is a representative organization chart. The following numbered bullets cross-reference and emphasize key points in the figure:

1. System owners and system users are located in the functional units and subunits of the business, as well as in the executive management.
2. System designers and builders are usually located in the information systems unit of the business. Most systems analysts work also for the information services unit of an organization.
3. As shown in the figure, systems analysts (along with systems designers and builders) may be permanently assigned to a team that supports a specific business function (e.g., financial systems).

Numbers 2 and 3 above represent a traditional approach to organizing systems analysts and other developers. Numbers 4 and 5 below represent strategies intended to emphasize either efficiency or business expertise. All of the strategies can be combined in a single organization.

The Next Generation: Career Prospects for Systems Analysts

Next Generations

Many of you are considering or preparing for a career as a systems analyst. The life of a systems analyst is both challenging and rewarding. But what are the prospects for the future? Do organizations need systems analysts? Will they need them in the foreseeable future? Is the job changing for the future, and if so, how? These questions are addressed in this box.

According to the U.S. Department of Labor, computer-related jobs account for 5 out of the 20 fastest-growing occupations in the economy. What's more, these fastest-growing computer-related occupations pay better than many other jobs.

In 2002, 468,000 workers were classified as systems analysts. By 2012, that number will grow to 653,000, an increase of 39%. This means that at least 185,000 new systems analysts must be educated and hired (not including those needed to replace the ones who retire or move into managerial positions or other occupations). The need is increasing because industry needs systems analysts to meet the seemingly endless demand for more information systems and software applications. As some programming jobs are being out-sourced to independent contractors and other countries, the need grows even greater for skilled systems analysts, who can create solid design specifications for remote development teams. Opportunities for success will be the greatest for the most educated, qualified, skilled, and experienced analysts.

What happens to the successful systems analyst? Does a position as a systems analyst lead to any other careers? Indeed, there are many career paths. Some analysts leave the information systems field and join the user community. Their experience with developing business applications, combined with their total systems perspective, can make experienced analysts unique business specialists. Alternatively, analysts can become project managers, information systems managers, or technical specialists (for databases, telecommunications, microcomputers, and so forth). Finally, skilled systems analysts are often recruited by the consulting and outsourcing industries. The career path opportunities are virtually limitless.

As with any profession, systems analysts can expect change. While it is always dangerous to predict changes, we'll take a shot at it. We believe that organizations will become increasingly dependent on external sources for their systems analysts—consultants and outsourcers. This will be driven by such factors as the complexity and rapid change of technology, the desire to accelerate systems development, and the continued difficulty in recruiting, retaining, and retraining skilled systems analysts (and other information technology professionals). In many cases, internally employed systems analysts will manage projects through consulting or outsourcing agreements.

We believe that an increasing percentage of tomorrow's systems analysts will not work in the information systems department. Instead, they will work directly for a business unit within an organization. This will enable them to better serve their users. It will also give users more power over what systems are built and supported.

Finally, we also believe that a greater percentage of systems analysts will come from noncomputing backgrounds. At one time most analysts were computer specialists. Today's computer graduates are becoming more business-literate. Similarly, today's business and noncomputing graduates are becoming more computer-literate. Their full-time help and insight will be needed to meet demand and to provide the business background necessary for tomorrow's more complex applications.

4. Systems analysts (along with system designers and builders) may also be pooled and temporarily assigned to specific projects for any business function as needed. (Some organizations believe this approach yields greater efficiency because analysts and other developers are always assigned to the highest-priority projects regardless of business area expertise.)
5. Some systems analysts may work for smaller, departmental computing organizations that support and report to their own specific business functions. (Some organizations believe this structure results in systems analysts that develop greater expertise in their assigned business area to complement their technical expertise.)

All of the above strategies can, of course, be reflected within a single organization.

Regardless of where systems analysts are assigned within the organization, it is important to realize that they come together in *project teams*. Project teams are usually created and disbanded as projects come and go. Project teams must also include appropriate representation from the other stakeholders that we previously discussed (system owners, system users, system designers, and system builders). Accordingly, we will emphasize team building and teamwork throughout this book.

Skills Needed by the Systems Analyst For those of you with aspirations of becoming a systems analyst, this section describes the skills you will need to develop. This book introduces many systems analysis and design concepts, tools, and techniques. But you will also need skills and experiences that neither this book nor your systems analysis and design course can fully provide.

When all else fails, the systems analyst who remembers the basic concepts and principles of "systems thinking" will still succeed. No tool, technique, process, or methodology is perfect in all situations! But concepts and principles of systems thinking will always help you adapt to new and different situations. This book emphasizes systems thinking.

Not too long ago, it was thought that the systems analyst's only real tools were paper, pencil, and a flowchart template. Over the years, several tools and techniques have been developed to help the systems analyst. Unfortunately, many books emphasize a specific class of tools that is associated with one methodology or approach to systems analysis and design. In this book, we propose a "toolbox" approach to systems analysis and design. As you read this book, your toolbox will grow to include many tools from different methodologies and approaches to systems analysis and design. Subsequently, you should pick and use tools based on the many different situations you will encounter as an analyst—the right tool for the right job!

In addition to having formal systems analysis and design skills, a systems analyst must develop or possess other skills, knowledge, and traits to complete the job. These include:

- *Working knowledge of information technologies*—The analyst must be aware of both existing and emerging information technologies. Such knowledge can be acquired in college courses, professional development seminars and courses, and in-house corporate training programs. Practicing analysts also stay current through disciplined reading and participation in appropriate professional societies. (To get started, see the Suggested Readings at the end of this and subsequent chapters.)
- *Computer programming experience and expertise*—It is difficult to imagine how systems analysts could adequately prepare business and technical specifications for a programmer if they didn't have some programming experience. Most systems analysts need to be proficient in one or more high-level programming languages.
- *General knowledge of business processes and terminology*—Systems analysts must be able to communicate with business experts to gain an understanding of their problems and needs. For the analyst, at least some of this knowledge comes only by way of experience. At the same time, aspiring analysts should avail themselves of every opportunity to complete basic business literacy courses available in colleges of business. Relevant courses may include financial accounting, management or cost accounting, finance, marketing, manufacturing or operations management, quality management, economics, and business law.
- *General problem-solving skills*—The systems analyst must be able to take a large business problem, break down that problem into its parts, determine problem causes and effects, and then recommend a solution. Analysts must avoid the tendency to suggest the solution before analyzing the problem. For aspiring analysts, many colleges offer philosophy courses that teach

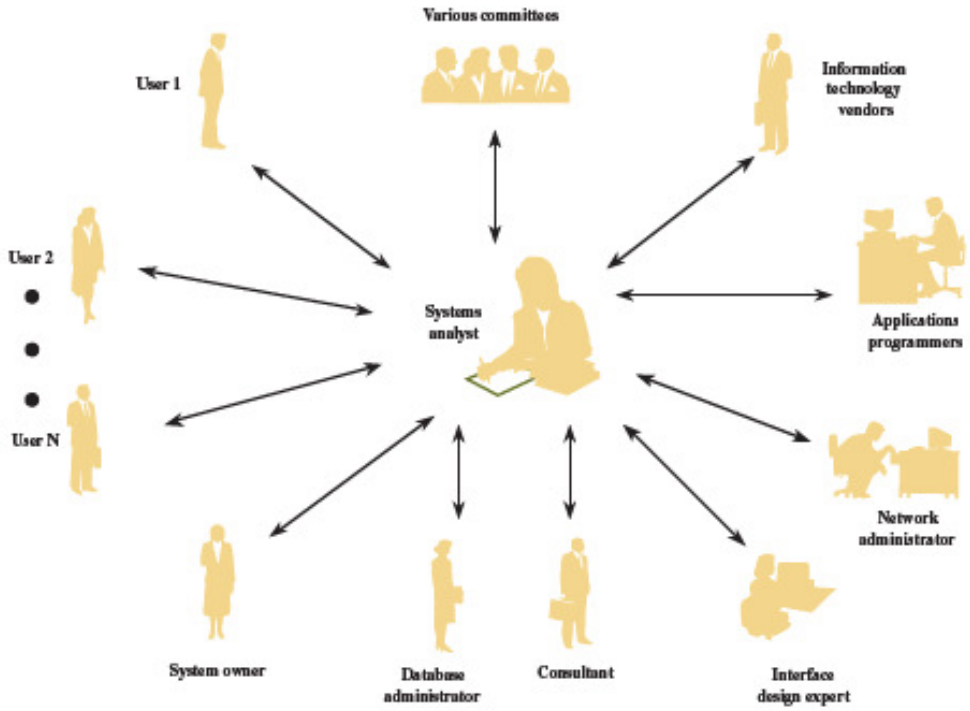


FIGURE 1-3
The Systems Analyst as a Facilitator

problem-solving skills, critical thinking, and reasoning. These "soft skills" will serve an analyst well.

- *Good interpersonal communication skills*—An analyst must be able to communicate effectively, both orally and in writing. Almost without exception, your communications skills, not your technical skills, will prove to be the single biggest factor in your career success or failure. These skills are learnable, but most of us must force ourselves to seek help and work hard to improve them. Most schools offer courses such as business and technical writing, business and technical speaking, interviewing, and listening—all useful skills for the systems analyst. These skills are taught in Chapter 6.
- *Good interpersonal relations skills*—As illustrated in Figure 1-3, systems analysts interact with all stakeholders in a systems development project. These interactions require effective interpersonal skills that enable the analyst to deal with group dynamics, business politics, conflict, and change. Many schools offer valuable interpersonal-skills development courses on subjects such as teamwork, principles of persuasion, managing change and conflict, and leadership.
- *Flexibility and adaptability*—No two projects are alike. Accordingly, there is no single, magical approach or standard that is equally applicable to all projects. Successful systems analysts learn to be flexible and to adapt to unique challenges and situations. Our aforementioned toolbox approach is intended to encourage flexibility in the use of systems analysis and design tools and methods. But you must develop an attitude of adaptability to properly use any box of tools.
- *Character and ethics*—The nature of the systems analyst's job requires a strong character and a sense of right and wrong. Analysts often gain access to sensitive or confidential facts and information that are not meant for public disclosure. Also, the products of systems analysis and design are usually considered the intellectual property of the employer. There are several standards for computer ethics. One such standard, from the Computer Ethics Institute, is called "The Ten Commandments of Computer Ethics" and is shown in Figure 1-4.

FIGURE 1-4 Ethics for Systems Analysts

The Ten Commandments of Computer Ethics

1. Thou shalt not use a computer to harm other people.
2. Thou shalt not interfere with other people's computer work.
3. Thou shalt not snoop around in other people's computer files.
4. Thou shalt not use a computer to steal.
5. Thou shalt not use a computer to bear false witness.
6. Thou shalt not copy or use proprietary software for which you have not paid.
7. Thou shalt not use other people's computer resources without authorization or proper compensation.
8. Thou shalt not appropriate other people's intellectual output.
9. Thou shalt think about the social consequences of the program you are writing or the system you are designing.
10. Thou shalt always use a computer in ways that insure consideration and respect for your fellow humans.

Source: Computer Ethics Institute.

> External Service Providers

external service provider (ESP) a systems analyst, system designer, or system builder who sells his or her expertise and experience to other businesses to help those businesses purchase, develop, or integrate their information systems solutions; may be affiliated with a consulting or services organization.

Those of you with some computing experience may be wondering where consultants fit in our taxonomy of stakeholders. They are not immediately apparent in our visual framework. But they are there! Any of our stakeholder roles may be filled by internal or external workers. Consultants are one example of an **external service provider (ESP).** Most ESPs are systems analysts, designers, or builders who are contracted to bring special expertise or experience to a specific project. Examples include technology engineers, sales engineers, systems consultants, contract programmers, and systems integrators.

> The Project Manager

project manager an experienced professional who accepts responsibility for planning, monitoring, and controlling projects with respect to schedule, budget, deliverables, customer satisfaction, technical standards, and system quality.

We've introduced most of the key players in modern information systems development—systems owners, users, designers, builders, and analysts. We should conclude by emphasizing the reality that these individuals must work together as a team to successfully build information systems and applications that will benefit the business. Teams require leadership. For this reason, usually one or more of these stakeholders takes on the role of **project manager** to ensure that systems are developed on time, within budget, and with acceptable quality. As Figure 1-1 indicates, most project managers are experienced systems analysts. But in some organizations, project managers are selected from the ranks of what we have called "system owners." Regardless, most organizations have learned that project management is a specialized role that requires distinctive skills and experience.

