GLOBAL EDITION

Essentials of Systems Analysis and Design

SIXTH EDITION

Joseph S. Valacich • Joey F. George • Jeffrey A. Hoffer

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To my mother, Mary Valacich.

—Joe

To Karen, Evan, and Caitlin.

—Joey

To Patty, for her sacrifices, encouragement, and support. To my students, for being receptive and critical, and for challenging me to be a better teacher.

—Jeff

Brief Contents

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Preface

Our Approach

In today's information- and technology-driven business world, students need to be aware of three key factors. First, it is more crucial than ever to know how to organize and access information strategically. Second, success often depends on the ability to work as part of a team. Third, the Internet will play an important part in their work lives. *Essentials of Systems Analysis and Design*, *Sixth Edition*, addresses these key factors.

More than 50 years' combined teaching experience in systems analysis and design have gone into creating *Essentials of Systems Analysis and Design*, *Sixth Edition*, a text that emphasizes hands-on, experimental learning. We provide a clear presentation of the concepts, skills, and techniques students need to become effective systems analysts who work with others to create information systems for businesses. We use the systems development life cycle model as an organizing tool throughout the book to provide a strong conceptual and systematic framework.

Electronic commerce coverage is provided in each chapter via an integrated, extended illustrative case (Pine Valley Furniture WebStore) and an end-of-chapter case (Petrie's Electronics).

Many systems analysis and design courses involve lab work and outside reading. Lecture time can be limited. Based on market research and our own teaching experience, we understand the need for a book that combines depth of coverage with brevity. So we have created a ten-chapter book that covers key systems analysis and design content without overwhelming students with unnecessary detail.

New to the Sixth Edition

The following features are new to the Sixth Edition:

- *Expanded coverage of business processes.* Process modeling is at the heart of systems analysis and design. Data-flow diagrams have been a staple of this book since its first edition, but now they are framed in the context of business process diagramming. The beginning of Chapter 6 has been rewritten to show how data-flow diagrams are just one of many common methods for modeling business processes. Business processes are defined and illustrated before the discussion of data-flow diagrams begins.
- *Updates to the WebStore running case.* Since the advent of electronic commerce, this book has featured an end-of-chapter Pine Valley Furniture (PVF) case focused on the WebStore, an e-commerce application for PVF. In the current edition, the WebStore case has been expanded to include the analysis, design, and testing of a new mobile app for PVF. Development of the e-commerce application and the mobile app now go hand-in-hand in the revised case.
- *Updated illustrations of technology.* Screen captures have been updated throughout the text to show examples using the latest versions of programming and Internet development environments, and user interface designs.
- *Updated content.* Throughout the book, the content in each chapter has been updated where appropriate.

Themes

Essentials of Systems Analysis and Design, Sixth Edition, is characterized by the following themes:

- *Systems development is firmly rooted in an organizational context.* The successful systems analyst requires a broad understanding of organizations, organizational culture, and operations.
- *Systems development is a practical field.* Coverage of current practices as well as accepted concepts and principles is essential for today's systems analyst.
- *Systems development is a profession.* The text presents standards of practice, and fosters a sense of continuing personal development, ethics, and a respect for and collaboration with the work of others.
- *Systems development has significantly changed with the explosive growth in databases, data-driven architecture for systems, and the Internet.* Systems development and database management can be taught in a highly coordinated fashion. The Internet has rapidly become a common development platform for database-driven electronic commerce systems.
- *Success in systems analysis and design requires not only skills in methodologies and techniques, but also in the management of time, resources, and risks.* Learning systems analysis and design requires a thorough understanding of the process as well as the techniques and deliverables of the profession.

Given these themes, the text emphasizes these approaches:

- A business rather than a technology perspective
- The role, responsibilities, and mindset of the systems analyst as well as the systems project manager, rather than those of the programmer or business manager
- The methods and principles of systems development rather than the specific tools or tool-related skills of the field

Audience

The book assumes that students have taken an introductory course on computer systems and have experience writing programs in at least one programming language. We review basic system principles for those students who have not been exposed to the material on which systems development methods are based. We also assume that students have a solid background in computing literacy and a general understanding of the core elements of a business, including basic terms associated with the production, marketing, finance, and accounting functions.