Business Drivers for Today's Information Systems

Another way to look at our information system product is from the perspective of business drivers. Using Figure 1-5, let's now briefly examine the most important business trends that are impacting information systems. Many trends quickly become fads, but here are some business trends we believe will influence systems development in the

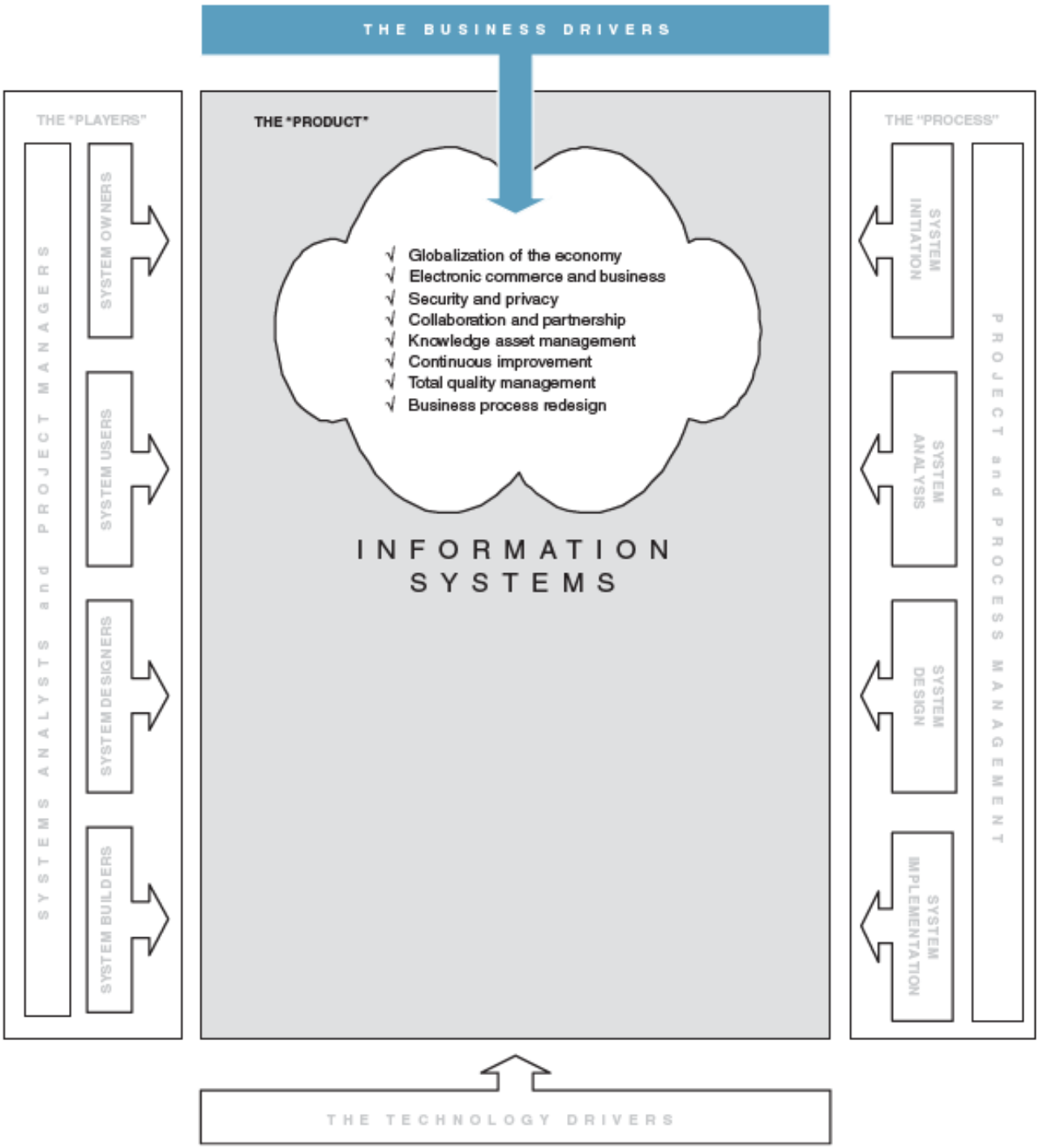


FIGURE 1-5 Business Drivers for an Information System

coming years. Many of these trends are related and integrated such that they form a new business philosophy that will impact the way everyone works in the coming years.

> Globalization of the Economy

Since the 1990s, there has been a significant trend of economic globalization. Competition is global, with emerging industrial nations offering lower-cost or higher-quality

alternatives to many products. American businesses find themselves with new international competitors. On the other hand, many American businesses have discovered new and expanded international markets for their own goods and services. The bottom line is that most businesses were forced to reorganize to operate in this global economy.

How does economic globalization affect the players in the systems game? First, information systems and computer applications must be internationalized. They must support multiple languages, currency exchange rates, international trade regulations, and different business cultures and practices. Second, most information systems ultimately require information consolidation for performance analysis and decision making. The aforementioned language barriers, currency exchange rates, transborder information regulations, and the like, complicate such consolidation. Finally, there exists a demand for players who can communicate, orally and in writing, with management and users that speak different languages, dialects, and slang. Opportunities for international employment of systems analysts should continue to expand.

> Electronic Commerce and Business

electronic commerce (e-commerce) the buying and selling of goods and services by using the Internet.

electronic business (e-business) the use of the Internet to conduct and support day-to-day business activities.

In part due to the globalization of the economy, and in part because of the pervasiveness of the Internet, businesses are changing or expanding their business model to implement **electronic commerce (e-commerce)** and **electronic business (e-business).** The Internet is fundamentally changing the rules by which business is conducted. We live in a world where consumers and businesses will increasingly expect to conduct commerce (business transactions) using the Internet. But the impact is even more substantive. Because people who work in the business world have become so comfortable with "surfing the Web," organizations are increasingly embracing the Web interface as a suitable architecture for conducting day-to-day business *within* the organization.

There are three basic types of e-commerce- and e-business-enabled information systems applications:

- Marketing of corporate image, products, and services is the simplest form of electronic commerce application. The Web is used merely to "inform" customers about products, services, and policies. Most businesses have achieved this level of electronic commerce.
- *Business-to-consumer (B2C)* electronic commerce attempts to offer new, Web-based channels of distribution for traditional products and services. You, as a typical consumer, can research, order, and pay for products directly via the Internet. Examples include Amazon.com (for books and music) and E-trade.com (for stocks and bonds). Both companies are businesses that were created on the Web. Their competition, however, includes traditional businesses that have added Web-based electronic commerce front ends as an alternative consumer option (such as Barnes and Noble and Merrill Lynch). Figure 1-6 illustrates a typical B2C Web storefront.
- *Business-to-business (B2B)* electronic commerce is the real future. This is the most complex form of electronic commerce and could ultimately evolve into electronic business—the complete, paperless, and digital processing of virtually all business transactions that occur within and between businesses.

One example of B2B electronic commerce is electronic procurement. All businesses purchase raw materials, equipment, and supplies—frequently tens or hundreds of millions of dollars worth per year. B2B procurement allows employees to browse electronic storefronts and catalogs, initiate purchase requisitions and work orders, route requisitions and work orders electronically for expenditure approvals, order the goods and services, and pay for the delivered goods and completed services—all

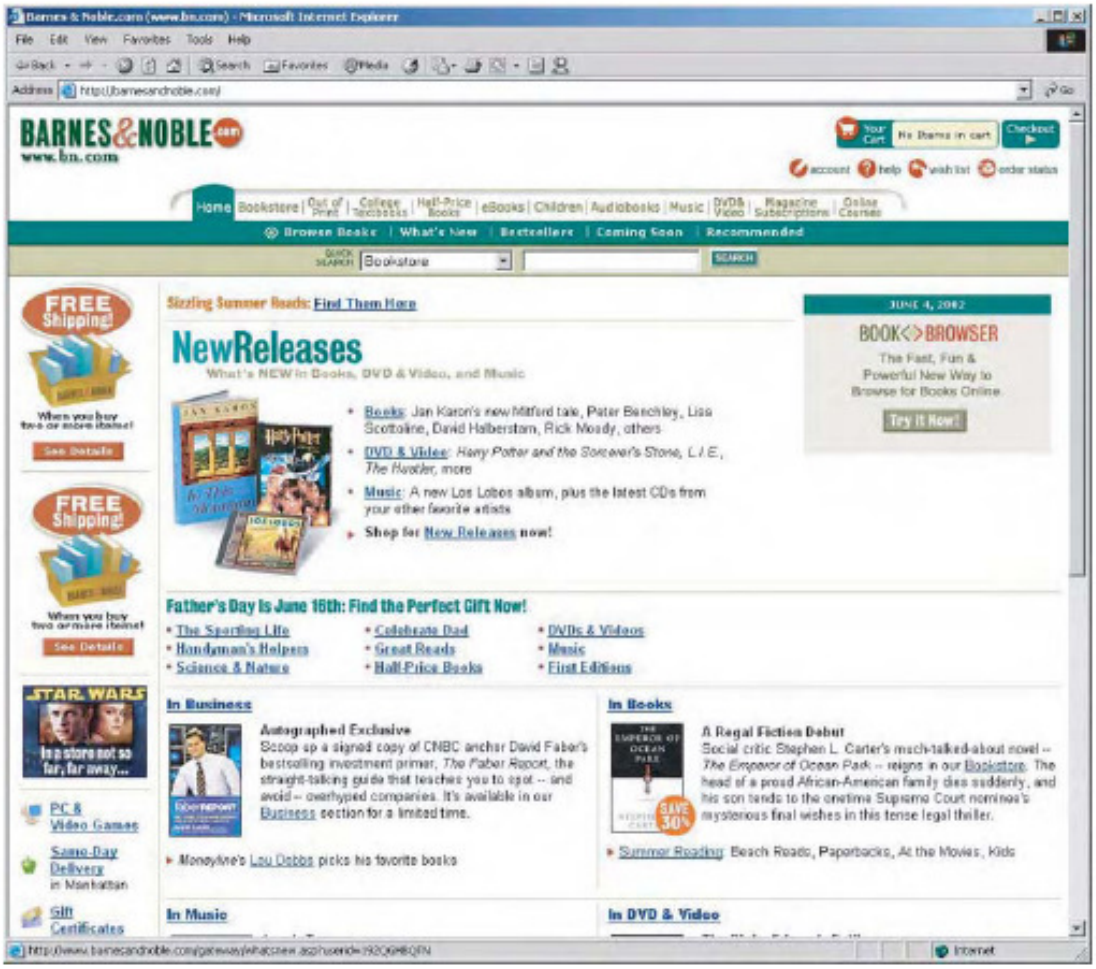


FIGURE 1-6 An Electronic Commerce Storefront

without the traditional time-consuming and costly paper flow and bureaucracy. Figure 1-7 illustrates a sample Web-based procurement storefront.

Largely due to the trend toward these e-business and e-commerce applications, most new information systems applications are being designed for an Internet architecture. Not that long ago, we were redesigning most applications to operate within a *Windows* user interface. Today, we increasingly see applications designed to run within an Internet browser such as *Internet Explorer* or *Netscape*. The choice of a desktop operating system, such as *Windows, Macintosh,* or *Linux,* is becoming less important than the availability of the browser itself.

> Security and Privacy

As the digital economy continues to evolve, citizens and organizations alike have developed a heightened awareness of the security and privacy issues involved in today's economy. Security issues tend to revolve around business continuity; that is, "How will the business continue in the event of a breach or disaster—any event that causes a disruption of business activity?" Additionally, businesses must ask themselves, "How can the business protect its digital assets from outside threats?" It is true that these questions ultimately come down to technology; however, the concerns have become fundamental business concerns.