Organization

The outline of the book follows the systems development life cycle:

- Part I, "Foundations for Systems Development," gives an overview of systems development and previews the remainder of the book.
- Part II, "Systems Planning and Selection," covers how to assess project feasibility and build the baseline project plan.
- Part III, "Systems Analysis," covers determining system requirements, process modeling, and conceptual data modeling.

- Part IV, "Systems Design," covers how to design the human interface and databases.
- Part V, "Systems Implementation and Operation," covers system implementation, operation, closedown, and system maintenance.
- Appendix A, "Object-Oriented Analysis and Design," and Appendix B, "Agile Methodologies," can be skipped or treated as advanced topics at the end of the course.

Distinctive Features

Here are some of the distinctive features of *Essentials of Systems Analysis and Design, Sixth Edition:*

1. The grounding of systems development in the typical architecture for systems in modern organizations, including database management and Web-based systems.
2. A clear linkage of all dimensions of systems description and modeling—process, decision, and data modeling—into a comprehensive and compatible set of systems analysis and design approaches. Such broad coverage is necessary for students to understand the advanced capabilities of many systems development methodologies and tools that automatically generate a large percentage of code from design specifications.
3. Extensive coverage of oral and written communication skills (including systems documentation), project management, team management, and a variety of systems development and acquisition strategies (e.g., life cycle, prototyping, rapid application development, object orientation, joint application development, participatory design, and business process reengineering).
4. Coverage of rules and principles of systems design, including decoupling, cohesion, modularity, and audits and controls.
5. A discussion of systems development and implementation within the context of management of change, conversion strategies, and organizational factors in systems acceptance.
6. Careful attention to human factors in systems design that emphasize usability in both character-based and graphical user interface situations.

Pedagogical Features

The pedagogical features of *Essentials of Systems Analysis and Design, Sixth Edition*, reinforce and apply the key content of the book.

SDLC Framework

Although several conceptual processes can be used for guiding a systems development effort, the systems development life cycle (SDLC) is arguably the most widely applied method for designing contemporary information systems. We highlight four key SDLC steps (Figure P-1):

- Planning and selection
- Analysis
- Design
- Implementation and operation

We use the SDLC to frame the part and chapter organization of our book. Most chapters open with an SDLC figure with various parts highlighted to show

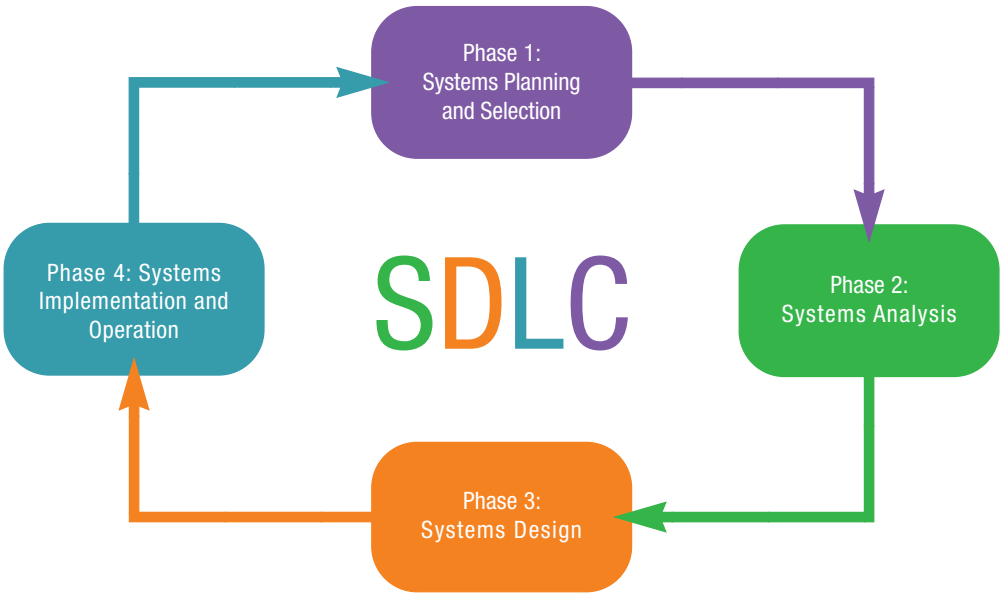

FIGURE P-1
The systems development life cycle (SDLC): management is necessary throughout.

students how these chapters, and each step of the SDLC, systematically build on the previous one.