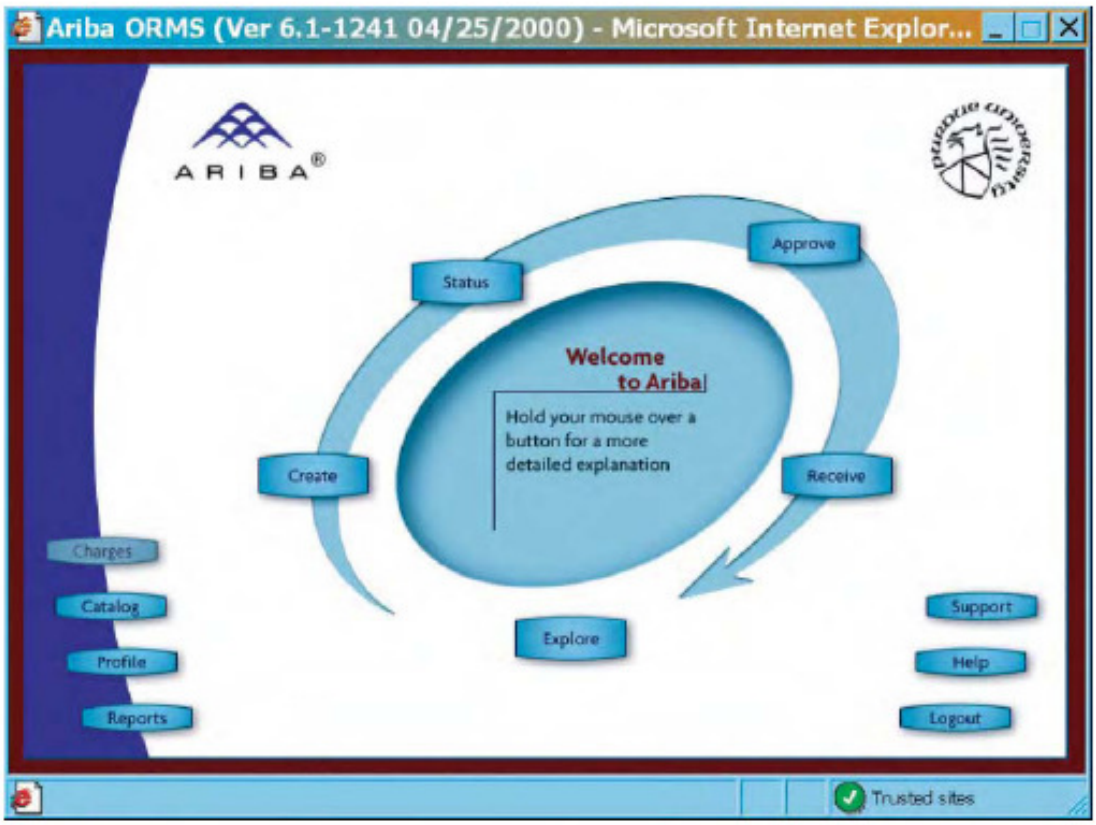


FIGURE 1-7 An Electronic Commerce Procurement Storefront

Related to security is the issue of privacy. Consumers are increasingly demanding privacy in the digital economy. Governments are regulating privacy issues, and the regulations will likely become more stringent as the digital economy continues to evolve. Go to your favorite commercial Web sites. Almost every business now has a privacy policy. Consumer groups are beginning to analyze and monitor such privacy policies, holding companies accountable and lobbying governments for stricter regulations and enforcement.

As information systems are developed and changed, you will increasingly be expected to incorporate more stringent security and privacy controls. In the global economy, you will need to become sensitive to a wide array of regulations that vary considerably from one country to another. Certainly, security and privacy mechanisms will be subject to the same internal audits that have become routine in systems that support or interact with financial systems.

> Collaboration and Partnership

Collaboration and partnership are significant business trends that are influencing information systems applications. Within organizations, management is emphasizing the need to break down the walls that separate organization departments and functions. Management speaks of "cross-functional" teams that collaborate to address common business goals from interdisciplinary perspectives. For example, new product design used to be the exclusive domain of engineers. Today, new product design typically involves a cross-functional team of representatives from many organizational units, such as engineering, marketing, sales, manufacturing, inventory control, distribution, and, yes, information systems.

Similarly, the trend toward collaboration extends beyond the organization to include other organizations—sometimes even competitors. Organizations choose to directly collaborate as partners in business ventures that make good business sense. Microsoft and Oracle sell competitive database management systems. But Microsoft and Oracle also partner to ensure that Oracle applications will operate on a Microsoft database. Both companies benefit financially from such cooperation.

In a similar vein, businesses have learned that it can be beneficial for their information systems to interoperate with one another. For example, while Wal-Mart could generate its own restocking orders for merchandise and send them to its suppliers, it makes more sense to integrate their respective inventory control systems. Suppliers can monitor Wal-Mart's inventory levels directly and can automatically initiate business-to-business transactions to keep the shelves stocked with their merchandise. Both companies benefit. (Of course, this also raises the aforementioned issue of requirements for good security.)

data raw facts about people, places, events, and things that are of importance in an organization. Each fact is, by itself, relatively meaningless.

> Knowledge Asset Management

What is knowledge? *Knowledge* is the result of a continuum of how we process raw data into useful information. Information systems collect raw **data** by capturing business facts (about products, employees, customers, and the like) and processing business transactions. Data gets combined, filtered, organized, and analyzed to produce **information** to help managers plan and operate the business. Ultimately, information is refined by people to create **knowledge** and expertise. Increasingly, organizations are asking themselves, "How can the company manage and share knowledge for competitive advantage? And as workers come and go, how can the workers' knowledge and expertise be preserved within the organization?"

information data that has been processed or reorganized into a more meaningful form for someone. Information is formed from combinations of data that hopefully have meaning to the recipient.

Thirty years of data processing and information systems have resulted in an enormous volume of data, information, and knowledge. All three are considered critical *business* resources, equal in importance to the classic economic resources of land, labor, and capital.

knowledge data and information that are further refined based on the facts, truths, beliefs, judgments, experiences, and expertise of the recipient. Ideally information leads to *wisdom*.

The need for knowledge asset management impacts information systems on a variety of fronts. Although we have captured (and continue to capture) a great amount of data and information in information systems, they are loosely integrated in most organizations—indeed, redundant and contradictory data and information are common in information systems. As new information systems are built, we will increasingly be expected to focus on integration of the data and information that can create and preserve knowledge in the organizations for which we work. This will greatly complicate systems analysis and design. In this book, we plan to introduce you to many tools and techniques that can help you integrate systems for improved knowledge management.

business processes tasks that respond to business events (e.g., an order). Business processes are the work, procedures, and rules required to complete the business tasks, independent of any information technology used to automate or support them.

> Continuous Improvement and Total Quality Management

Information systems automate and support **business processes.** In an effort to continuously improve a business process, **continuous process improvement (CPI)** examines a business process to implement a series of small changes for improvement. These changes can result in cost reductions, improved efficiencies, or increased value and profit. Systems analysts are both affected by continuous process improvements and expected to initiate or suggest such improvements while designing and implementing information systems.

continuous process improvement (CPI) the continuous monitoring of business processes to effect small but measurable improvements in cost reduction and value added.

Another ongoing business driver is **total quality management (TQM).** Businesses have learned that quality has become a critical success factor in competition. They have also learned that quality management does not begin and end with the products and services sold by the business. Instead, it begins with a culture that recognizes that

total quality management (TQM) a comprehensive approach to facilitating quality improvements and management within a business.

everyone in the business is responsible for quality. TQM commitments require that every business function, including information services, identify quality indicators, measure quality, and make appropriate changes to improve quality.

Information systems, and hence systems analysts, are part of the TQM requirement. Our discussions with college graduate recruiters suggest that an "obsessive" attitude toward quality management will become an essential characteristic of successful systems analysts (and all information technology professionals). Throughout this book, continuous process improvement and total quality management will be an underlying theme.

> Business Process Redesign

As stated earlier, many information systems support or automate business processes. Many businesses are learning that those business processes have not changed substantially in decades and that those business processes are grossly inefficient and/or costly. Many business processes are overly bureaucratic, and all their steps do not truly contribute value to the business. Unfortunately, information systems have merely automated many of these inefficiencies. Enter business process redesign!

business process redesign (BPR) the study, analysis, and redesign of fundamental business processes to reduce costs and/or improve value added to the business.

Business process redesign (BPR) involves making substantive changes to business processes across a larger system. In effect, BPR seeks to implement more substantial changes and improvements than does CPI. In a BPR, business processes are carefully documented and analyzed for timeliness, bottlenecks, costs, and whether or not each step or task truly adds value to the organization (or, conversely, adds only bureaucracy). Business processes are then redesigned for maximum efficiency and lowest possible costs.

So how does BPR affect information systems? There are two basic ways to implement any information system—build it or buy it. In other words, you can write the software yourself, or you can purchase and implement a commercial software package. In both cases, BPR figures prominently. In writing your own software, it is useful to redesign business processes before writing the software to automate them. This way, you avoid automating underlying inefficiencies. Alternatively, in purchasing software packages, most businesses have discovered it is easier to redesign the business processes to work with the software package than to attempt to force (and even cripple) the software package to work with existing business processes.

Technology Drivers for Today's Information Systems

Advances in information technology can also be drivers for information systems (as suggested in Figure 1-8). In some cases, outdated technologies can present significant problems that drive information system development projects. In other cases, newer technologies present business opportunities. Let's examine several technologies that are influencing today's information systems.

> Networks and the Internet

Scott McNealy, Sun Computer's charismatic CEO, is often cited as stating, "The network has become the computer." Few would argue that today's information systems are installed on a network architecture consisting of local and wide area networks. These networks include mainframe computers, network servers, and a variety of desktop, laptop, and handheld client computers. But today, the most pervasive networking technologies are based on the Internet. Some of the more relevant Internet technologies that you need to become aware of, if not develop some basic skill with, are described in the following list. (For now, don't be intimidated by these terms—we

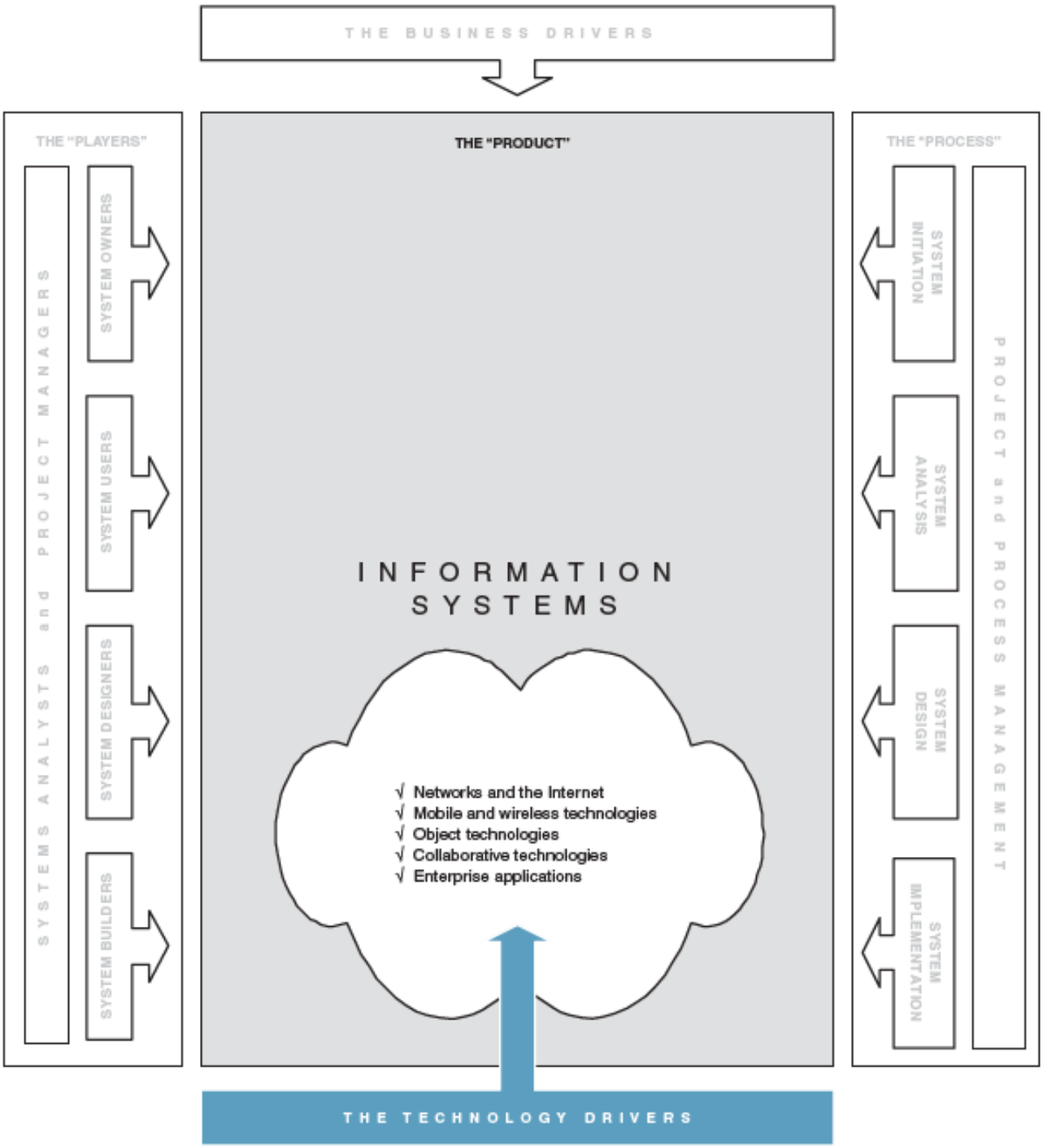


FIGURE 1-8 Technology Drivers for an Information System

will be teaching you more about these technologies and how to design systems that use them throughout this textbook.)

- *xHTML* and *XML* are the fundamental languages of Web page authoring and Internet application development. Extensible Hypertext Markup Language (xHTML) is the emerging second-generation version of HTML, the language used to construct Web pages. Extensible Markup Language (XML) is the language used to effectively transport data content along with its proper inter-

pretation over the Internet. Introductory xHTML and XML courses have become core requirements in most information systems and information technology college curricula.

- *Scripting* languages are simple programming languages designed specifically for Internet applications. Examples include *Perl, VBScript,* and *JavaScript.* These languages are increasingly taught in college Web development and programming courses.
- Web-specific programming languages such as *Java* and *Cold Fusion* have emerged to specifically address construction of complex, Web-based applications that involve multiple servers and Web browsers. These languages are also becoming prevalent in college programming curricula.
- *Intranets* are essentially private Internets designed for use by employees of an organization. They offer the look and feel of the Internet; however, security and firewalls restrict their use to employees.
- *Extranets,* like intranets, are private Internets. But extranets are for use between specific organizations. Only the employees of those identified businesses can access and use the extranet. For example, an automotive manufacturer such as Chevrolet might set up an extranet for the sole use of its dealers. Through this extranet, the manufacturer can communicate information about parts, problems, sales incentives, and the like.
- *Portals* (in corporations) are "home pages" that can be customized to the specific needs of different individuals who use them. For example, portal technology can define Web pages that provide appropriate information and applications for different roles in the same company. Each individual's role determines which information and applications that person can use from her or his Web page. Examples of roles include "customer," "supplier," and different types of "employee." Portals can also effectively integrate public Internet, private intranet, and extranet content into each individual user's home page.
- *Web services* are the latest rage. Web services are reusable, Web-based programs that can be called from any other Internet program. For example, let's say you need to write a program to accept credit card payments over the Web. Sure, you could write, debug, and test the credit card validation program yourself. But an alternative approach would be to purchase the right to use a credit card validation program over the Web. By doing so, you need not maintain responsibility for the credit card validation code. You need only "call" the Web service from your program, much as you would call an internal subroutine. Of course, you will pay for the privilege of using Web services since somebody had to write the original Web service program.

These are but a few of the network and Internet technologies that you should seek out during your education. But you must recognize the volatility of the Internet and accept that these and other technologies will emerge and disappear frequently in the near future.

Wireless Handheld

> Mobile and Wireless Technologies

Mobile and wireless technologies are poised to significantly change the next generation of information systems. Handheld computers, or *personal data assistants* (*PDAs,* such as the HP *iPaq,* Palm, and RIM *BlackBerry®*), have become common in the ranks of information workers. These devices are increasingly including wireless capabilities (see margin photo) that provide Web access and e-mail. *Cell phones* are also increasingly featuring Internet and e-mail capabilities. And now, integrated devices such as *smart phones* are emerging that integrate the capabilities of PDAs and cell phones into a single device (see margin photo). For those who prefer separate devices, technologies like *Bluetooth* are emerging to allow the separate devices to interoperate as one logical device while preserving each one's form factors and advantages.

Additionally, laptop computers are increasingly equipped with wireless and mobile capabilities to allow information workers to more easily move between locations while preserving connectivity to information systems. All of these technical trends will significantly impact the analysis and design of new information systems. Increasingly, wireless access must be assumed. And the limitations of mobile devices and screen sizes must be accommodated in an information system's design. This textbook will teach and demonstrate tools and techniques to deal with the design of emerging mobile applications.

Smart Phone

> Object Technologies

Today, most contemporary information systems are built using **object technologies.** Today's pervasive programming languages are object-oriented. They include *C++*, *Java*, *Smalltalk*, and *Visual Basic .NET*. Object technologies allow programmers to build software from software parts called *objects*. (We will get into more specifics about objects later in this book.) Object-oriented software offers two fundamental advantages over nonobject software. First, objects are reusable. Once they are designed and built, objects can be reused in multiple information systems and applications. This reduces the time required to develop future software applications. Second, objects are extensible. They can be changed or expanded easily without adversely impacting any previous applications that used them. This reduces the lifetime costs of maintaining and improving software.

object technology a software technology that defines a system in terms of objects that consolidate data and behavior (into objects). Objects become reusable and extensible components for the software developers.

The impact of object technology is significant in the world of systems analysis and design. Prior to object technologies, most programming languages were based on so-called *structured methods*. Examples include *COBOL* (the dominant language), *C*, *FORTRAN*, *Pascal*, and *PL/1*. It is not important at this time for you to be able to differentiate between structured and object technologies and methods. Suffice to say, structured methods are inadequate to the task of analyzing and designing systems that will be built using object technologies. Accordingly, **object-oriented analysis and design** methods have emerged as the preferred approach for building *most* contemporary information systems. For this reason, we will integrate object-oriented analysis and design tools and techniques throughout this book to give you a competitive advantage in tomorrow's job market.

object-oriented analysis and design a collection of tools and techniques for systems development that will utilize object technologies to construct a system and its software.

At the same time, structured tools and techniques are still important. Databases, for example, are still commonly designed using structured tools. And structured tools are still preferred by many systems analysts for analyzing and designing work flows and business processes. Thus, we will also teach you several popular structured tools and techniques for systems analysis and design.

It is easy to become a devout disciple of one analysis and design strategy, such as structured analysis and design or object-oriented analysis and design. You should avoid doing so! We will advocate both and teach you when and how to combine structured and object-oriented tools and techniques for systems analysis and design. As we write this chapter, this approach—called **agile development**—is gaining favor among experienced analysts who have become weary of overly prescriptive methods that usually insist that you use only *one* methodology's tools and processes. At the risk of oversimplifying agile methods, think of it as assembling a toolbox of different tools and techniques—structured, object-oriented, and others—and then selecting the best tool or technique for whatever problems or need you encounter as a systems analyst.

agile development a systems development strategy wherein the system developers are given the flexibility to select from a variety of appropriate tools and techniques to best accomplish the tasks at hand. Agile development is believed to strike an optimal balance between productivity and quality for systems development.

> Collaborative Technologies

Another significant technology trend is the use of collaborative technologies. Collaborative technologies are those that enhance interpersonal communications and teamwork. Four important classes of collaborative technologies are e-mail, instant messaging, groupware, and work flow.

Everybody knows what e-mail is. But e-mail's importance in information systems development is changing. Increasingly, modern information systems are *e-mail-enabled;*

that is, e-mail capabilities are built right into the application software. There is no need to switch to a dedicated e-mail program such as *Outlook*. The application merely invokes the user's or organization's default e-mail program to enable relevant messages to be sent or received.

Related to e-mail technology is instant messaging (e.g., AOL's *Instant Messenger* and Microsoft's *MSN Messenger Service*). Instant messaging was popularized in public and private "chat rooms" on the Internet. But instant messaging is slowly being incorporated into enterprise information systems applications as well. For example, instant messaging can implement immediate response capabilities into a help system for a business application. Imagine being able to instantly send and receive messages with the corporate help desk when using a business application. The productivity and service-level implications are significant.

Finally, groupware technology allows teams of individuals to collaborate on projects and tasks regardless of their physical location. Examples of groupware technologies include Lotus's *SameTime* and Microsoft's *NetMeeting*. Using such groupware allows multiple individuals to participate in meetings and share software tools across a network. As with e-mail and instant messaging, groupware capabilities can be built into appropriate business applications.

Clearly, systems analysts and system designers must build these innovative collaborative technologies into their applications.

> Enterprise Applications

Virtually all organizations, large and small, require a core set of enterprise applications to conduct business. As shown in Figure 1-9, for most businesses the core applications include financial management, human resource management, marketing and sales, and operations management (inventory and/or manufacturing control). At one time, most organizations custom-built most or all of these core enterprise applications. But today, these enterprise applications are frequently purchased, installed, and configured for the business and integrated into the organization's business processes. Why? Because these core enterprise applications in different organizations or industries tend to be more alike than they are different.

systems integration the process of building a unified information system out of diverse components of purchased software, custom-built software, hardware, and networking.

Today, these "internal" core applications are being supplemented with other enterprise applications that integrate an organization's business processes with those of its suppliers and customers. These applications, called *customer relationship management* and *supply chain management*, are also illustrated in Figure 1-9.

The trend toward the use of purchased enterprise applications significantly impacts systems analysis and design. Purchased and installed enterprise applications are never sufficient to meet all of the needs for information systems in any organization. Thus, systems analysts and other developers are asked to develop value-added applications to meet additional needs of the business. But the purchased and installed enterprise applications become a technology constraint. Any custom application must properly integrate with and interface to the purchased enterprise applications. This is often called **systems integration**, and this is the business and systems environment into which most of you will graduate. Let's briefly explore some of the more common enterprise applications and describe their implications for systems analysis and design.

enterprise resource planning (ERP) a software application that fully integrates information systems that span most or all of the basic, core business functions (including transaction processing and management information for those business functions).

Enterprise Resource Planning (ERP) As previously noted, the core business information system applications in most businesses were developed in-house incrementally over many years. Each system had its own files and databases with loose and awkward integration of all applications. During the 1990s, businesses tried very hard to integrate these legacy information systems, usually with poor results. Organizations would have probably preferred to redevelop these core business applications (see Figure 1-9 again) from scratch as a single *integrated* information system. Unfortunately, few if any businesses had enough resources to attempt this. Recognizing that the basic applications needed by most businesses were more similar than different, the software industry developed a solution—**enterprise resource planning (ERP)**

REPRESENTATIVE ERP VENDORS

SSA
Oracle/PeopleSoft
SAP AG (the Market Leader)

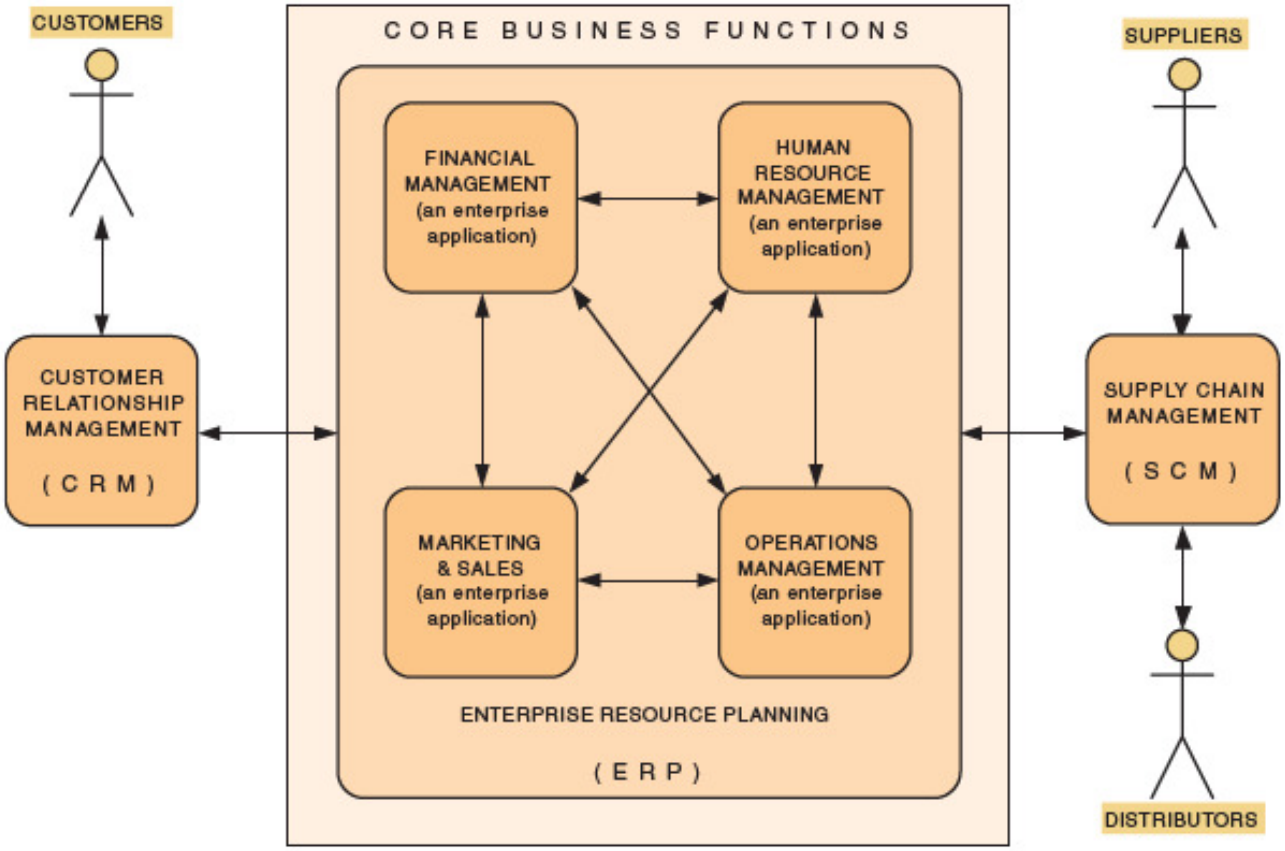


FIGURE 1-9 Enterprise Applications

applications. An ERP solution is built around a common database shared by common business functions. Examples of ERP software vendors are listed in the margin.