Internet Coverage and Features

Pine Valley Furniture WebStore A furniture company founded in 1980 has decided to explore electronic commerce as an avenue to increase its market share. Should this company sell its products online? Should this system include a custom mobile app? How would a team of analysts work together to develop, propose, and implement a plan? Beginning in Chapter 4, we explore the step-by-step process.

Petrie's Electronics This end-of-chapter fictional case illustrates how a national electronics retailer develops a Web-based customer loyalty program to build and strengthen customer relationships. The case first appears at the end of Chapter 2 and concludes at the end of Chapter 10.

Three Illustrative Fictional Cases

Pine Valley Furniture (PVF) This case is introduced in Chapter 3 and revisited throughout the book. As key systems development life cycle concepts are presented, they are applied and illustrated. For example, in Chapter 3, we explore how PVF implements the purchasing fulfillment system, and in Chapter 4, we explore how PVF implements a customer tracking system. A margin icon identifies the location of the case segments. A case problem related to PVF is included in the end-of-chapter material.

Hoosier Burger (HB) This second illustrative case is introduced in Chapter 6 and revisited throughout the book. Hoosier Burger is a fictional fast-food restaurant in Bloomington, Indiana. We use this case to illustrate how analysts would develop and implement an automated food-ordering system. A margin icon identifies the location of these case segments. A case problem related to HB is included in the end-of-chapter material.

Petrie's Electronics This fictional electronics retailer is used as an extended case at the end of each chapter, beginning with Chapter 2. Designed to bring the chapter concepts to life, this case illustrates how a company initiates,

plans, models, designs, and implements a Web-based customer loyalty program. Discussion questions are included to promote critical thinking and class participation. Suggested solutions to the discussion questions are provided in the Instructor's Manual.

End-of-Chapter Material

We have developed an extensive selection of end-of-chapter material designed to accommodate various learning and teaching styles.

Key Points Review This section repeats the learning objectives that appear at the opening of the chapter and summarizes the key points related to the objectives.

Key Terms Checkpoint In this self-test feature, students match each key term in the chapter with its definition.

Review Questions These questions test students' understanding of key concepts.

Problems and Exercises These exercises test students' analytical skills and require them to apply key concepts.

Discussion Questions These questions promote class participation and discussion.

Case Problems These problems require students to apply the concepts of the chapter to fictional cases from various industries. The two illustrative cases from the chapters are revisited—Pine Valley Furniture and Hoosier Burger. Other cases are from various fields such as medicine, agriculture, and technology. Solutions are provided in the Instructor's Manual.

Margin Term Definitions

Each key term and its definition appear in the margin. A glossary of terms appears at the back of the book.

References

Located at the end of the text, references are organized by chapter and list more than 200 books and journals that can provide students and faculty with additional coverage of topics.

The Supplement Package: www.pearsonglobaleditions.com/Valacich

A comprehensive and flexible technology support package is available to enhance the teaching and learning experience. Instructor supplements are available at www.pearsonglobaleditions.com/Valacich:

- An *Instructor's Resource Manual* provides chapter-by-chapter instructor objectives, teaching suggestions, and answers to all text review questions, problems, and exercises.
- The *Test Item File* and *TestGen* include a comprehensive set of more than 1,500 test questions in multiple-choice, true-false, and short-answer format; questions are ranked according to level of difficulty and referenced with page numbers and topic headings from the text. The Test Item File is available in Microsoft Word and as a computerized TestGen test bank. The TestGen software is PC-compatible

and preloaded with all of the Test Item File questions. You can manually or randomly view test questions and drag-and-drop to create a test. You can add or modify test-bank questions as needed.

- *PowerPoint Presentation Slides* feature lecture notes that highlight key text terms and concepts. Professors can customize the presentation by adding their own slides or by editing the existing ones.
- The *Image Library* is a collection of the text art organized by chapter. This collection includes all of the figures, tables, and screenshots (as permission allows) from the book. These images can be used to enhance class lectures and PowerPoint slides.