An ERP solution provides the core information system functions for the entire business. But usually an organization must redesign its business processes to fully exploit and use an ERP solution. Most organizations must still supplement the ERP solution with custom software applications to fulfill business requirements that are unique to the industry or business. For most organizations, an ERP implementation and integration represents the single largest information system project ever undertaken by the organization. It can cost tens of millions of dollars and require a small army of managers, users, analysts, technical specialists, programmers, and consultants.

ERP applications are significant to systems analysts for several reasons. First, systems analysts may be involved in the decision to select and purchase an ERP solution. Second, and more common, systems analysts are frequently involved in the customization of the ERP solution, as well as the redesign of business processes to use the ERP solution. Third, if custom-built applications are to be developed within an organization that uses an ERP core solution, the ERP system's architecture significantly impacts the analysis and design of the custom application that must coexist and interoperate with the ERP system.

REPRESENTATIVE SCM VENDORS

i2 Technologies
Manugistics
SAP
SCT

Supply Chain Management Today, many organizations are expending effort on enterprise applications that extend support beyond their core business functions. Companies are extending their core business applications to interoperate with their suppliers and distributors to more efficiently manage the flow of raw materials and products between their respective organizations. These **supply chain management (SCM)** applications utilize the Internet as a means for integration and communications.

supply chain management (SCM) a software application that optimizes business processes for raw material procurement through finished product distribution by directly integrating the logistical information systems of organizations with those of their suppliers and distributors.

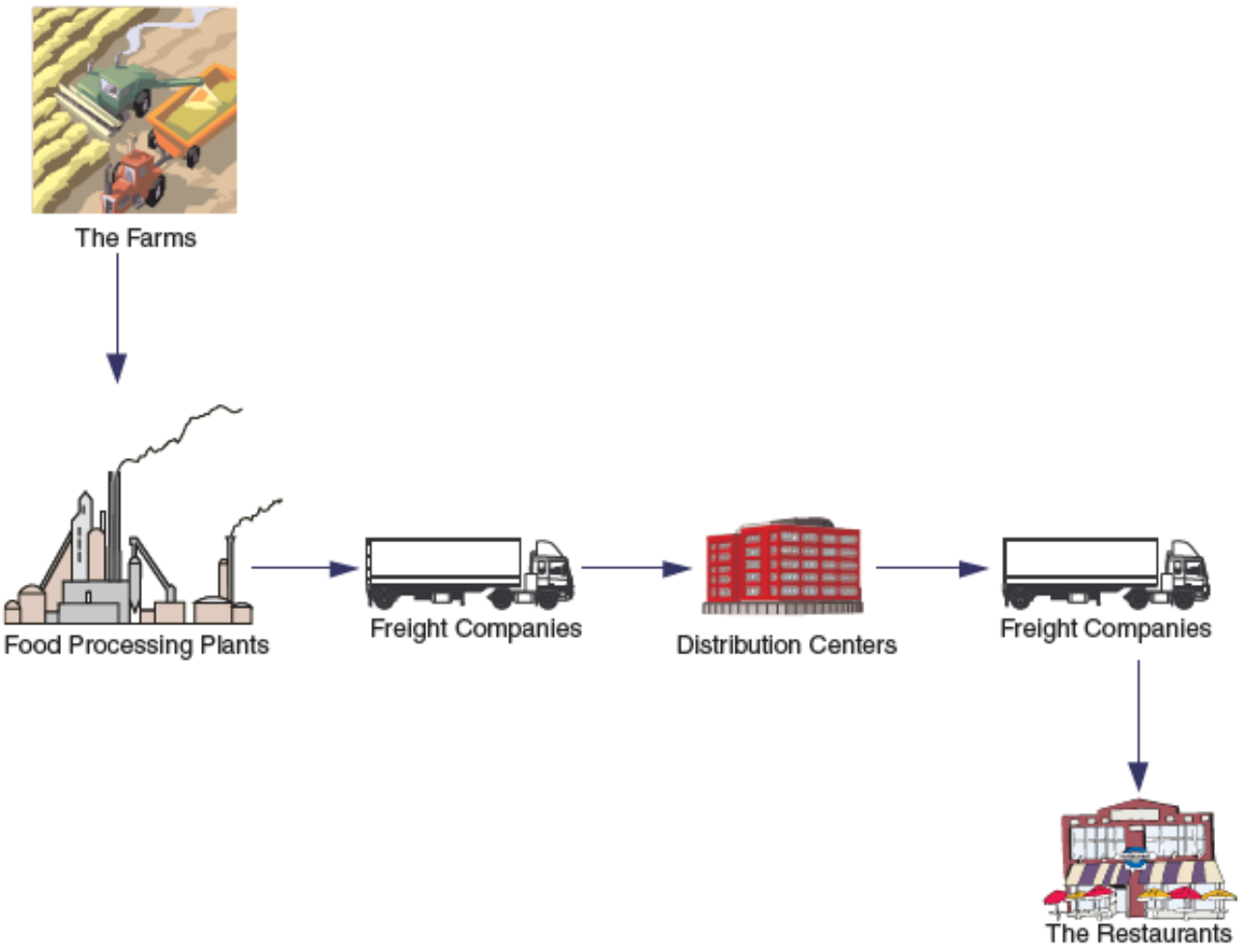


FIGURE 1-10 Supply Chain

REPRESENTATIVE CRM VENDORS

BroadVision
E.piphany
Kana
Amdocs
Oracle/PeopleSoft
Siebel (the Market Leader)
SAP

For example, Figure 1-10 demonstrates a logical supply chain ending at restaurants belonging to a franchise (e.g., Outback, Red Lobster, Wendy's). Notice that this supply chain includes many businesses and carriers to achieve its final result—ensuring that the restaurants have adequate food supplies to do business. Any delays or problems in any single link of this supply chain will adversely affect one and all. For that reason, several of these businesses will implement supply chain management using SCM software technology to plan, implement, and manage the chain. Examples of supply chain management vendors are listed in the margin. (It should be noted that several ERP application vendors are extending ERP software applications to include SCM capabilities. The SCM market is due for a shakeout because there are too many vendors for all to succeed.)

SCM applications are significant to systems analysts for the same reasons as stated for ERP applications. As an analyst, you may be involved in the evaluation and selection of an SCM package. Or you may be expected to implement and perhaps customize such packages to meet the organization's needs. And again, you may expect to participate in redesigning existing business processes to work appropriately with the SCM solution.

customer relationship management (CRM) a software application that provides customers with access to a business's processes from initial inquiry through postsale service and support.

Customer Relationship Management Many companies have discovered that highly focused customer relationship management can create loyalty that results in increased sales. Thus, many businesses are implementing **customer relationship management (CRM)** solutions that enable customer self-service via the Internet.

The theme of all CRM solutions is a focus on the "customer." CRM is concerned with not only providing effective customer inquiry responses and assistance but also helping the business better profile its customer base for the purpose of improving customer relations and marketing. Examples of CRM vendors are listed in the margin. As was the case with SCM technologies, many ERP vendors are developing or acquiring CRM capabilities to complement and extend their ERP solutions. And as with SCM, the larger number of players will likely be reduced through acquisition and attrition.

CRM technology impacts systems analysts in precisely the same ways as those we described for ERP and SCM technology. In many businesses, new applications must interface with a core, CRM enterprise application.

REPRESENTATIVE EAI VENDORS

BEA Systems
IBM (MQSeries)
Mercator Software
TIBCO Software

Enterprise Application Integration Many companies face the significant challenge of integrating their existing legacy systems with new applications such as ERP, SCM, and CRM solutions. Any company that wants to do business across the Internet will also have to meet the challenge of integrating its systems with those of other organizations and their different systems and technologies. To meet this challenge, many organizations are looking at enterprise application integration software. **Enterprise application integration (EAI)** involves linking applications, whether purchased or developed in-house, so that they can transparently interoperate with one another. This is illustrated conceptually in Figure 1-11. Some vendors offering EAI tools are listed in the margin.

enterprise application integration (EAI) the process and technologies used to link applications to support the flow of data and information between those applications. EAI solutions are usually based on **middleware.**

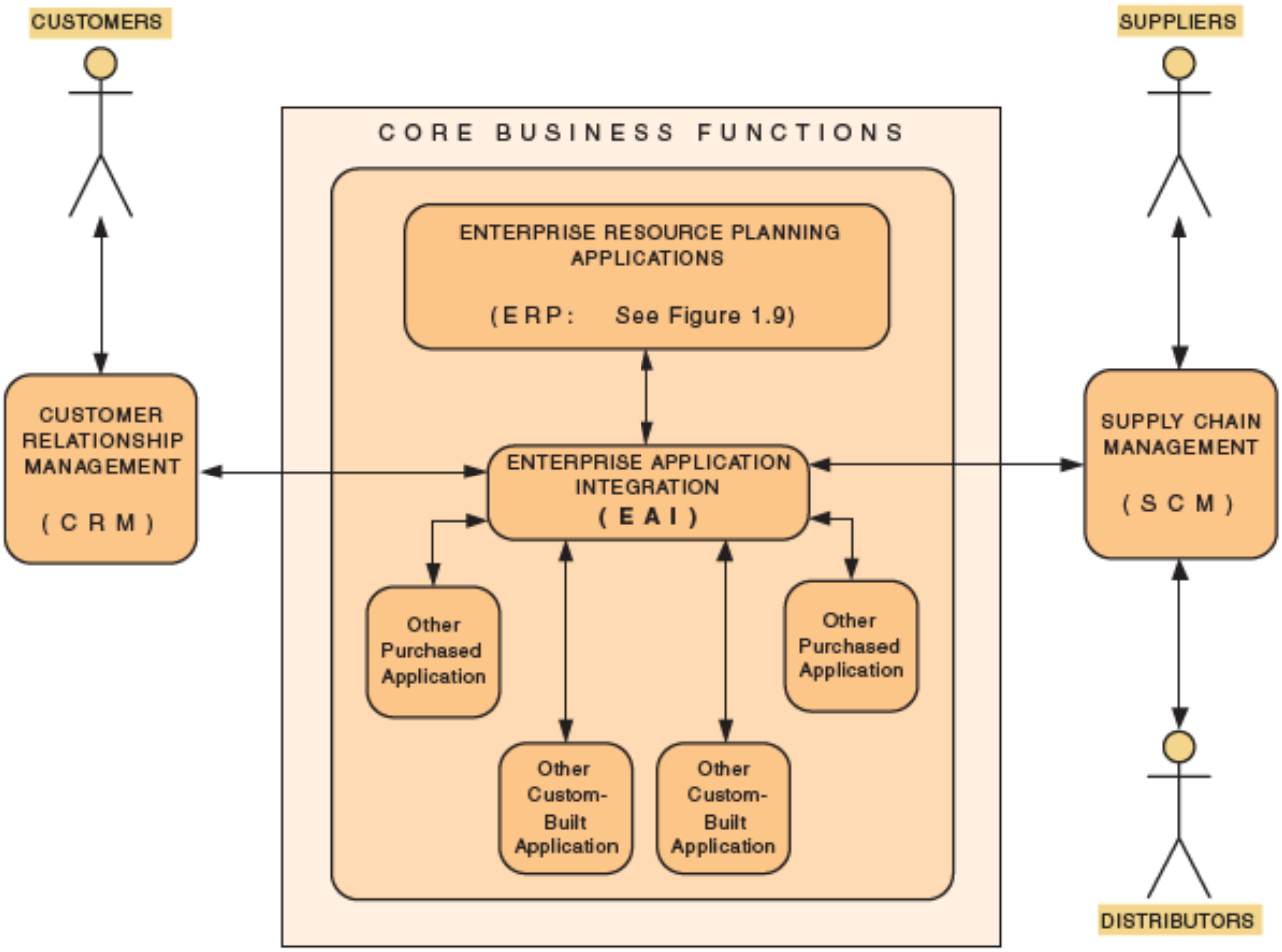


FIGURE 1-11 Enterprise Application Integration

middleware software (usually purchased) used to translate and route data between different applications.

Again, this market is rapidly expanding and contracting. The tools are used to define and construct communication pipelines between differing applications and technologies.

Today, as any new information system is developed, it must be integrated with all the information systems that preceded it. These "legacy" information systems may have been purchased or built in-house. Regardless, systems analysts and other developers must consider application integration for any new information system to be developed. And EAI technologies are at the core of the integration requirements.

A Simple System Development Process

Thus far you have learned about different types of information systems, the players involved in developing those systems, and several business and technology drivers that influence the development of information systems. In this section you will learn about another information system perspective, the "process" for developing an information system.

system development process a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain information systems and software.

Most organizations have a formal **system development process** consisting of a standard set of processes or steps they expect will be followed on any system development project. While these processes may vary greatly for different organizations, a common characteristic can be found: Most organizations' system development process follows a problem-solving approach. That approach typically incorporates the following general problem-solving steps:

1. Identify the problem.
2. Analyze and understand the problem.
3. Identify solution requirements and expectations.
4. Identify alternative solutions and choose the best course of action.
5. Design the chosen solution.
6. Implement the chosen solution.
7. Evaluate the results. (If the problem is not solved, return to step 1 or 2 as appropriate.)

Figure 1-12 adds a system development process perspective that we will use (with appropriate refinements) throughout this book as we study the development process, tools, and techniques. For the sake of simplicity our initial problem-solving approach establishes four stages or phases that must be completed for any system development project—system initiation, system analysis, system design, and system

Our Simplified System Development Process	General Problem-Solving Steps
System initiation	1. Identify the problem. (Also plan for the solution of the problem.)
System analysis	2. Analyze and understand the problem. 3. Identify solution requirements and expectations.
System design	4. Identify alternative solutions and choose the best course of action. 5. Design the chosen solution.
System implementation	6. Implement the chosen solution. 7. Evaluate the results. (If the problem is not solved, return to step 1 or 2 as appropriate.)

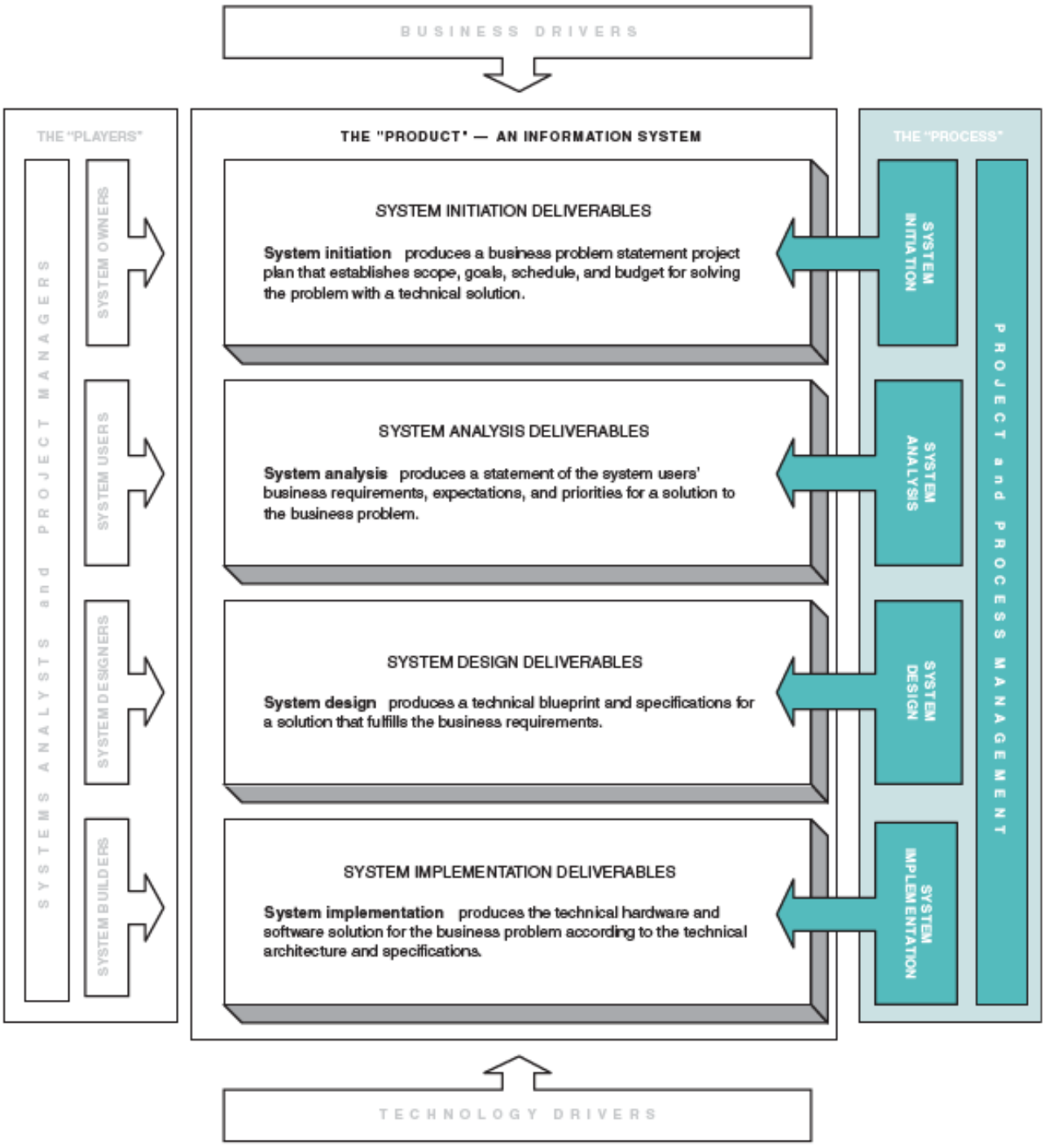


FIGURE 1-12 Systems Development and Problem Solving

implementation. The table on the previous page shows the correlation between the above general problem-solving steps and our process.

It is important to note that any system development process must be managed on a project-by-project basis. You learned earlier that at least one stakeholder accepts responsibility as the project manager for ensuring that the system is developed on time, within budget, and with acceptable quality. The activity of managing a project is referred to as **project management.** Accordingly, in Figure 1-12 we have added a process for project management. Also, to ensure that all projects are

project management the activity of defining, planning, directing, monitoring, and controlling a project to develop an acceptable system within the allotted time and budget.

process management the ongoing activity that defines, improves, and coordinates the use of an organization's chosen methodology (the "process") and standards for all system development projects.

managed according to the same development process, we have included **process management** as an ongoing activity. Notice that project and process management overlap all of the process phases.

Let's *briefly* examine our system development process in Figure 1-12 to expand your understanding of each phase and activity in the process. Given a problem to be solved or a need to be fulfilled, what will we do during system initiation, analysis, design, and implementation? Also, who will be involved in each phase?

> System Initiation

Information system projects are usually complicated. They require a significant time, effort, and economic investment. The problems to be solved are frequently stated vaguely, which means that the initial envisioned solution may be premature. For these reasons, system projects should be carefully planned. System initiation establishes project scope and the problem-solving plan. Thus, as shown in Figure 1-12, we see that **system initiation** establishes the project scope, goals, schedule, and budget required to solve the problem or opportunity represented by the project. Project scope defines the area of the business to be addressed by the project and the goals to be achieved. Scope and goals ultimately impact the resource commitments, namely, schedule and budget, that must be made to successfully complete the project. By establishing a project schedule and budget against the *initial* scope and goals, you also establish a *baseline* against which all stakeholders can accept the reality that any future changes in scope or goals *will* impact the schedule and budget.

system initiation the initial planning for a project to define initial business scope, goals, schedule, and budget.

Figure 1-12 also shows that project managers, system analysts, and system owners are the primary stakeholders in a system analysis. This book will teach you many tools and techniques for initiating a system project and establishing a suitable project plan.

> System Analysis

system analysis the study of a business problem domain to recommend improvements and specify the business requirements and priorities for the solution.

The next step in our system development process is **system analysis.** System analysis is intended to provide the project team with a more thorough understanding of the problems and needs that triggered the project. As such, the business area (scope of the project—as defined during system initiation) may be studied and analyzed to gain a more detailed understanding of what works, what doesn't, and what's needed. As depicted in Figure 1-12, the system analysis requires working with system users to clearly define business requirements and expectations for any new system that is to be purchased or developed. Also, business priorities may need to be established in the event that schedule and budget are insufficient to accomplish all that is desired.

Recall the business drivers discussed earlier in the chapter. These (and future) business drivers most closely affect system analysis, which often defines business requirements in response to the business drivers. For example, we discussed a current trend toward e-business and e-commerce. This business driver may influence the business requirement for any information system, leading us to establish project goals to conduct all business transactions on the Web.

The completion of a system analysis often results in the need to update many of the deliverables produced earlier, during system initiation. The analysis may reveal the need to revise the business scope or project goals—perhaps we now feel the scope of the project is too large or too small. Accordingly, the schedule and budget for the project may need to be revised. Finally, the feasibility of the project itself becomes questionable. The project could be canceled or could proceed to the next phase.

As shown in Figure 1-12, project managers, system analysts, and system users are the primary stakeholders in a system analysis. Typically, results must be summarized and defended to the system owners, who will pay to design and implement an information system to fulfill the business requirements. This book will teach you

many tools and techniques for performing a system analysis and documenting user requirements.

> System Design

Given an understanding of the business requirements for an information system, we can now proceed to **system design.** During system design we will initially need to explore alternative technical solutions. Rarely is there only one solution to any problem. For example, today most companies need to choose between purchasing a solution that is good enough and building a custom solution in-house. (We'll explore options such as this throughout this book.)

system design the specification or construction of a technical, computer-based solution for the business requirements identified in a system analysis. (Note: Increasingly, the design takes the form of a working prototype.)

Once a technical alternative is chosen and approved, the system design phase develops the technical blueprints and specifications required to implement the final solution. These blueprints and specifications will be used to implement required databases, programs, user interfaces, and networks for the information system. In the case where we choose to purchase software instead of build it, the blueprints specify how the purchased software will be integrated into the business and with other information systems.

Recall the technology drivers discussed in the last section of the chapter. These (and future) technology drivers most closely impact the system design process and decisions. Many organizations define a common information technology architecture based on these technology drivers. Accordingly, all system designs for new information systems must conform to the standard IT architecture.

As depicted in Figure 1-12, project managers, system analysts, and system designers are the primary stakeholders in a system design. This book will teach you many tools and techniques for performing a system design.

> System Implementation

The final step in our simple system development process is **system implementation.** As shown in Figure 1-12, system implementation constructs the new information system and puts it into operation. It is during system implementation that any new hardware and system software are installed and tested. Any purchased application software and databases are installed and configured. And any custom software and databases are constructed using the technical blueprints and specifications developed during system design.

system implementation the construction, installation, testing, and delivery of a system into production (meaning day-to-day operation).

As system components are constructed or installed, they must be individually tested. And the complete system must also be tested to ensure that it works properly and meets user requirements and expectations. Once the system has been fully tested, it must be placed into operation. Data from the previous system may have to be converted or entered into start-up databases, and system users must be trained to properly use the system. Finally, some sort of transition plan from older business processes and information systems may have to be implemented.

And once again, as depicted in Figure 1-12, project managers, system analysts, and system builders are the primary stakeholders in a system implementation. While this book will teach you some of the tools and techniques for performing a system implementation, most of these methods are taught in programming, database, and networking courses. This book emphasizes system initiation, analysis, and design skills, but it will also teach you the unique system implementation tools and techniques that are most commonly performed by systems analysts and, therefore, are not typically covered in these other information technology courses.

> System Support and Continuous Improvement

We would be remiss not to briefly acknowledge that implemented information systems face a lifetime of support and continuous improvement. But where is that shown in Figure 1-12? It is there! But it is subtle.

Implemented information systems are rarely perfect. Your users will find errors (bugs) and you will discover, on occasion, design and implementation flaws that require attention and fixes. Also, business and user requirements constantly change. Thus, there will be a need to continuously improve any information system until the time it becomes obsolete. So where does system support and change fit into our development process?