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Prior to his academic career, Dr. Valacich worked in the information systems field as a programmer, systems analyst, and technical product manager. He has conducted numerous corporate training and executive development programs for organizations, including AT&T, Boeing, Dow Chemical, EDS, Exxon, FedEx, General Motors, Microsoft, and Xerox.

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Dr. George has published dozens of articles in such journals as *Information Systems Research*, *Communications of the ACM*, *MIS Quarterly*, *Journal of*

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Dr. George is coauthor of the textbooks *Modern Systems Analysis and Design*, *Seventh Edition*, published in 2014, and *Object-Oriented Systems Analysis and Design*, *Second Edition*, published in 2007, both from Pearson. He has served as an associate editor and senior editor for both *MIS Quarterly* and *Information Systems Research*. He served three years as the editor-in-chief of the *Communications of the AIS*. Dr. George was the conference co-chair for the 2001 ICIS, held in New Orleans, Louisiana; conference chair for the 2012 ICIS, held in Orlando, Florida; and the doctoral consortium co-chair for the 2003 ICIS, held in Seattle, Washington. He is a Fellow of the Association for Information Systems (AIS) and served as President of AIS in 2010–11.

Jeffrey A. Hoffer is the Sherman–Standard Register Professor of Data Management for the Department of MIS, Operations Management, and Decision Sciences in the School of Business Administration at the University of Dayton. He also taught at Indiana University and Case Western Reserve University. Dr. Hoffer earned his BA from Miami University in 1969 and his Ph.D. from Cornell University in 1975.

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Dr. Hoffer is cofounder of the International Conference on Information Systems and Association for Information Systems and has served as a guest lecturer at the Catholic University of Chile, Santiago, and the Helsinki School of Economics and Business in Mikkeli, Finland.

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Essentials of Systems Analysis and Design

one

The Systems Development Environment

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Chapter Objectives

After studying this chapter, you should be able to:

- Define information systems analysis and design.
- Describe the role of the systems analyst in information systems development.
- Describe the information systems development life cycle (SDLC).
- List alternatives to the systems development life cycle, including a description of the role of computer-aided software engineering (CASE) tools in systems development.

Chapter Preview . . .

The key to success in business is the ability to gather, organize, and interpret information. Systems analysis and design is a proven methodology that helps both large and small businesses reap the rewards of utilizing information to its full capacity. As a systems analyst—the person in the organization most involved with systems analysis and design—you will enjoy a rich career path that will enhance both your computer and interpersonal skills.

The systems development life cycle (SDLC) is central to the development of an efficient information system. We will highlight four key SDLC steps: (1) planning and selection, (2) analysis, (3) design, and (4) implementation and operation. Be aware that these steps may vary in each organization, depending on its goals. The SDLC is illustrated in Figure 1-1.

This text requires that you have a general understanding of computer-based information systems as provided in an introductory information systems course. This chapter previews systems analysis and lays the groundwork for the rest of the book.

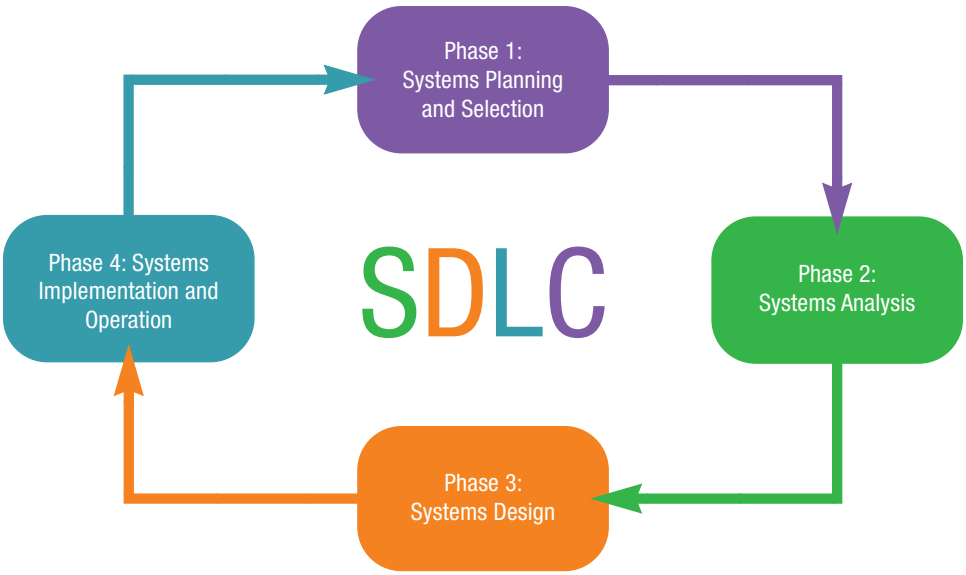


FIGURE 1-1
The four steps of the systems development life cycle (SDLC): (1) planning and selection, (2) analysis, (3) design, and (4) implementation and operation.

What Is Information Systems Analysis and Design?

Information systems analysis and design
The process of developing and maintaining an information system.

Information systems analysis and design is a method used by companies ranging from IBM to PepsiCo to Sony to create and maintain information systems that perform basic business functions such as keeping track of customer names and addresses, processing orders, and paying employees. The main goal of systems analysis and design is to improve organizational systems, typically through applying software that can help employees accomplish key business tasks more easily and efficiently. As a systems analyst, you will be at the center of developing this software. The analysis and design of information systems are based on:

- Your understanding of the organization's objectives, structure, and processes
- Your knowledge of how to exploit information technology for advantage

To be successful in this endeavor, you should follow a structured approach. The SDLC, shown in Figure 1-1, is a four-phased approach to identifying, analyzing, designing, and implementing an information system. Before we talk about the SDLC, we first describe what is meant by systems analysis and design.

Systems Analysis and Design: Core Concepts

Application software
Software designed to process data and support users in an organization. Examples include spreadsheets, word processors, and database management systems.

The major goal of systems analysis and design is to improve organizational systems. Often this process involves developing or acquiring **application software** and training employees to use it. Application software, also called a *system*, is designed to support a specific organizational function or process, such as inventory management, payroll, or market analysis. The goal of application software is to turn data into information. For example, software developed for the inventory department at a bookstore may keep track of the number of books in stock of the latest bestseller. Software for the payroll department may keep track of the changing pay rates of employees. A variety of off-the-shelf application software can be purchased, including TurboTax, Excel, and Photoshop. However, off-the-shelf software may not fit the needs of a particular organization, and so the organization must develop its own product.

In addition to application software, the information system includes:

- The hardware and systems software on which the application software runs. Note that the systems software helps the computer function, whereas the application software helps the user perform tasks such as writing a paper, preparing a spreadsheet, and linking to the Internet.
- Documentation and training materials, which are materials created by the systems analyst to help employees use the software they've helped create.
- The specific job roles associated with the overall system, such as the people who run the computers and keep the software operating.
- Controls, which are parts of the software written to help prevent fraud and theft.
- The people who use the software in order to do their jobs.

The components of a computer-based information system application are summarized in Figure 1-2. We address all the dimensions of the overall system, with particular emphasis on application software development—your primary responsibility as a systems analyst.