A change made for system support or improvement is merely another project, sometimes called a *maintenance* or *enhancement* project. Such a project should follow the exact same problem-solving approach defined for any other project. The only difference is the effort and budget required to complete the project. Many of the phases will be completed much more quickly, especially if the original stakeholders properly documented the system as initially developed. Of course, if they did not, a system improvement project can quickly consume much greater time, effort, and money. Much of what we will teach you in this book is intended to help you appropriately document information systems to significantly reduce lifetime costs of supporting and improving your information systems.

Learning Roadmap

Each chapter will provide guidance for self-paced instruction under the heading "Learning Roadmap." Recognizing that different students and readers have different backgrounds and interests, we will propose appropriate learning paths—most within this book, but some beyond the scope of this book.

Most readers should proceed directly to Chapter 2 because the first four chapters provide much of the context for the remainder of the book. Several recurring themes, frameworks, and terms are introduced in those chapters to allow you to define your own learning path from that point forward. This chapter focused on information systems from four different perspectives:

- The *players*—both developers and users of information systems.
- The *business drivers* that currently influence information systems.
- The *technology drivers* that currently influence information systems.
- The *process* of developing information systems.

Chapter 2 will take a closer look at the *product* itself—information systems—from an architectural perspective appropriate for systems development. We will define how different players and development stages view an information system.

Looking further ahead, Chapter 3 more closely examines the *process* of systems development. Chapter 4 completes the introduction to systems analysis and design methods by examining the *management* of systems development.

Summary

1. Information systems in organizations capture and manage data to produce useful information that supports an organization and its employees, customers, suppliers, and partners.
2. Information systems can be classified according to the functions they serve, including:
   a. Transaction processing systems that process business transactions such as orders, time cards, payments, and reservations.
   b. Management information systems that use transaction data to produce information needed by managers to run the business.

c. Decision support systems that help various decision makers identify and choose between options or decisions.
d. Executive information systems that are systems tailored to the unique information needs of executives who plan for the business and assess performance against the plans.
e. Expert systems that are systems that capture and reproduce the knowledge of an expert problem solver or decision maker and then simulate the "thinking" of that expert.
f. Communication and collaboration systems that enhance communication and collaboration between people, both internal and external to the organization.
g. Office automation systems that help employees create and share documents that support day-to-day office activities.

3. Information systems can be viewed from various perspectives, including from the perspective of the "players," the "business drivers" influencing the information system, the "technology drivers" used by the information system, and the "process" used to develop the information system.
4. Information workers are the stakeholders in information systems. Information workers include those people whose jobs involve the creation, collection, processing, distribution, and use of information. They include:

   a. System owners, the sponsors and chief advocates of information systems.
   b. System users, the people who use or are impacted by the information system on a regular basis. Geographically, system users may be internal or external.
   c. System designers, technology specialists who translate system users' business requirements and constraints into technical solutions.
   d. System builders, technology specialists who construct the information system based on the design specifications.
   e. Systems analysts, who facilitate the development of information systems and computer applications. They coordinate the efforts of the owners, users, designers, and builders. Frequently, they may play one of those roles as well. Systems analysts perform systems analysis and design.

5. In addition to having formal systems analysis and design skills, a systems analyst must develop or possess the following skills, knowledge, and traits:

   a. Working knowledge of information technologies.
   b. Computer programming experience and expertise.
   c. General knowledge of business processes and terminology.
   d. General problem-solving skills.
   e. Good interpersonal communication skills.
   f. Good interpersonal relations skills.
   g. Flexibility and adaptability.
   h. Character and ethics.

6. Any stakeholder role may be filled by an internal or external worker referred to as an external service provider (ESP). Most ESPs are systems analysts, designers, or builders who are contracted to bring special expertise or experience to a specific project.
7. Most information systems projects involve working as a team. Usually one or more of the stakeholders (team members) takes on the role of project manager to ensure that the system is developed on time, within budget, and with acceptable quality. Most project managers are experienced systems analysts.
8. Business drivers influence information systems. Current business drivers that will continue to influence the development of information systems include:

   a. Globalization of the economy.
   b. Electronic commerce and business.
   c. Security and privacy.
   d. Collaboration and partnership.
   e. Knowledge asset management.
   f. Continuous improvement and total quality management.
   g. Business process redesign.

9. Information technology can be a driver of information systems. Outdated technologies can present problems that drive the need to develop new systems. Newer technologies such as the following are influencing today's information systems:

   a. Networks and the Internet:

      i) *xHTML* and *XML* are the fundamental languages of Web page authoring and Internet application development. Extensible Hypertext Markup Language (xHTML) is the emerging second-generation version of HTML, the language used to construct Web pages. Extensible Markup Language (XML) is the language used to effectively

transport data content along with its proper interpretation over the Internet.
ii) *Scripting* languages are simple programming languages designed specifically for Internet applications.
iii) Web-specific programming languages such as *Java* and *Cold Fusion* have emerged to specifically address construction of complex, Web-based applications that involve multiple servers and Web browsers.
iv) *Intranets* are essentially private Internets designed for use by employees of an organization. They offer the look and feel of the Internet; however, security and firewalls restrict their use to employees.
v) *Extranets,* like intranets, are private Internets. But extranets are for use between specific organizations. Only the employees of those identified businesses can access and use the extranet.
vi) *Portals* (in corporations) are "home pages" that can be customized to the specific needs of different individuals who use them. For example, portal technology can define Web pages that provide appropriate information and applications for different roles in the same company. Each individual's role determines which information and applications that person can use from her or his Web page.
vii) Web services are reusable, Web-based programs that can be called from any other Internet program.

b. Mobile and wireless technologies—Increasingly, wireless access must be assumed. And the limitations of mobile devices and screen sizes must be accommodated in an information system's design. All of the following technical trends will significantly impact the analysis and design of new information systems:

i) Handheld computers, or *personal data assistants* (such as the HP *iPaq,* Palm, and RIM *BlackBerry*) have become common in the ranks of information workers. These devices are increasingly including wireless capabilities that provide Web access and e-mail
ii) *Cell phones* are also increasingly featuring Internet and e-mail capabilities.
iii) Integrated devices such as *smart phones* are emerging that integrate the capabilities of PDAs and cell phones into a single device.
iv) Technologies like *Bluetooth* are emerging to allow separate devices to interoperate as one logical device while preserving each one's form factors and advantages.

c. Object technologies—Most contemporary information systems are built using object technologies. Object technologies allow programmers to build software from software parts called objects. Object-oriented software offers the advantage of reusability and extensibility.
d. Collaborative technologies—Collaborative technologies are those that enhance interpersonal communications and teamwork. Four important classes of collaborative technologies are e-mail, instant messaging, groupware, and work flow.
e. Enterprise applications—Virtually all organizations, large and small, require a core set of enterprise applications to conduct business. For most businesses the core applications include financial management, human resource management, marketing and sales, and operations management (inventory and/or manufacturing control). At one time, most organizations custom-built most or all of these core enterprise applications. But today, these enterprise applications are frequently purchased, installed, and configured for the business and integrated into the organization's business processes. These "internal" core applications are being supplemented with other enterprise applications that integrate an organization's business processes with those of its suppliers and customers. These applications are called customer relationship management (CRM) and supply chain management (SCM). Enterprise application integration (EAI) involves linking applications, whether purchased or developed in-house, so that they can transparently interoperate with one another.

10. Many organizations have a formal systems development process consisting of a standard set of processes or steps they expect will be followed on any systems development project. Systems development processes tend to mirror general problem-solving approaches. This chapter presented a simplified system development process that is composed of the following phases:

a. System initiation—the initial planning for a project to define initial business scope, goals, schedule, and budget.

b. System analysis—the study of a business process domain to recommend improvements and specify the business requirements and priorities for the solution.
c. System design—the specification or construction of a technical, computer-based solution for the business requirements identified in system analysis.
d. System implementation—the construction, installation, testing, and delivery of a system into operation.

11. Information systems face a lifetime of support and continuous improvement. A change made for system support or improvement is merely another project, sometimes called a maintenance or enhancement project. These projects follow the exact same problem-solving approach defined for any other project, but they require less effort and budget.
12. Sequential development requires that each development process (phase) be completed—one after the other. This approach is referred to as the waterfall approach. An alternative development approach is iterative (or incremental) development. This approach requires completing enough analysis, design, and implementation as is necessary to fully develop a part of the new system. Once that version of the system is implemented, the strategy is to then perform some additional analysis, design, and implementation in order to release the next version of the system. These iterations continue until all parts of the entire information system have been developed.

Review Questions

1. Why are information systems (IS) essential in organizations?
2. Why do systems analysts need to know who the stakeholders are in the organization?
3. Who are the typical stakeholders in an information system? What are their roles?
4. Please explain what the consequences are if an information system lacks a system owner.
5. What are the differences between internal users and external users? Give examples.
6. What are the differences between the role of system analysts and the role of the rest of the stakeholders?
7. What kind of knowledge and skills should a system analyst possess?
8. In addition to the business and computing knowledge that system analysts should possess, what are the other essential skills that they need to effectively complete their jobs?
9. Why are good interpersonal communication skills essential for system analysts?
10. What are some of the business drivers for today's information systems?
11. What are the differences between electronic commerce (e-commerce) and electronic business (e-business)?
12. What are the differences between information and knowledge?
13. What are the most important technology drivers for today's information systems?
14. What are the four steps in a system development process? What happens in each step?
15. Why is system initiation essential in the system development process?

Problems and Exercises

1. Assume you are a systems analyst who will be conducting a requirements analysis for an individually owned brick-and-mortar retail store with a point-of-sale system. Identify who the typical internal and external users might include.
2. Assume you are a systems analyst for a consulting company and have been asked to assist the chief executive officer (CEO) of a regional bank. The bank recently implemented a plan to reduce the number of staff, including loan officers, as a strategy to maintain profitability. Subsequently, the bank has experienced chronic problems with backlogged loan requests because of the limited number of loan officers who are able to review and approve or disapprove loans. The CEO of the bank is interested in solutions that would allow the approval process to move faster without increasing the number of loan officers, and has

engaged your company to come up with suggestions. What is one type of system that you might recommend to the bank?

3. How do communication and collaboration systems improve efficiency and effectiveness? What are some of the communication and collaboration systems that are being used by an increasing number of organizations?
4. Identify the type of information system that clerical workers in an organization would typically use and why.
5. As information systems increase in complexity and comprehensiveness, ethical issues regarding accessing and using data from these systems are also increasing. What are some of these ethical issues?
6. What are business to consumer (B2C) and business to business (B2B) Web applications, and what are some examples of each type?
7. While system development processes and methodologies can vary greatly, identify and briefly explain the "generic" phases of the system development process that are described in the textbook and which must be completed for any project. You are a contractor with a systems integration company.
8. Your company has a contract with a local firm to link all of their systems so they can transparently work together. Their applications include a number of existing legacy systems, which were built at different times by different developers using a variety of languages and platforms, as well as several newer contemporary applications. What is the term for this type of linking? What type of tool would you most likely use, and what are some examples of these tools?
9. Your company has asked you to develop a new Web-based system to replace its existing legacy system. There will be very little change in business requirements and functionality from the existing legacy system. Suggest which system development process you might use and why.
10. You recently joined a retail sales company which has recently bought out and assimilated a commercial industrial supply house. You have been asked to lead a project to develop a consolidated inventory-tracking system. Suggest which system development process you might use and why.
11. Your company president sits down beside you just before a meeting is to begin and tells you that people keep saying the customer needs to install a CRM, but doesn't really know what it is. The company president then asks you to explain it in nontechnical terms in the next 30 seconds.
12. Industry studies indicate that mobile and wireless technology has become one of the major technology drivers for designing new information systems. Why is this the case and what is the impact?
13. Briefly explain the impact of Web services on Web development. Give some examples of Web services.
14. Identify in which phase of the development process the following activities belong:

    a. Development of the technical blueprint or design document.
    b. Project scheduling.
    c. Integration testing.
    d. Interviewing system users to define business requirements.

15. What are the two most important advantages of object-oriented software technologies over structured software technologies?

Projects and Research

1. Research the average and/or median salaries for IT professionals. You can use a variety of methods to find this information, such as searching the Web for online sites that publish the results of salary surveys for IT professionals. You can also look at classified ads in newspapers, trade magazines, and/or online.

    a. Is there a significant difference between typical salaries for system analysts, designers and developers?
    b. Roughly, what is the difference in the typical salaries for these different groups?
    c. What do you think are the reasons for the difference?
    d. Is there a gender gap in the salaries of IT professionals? Discuss any trends that you found, and the implications.

2. Contact the chief information officers (CIOs) or top IT managers of several local or regional organizations. Ask them about the process or

methodology they use for system development in their organizations, and why they utilize that particular approach.

a. Describe and compare the different approaches that you have found.
b. Which approach do you believe to be the most effective approach?
c. Why?

3. Career choices and personal skills:

a. At this point in your education, if you had to choose between becoming a systems analyst, systems designer, or systems builder, which one would you choose?
b. Why?
c. Now divide a piece of paper into two columns. On one side, list the personal skills and traits you think are most important for each of these three groups of systems analysts, designers, and builders. In the second column, list at least five skills and traits that you feel to be your strongest ones, then map them to the skills and traits you listed for each of the three groups. With which group do you have the most skills and traits in common?
d. Is this group the same one as the one you would choose in Question 3a? Why do you think this is (or is not) the case?

4. Your school library should have journals and periodicals dating back at least several decades, or may subscribe to online research services which do. Look at several recent articles in information technology journals regarding systems analysis, as well as several articles from at least 25 years ago.

a. Compare the recent articles to the older ones. Do there appear to be significant differences in the typical knowledge, skills, abilities, and/or experience that systems analysts needed 25 years ago compared to now?
b. If you found some differences, what are the ones that you consider most important?
c. What do you think are some of the reasons for these changes?
d. Now get out your crystal ball and look into the future 25 years from now. What differences do you predict between the systems analysts of today and those in 25 years?

5. Search the Web for several articles and information on ethical issues related to information technology professionals.

a. What articles did you find?
b. Based on your research, which ethical issues do you think systems analysts might face during their careers?
c. Pick a particular ethical issue and explain the steps you would take if you were confronted with this issue.
d. What would you do if you found your best friend and co-worker had committed a serious ethical violation? Facts to consider: The violation may never be discovered, but it will cost your company many thousands of dollars in higher costs over the next several years. Your company has a stringent policy of firing employees who commit serious ethical violations. Make sure to explain your reasons for the action(s) you would take, if any.

6. Search the Web or business periodicals in your library such as Forbes Magazine for information on three or four chief information officers of large companies or organizations.

a. Which industry sector, companies, and CIOs did you find?
b. For each CIO that you researched, what was their predominant experience prior to becoming a CIO; that is, did they have an information technology background, a business background, or both?
c. For each CIO, what is their level of education?
d. How many years has each been a CIO, and for approximately how many different companies has each one worked?
e. Based upon your research, what knowledge and skills does a CIO need in order to be successful? Why?

Minicases

1. What do you think will be possible technologically 10 years from now? How about 20 or 30 years from now? Research a new and interesting technology that is in the research and development stage. Prepare a presentation using a movie clip and PowerPoint on this technology and present it to the class. Submit a short paper on the impacts this new technology might have on society and/or businesses.
2. Consider outsourcing: It is many times the case that at least part of the development process is outsourced. In fact, project leaders today must be

capable of handling geographically diverse teams as well as timeline and resource constraints. Outsourcing brings to the table increased efficiency and economic gains to the societies that are interacting. However, these gains are not quickly realized, and the negative impacts on a society that is outsourcing can be significant from a jobs perspective. Dr. Mankiw, as an economic advisor to President Bush, publicly touted the benefits of outsourcing and was deeply criticized for his stance. Do you think that it is good or bad for a business to outsource work? Do you think there are ethical dilemmas for companies who outsource? Find at least two articles on the impacts of outsourcing, and bring them to share with the class.

3. You are a network administrator, and as part of your job, you monitor employee e-mails. You discover that your boss is cutting corners on a system that your company is developing in order to finish the project more quickly and to stay under budget. There is a flaw in the system as a result, and this flaw will cause a network crash if more than 20 people are on the network at a time. The client expects approximately 12 people on the network at any given time. You are sure, as apparently your boss is, that the customer will not find out until well after the project is accepted (if ever). What do you do?
4. A systems analyst must be both technically proficient and capable of successful customer communication. Developing a good system requires a complete understanding of user requirements. Many times, users don't know what is available (technologically) or even what they would like from a system. What are characteristics of good communication?

Team and Individual Exercises

1. Get together into small groups of two. The first person will decide on a task that he/she wishes to be completed—for instance, sharpen a pencil or write down the name of the professor. It should be simple and straightforward. That person is to communicate on paper using only diagrams and no words (verbal or written) what he/she wishes to be done, and give it to person number two. Person number two should then complete the requested task.
2. What did you discover from this exercise? How long did it take until the second person understood what the first person was asking for? Was there miscommunication? Write down your thoughts and observations, and share them with the class.
3. Individual exercise: Imagine a really cool technology. The sky is the limit, and anything is possible. How does this technology impact your life? Does it impact business?
4. Individual exercise: Think back on the last time someone told you something *couldn't* be done. What was it? Did you listen to them? Why or why not?

Suggested Readings

Ambler, Scott. *Agile Modeling: Effective Practices for eXtreme Programming and the Unified Process.* New York: John Wiley & Sons, 2002. This book has significantly shaped our thinking about the software development process. Those of you who are critical of the "extreme-programming" movement need not fear that our enthusiasm for this suggested reading indicates an endorsement of extreme programming. We simply like the sanity that Scott brings to the process of systems and software development through the use of flexible methods within the context of an iterative process. We will reference this book in several chapters.

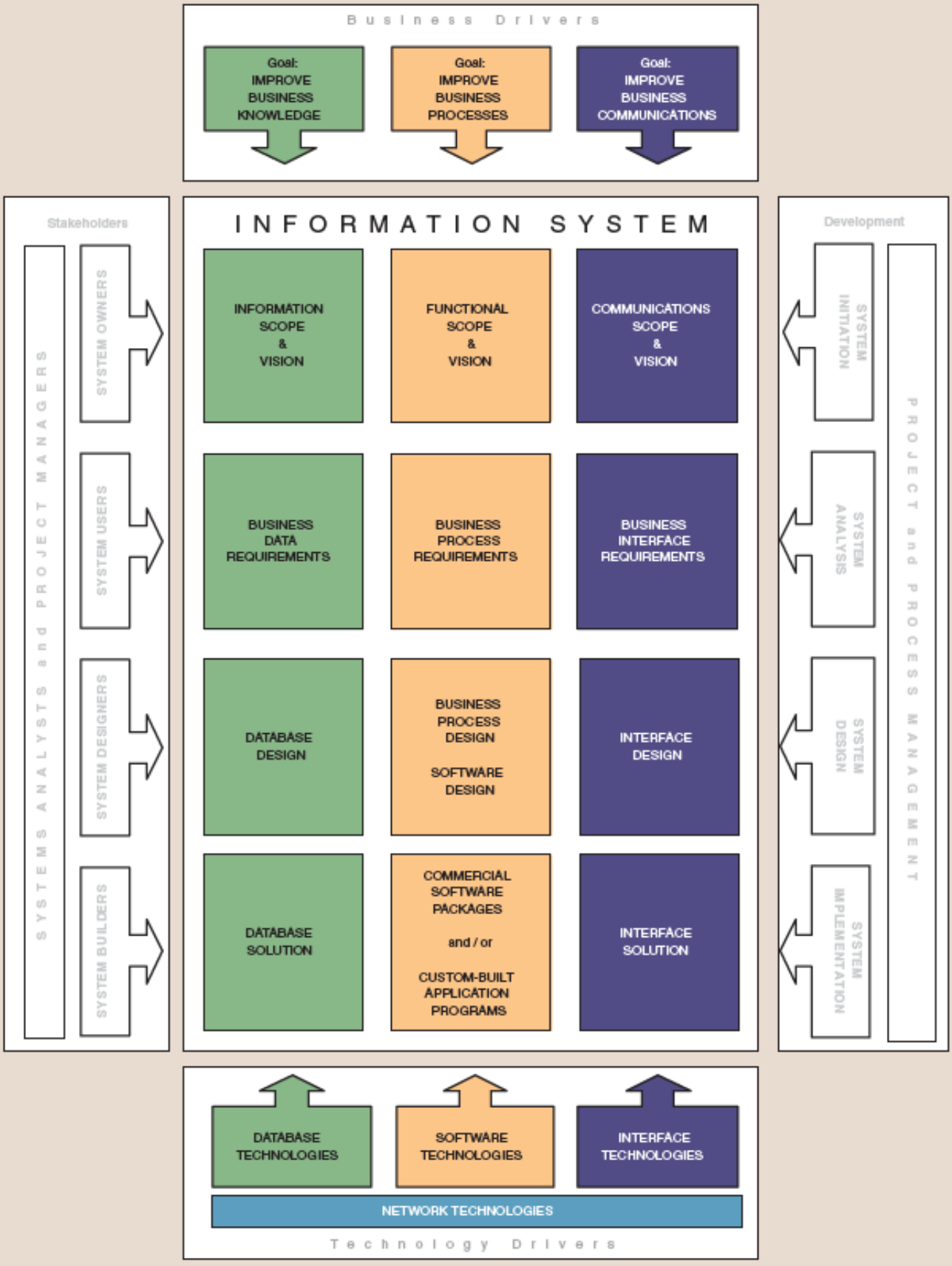
Ernest, Kallman; John Grillo; and James Linderman. *Ethical Decision Making and Information Technology: An Introduction with Cases,* 2nd ed. Burr Ridge, IL: McGraw-Hill/Irwin, 1995. This is an excellent textbook for teaching ethics in an MIS curriculum. It is a collection of case studies that can complement a systems analysis and design course.

Gartner Group IT Symposium and Expo (annual). Our university's management information unit has long subscribed to the Gartner Group's service that reports on industry trends, the probabilities for success of trends and technologies, and suggested strategies for information technology transfer. Gartner research has played a significant, ongoing role in helping us to chart business and technology drivers as described in this chapter. We have also been fortunate to be able to attend Gartner's annual IT symposium. Gartner Group reports and symposiums have influenced each edition of the book. For more information about the Gartner Group, see www.gartner.com.

Gause, Donald, and Gerald Weinberg. *Are Your Lights On? How to Figure Out What the Problem REALLY Is.* New York: Dorset House Publishing, 1990. Yes, this is not a recent book, but neither are the fundamentals of problem solving. Here's a short and easy-to-read book about general problem solving. You can probably read the entire book in one night, and it could profoundly improve your problem-solving potential as a systems analyst (or, for that matter, any other profession).

Levine, Martin. *Effective Problem Solving,* 2nd ed. Englewood Cliffs, NJ: Prentice Hall, 1994. This is another older book, but as we stated before, problem-solving methods are timeless. At only 146 pages, this title can serve as an excellent professional reference.

Weinberg, Gerald. *Rethinking Systems Analysis and Design.* New York: Dorset House Publishing, 1988. Don't let the date fool you. This is one of the best and most important books on this subject ever written. This book may not teach any of the popular systems analysis and design methods of our day, but it challenges the reader to leap beyond those methods to consider something far more important—the people side of systems work. Dr. Weinberg's theories and concepts are presented in the context of dozens of delightful fables and short experiential stories. We are grateful to him for our favorite systems analysis fable of all time, "The Three Ostriches."


Business Drivers
Goal: IMPROVE BUSINESS KNOWLEDGE
Goal: IMPROVE BUSINESS PROCESSES
Goal: IMPROVE BUSINESS COMMUNICATIONS
Stakeholders
SYSTEMS ANALYSTS and PROJECT MANAGERS
SYSTEM OWNERS
SYSTEM USERS
SYSTEM DESIGNERS
SYSTEM BUILDERS
INFORMATION SYSTEM
INFORMATION SCOPE & VISION
FUNCTIONAL SCOPE & VISION
COMMUNICATIONS SCOPE & VISION
BUSINESS DATA REQUIREMENTS
BUSINESS PROCESS REQUIREMENTS
BUSINESS INTERFACE REQUIREMENTS
DATABASE DESIGN
BUSINESS PROCESS DESIGN
SOFTWARE DESIGN
INTERFACE DESIGN
DATABASE SOLUTION
COMMERCIAL SOFTWARE PACKAGES
and / or
CUSTOM-BUILT APPLICATION PROGRAMS
INTERFACE SOLUTION
Development
SYSTEM INITIATION
SYSTEM ANALYSIS
SYSTEM DESIGN
SYSTEM IMPLEMENTATION
PROJECT and PROCESS MANAGEMENT
DATABASE TECHNOLOGIES
SOFTWARE TECHNOLOGIES
INTERFACE TECHNOLOGIES
NETWORK TECHNOLOGIES
Technology Drivers