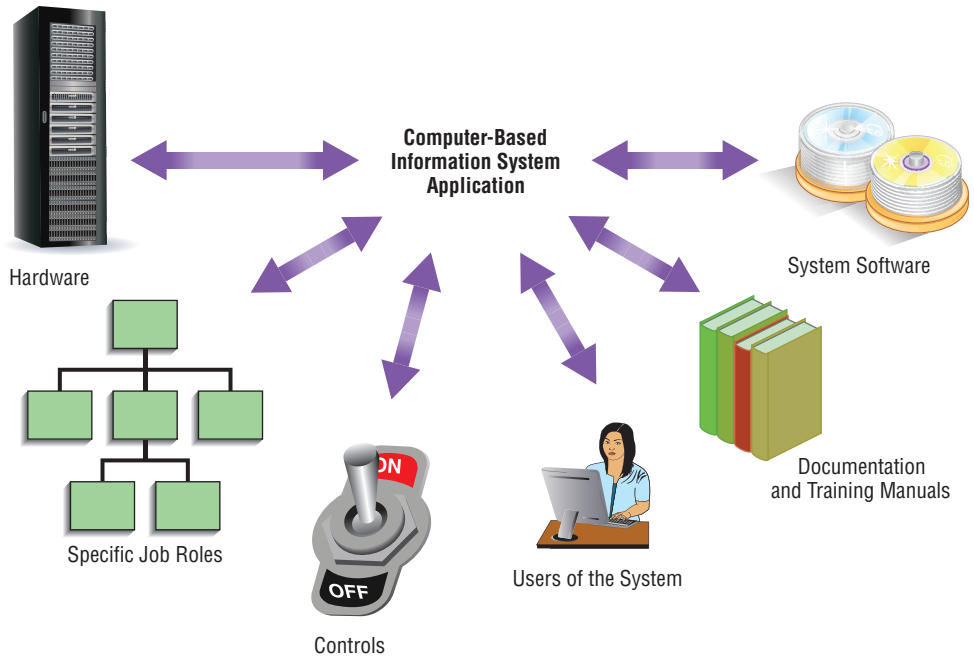


FIGURE 1-2
Components of a computer-based information system application.

Our goal is to help you understand and follow the software engineering process that leads to the creation of information systems. As shown in Figure 1-3, proven methodologies, techniques, and tools are central to software engineering processes.

Methodologies are a sequence of step-by-step approaches that help develop your final product: the information system. Most methodologies incorporate several development techniques, such as direct observations and interviews with users of the current system.

Techniques are processes that you, as an analyst, will follow to help ensure that your work is well thought-out, complete, and comprehensible to others on your project team. Techniques provide support for a wide range of tasks, including conducting thorough interviews with current and future users of the information system to determine what your system should do, planning and managing the activities in a systems development project, diagramming how the system will function, and designing the reports, such as invoices, your system will generate for its users to perform their jobs.

Tools are computer programs, such as computer-aided software engineering (CASE) tools, that make it easy to use specific techniques. These three elements—methodologies, techniques, and tools—work together to form an organizational approach to systems analysis and design.

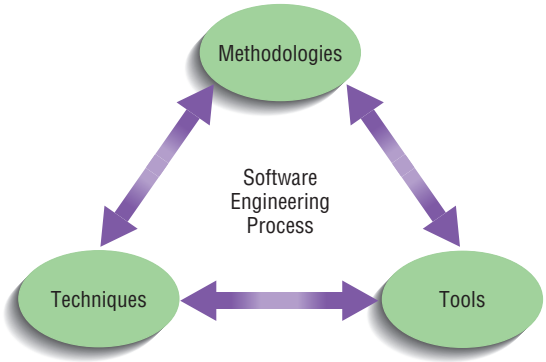


FIGURE 1-3
The software engineering process uses proven methodologies, techniques, and tools.

In the rest of this chapter, you will learn about approaches to systems development—the data- and process-oriented approaches. You will also identify the various people who develop systems and the different types of systems they develop. The chapter ends with a discussion of some of the methodologies, techniques, and tools created to support the systems development process. Before we talk more about computer-based information systems, let's briefly discuss what we mean by the word *system*.

Systems

The key term used most frequently in this book is *system*. Understanding systems and how they work is critical to understanding systems analysis and design.

Definition of a System and Its Parts

System
A group of interrelated procedures used for a business function, with an identifiable boundary, working together for some purpose.

A **system** is an interrelated set of business procedures (or components) used within one business unit, working together for some purpose. For example, a system in the payroll department keeps track of checks, whereas an inventory system keeps track of supplies. The two systems are separate. A system has nine characteristics, seven of which are shown in Figure 1-4. A detailed explanation of each characteristic follows, but from the figure you can see that a system exists within a larger world, an environment. A boundary separates the system from its environment. The system takes input from outside, processes it, and sends the resulting output back to its environment. The arrows in the figure show this interaction between the system and the world outside of it.

1. Components
2. Interrelated components
3. Boundary
4. Purpose
5. Environment
6. Interfaces
7. Constraints
8. Input
9. Output

Component
An irreducible part or aggregation of parts that makes up a system; also called a *subsystem*.

Interrelated
Dependence of one part of the system on one or more other system parts.

Boundary
The line that marks the inside and outside of a system and that sets off the system from its environment.

Purpose
The overall goal or function of a system.

Environment
Everything external to a system that interacts with the system.

A system is made up of components. A **component** is either an irreducible part or an aggregate of parts, also called a *subsystem*. The simple concept of a component is very powerful. For example, as with an automobile or a stereo system, with proper design, we can repair or upgrade the system by changing individual components without having to make changes throughout the entire system. The components are **interrelated**; that is, the function of one is somehow tied to the functions of the others. For example, the work of one component, such as producing a daily report of customer orders received, may not progress successfully until the work of another component is finished, such as sorting customer orders by date of receipt. A system has a **boundary**, within which all of its components are contained and that establishes the limits of a system, separating it from other systems. Components within the boundary can be changed, whereas systems outside the boundary cannot be changed. All of the components work together to achieve some overall **purpose** for the larger system: the system's reason for existing.

A system exists within an **environment**—everything outside the system's boundary that influences the system. For example, the environment of a state university includes prospective students, foundations and funding agencies, and

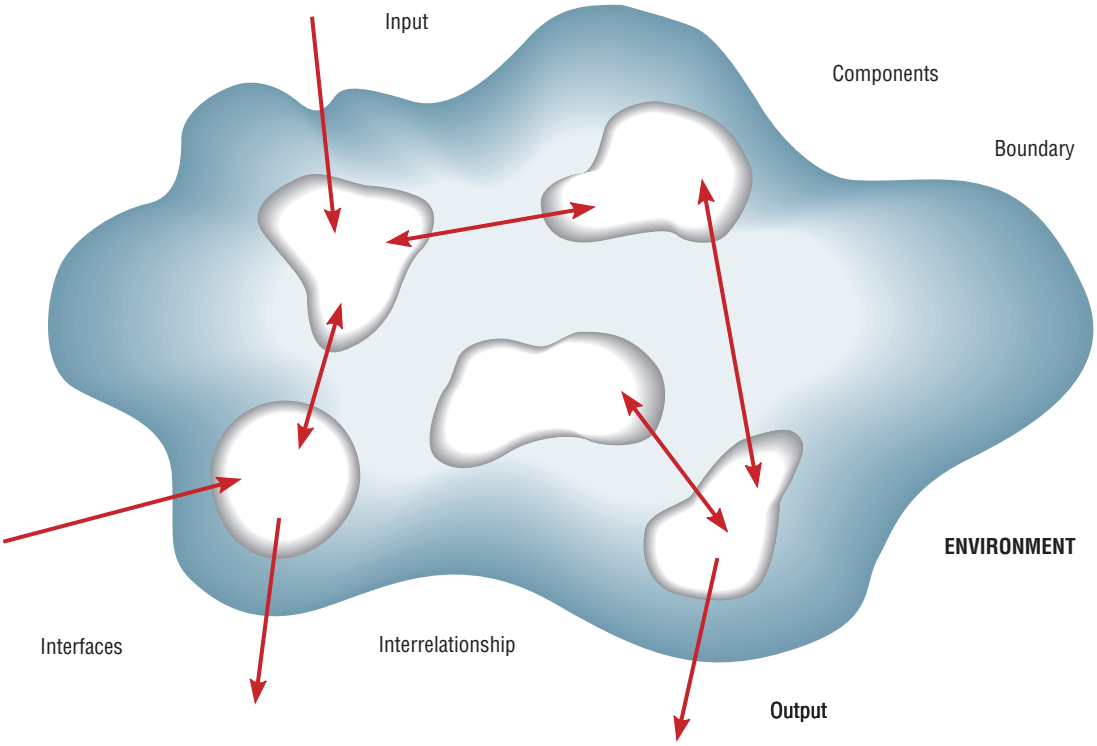


FIGURE 1-4
Seven characteristics of a system.

the news media. Usually the system interacts with its environment. A university interacts with prospective students by having open houses and recruiting from local high schools. An information system interacts with its environment by receiving data (raw facts) and information (data processed in a useful format). Figure 1-5 shows how a university can be seen as a system. The points at which the system meets its environment are called **interfaces**; an interface also occurs between subsystems.

Interface
Point of contact where a system meets its environment or where subsystems meet each other.

In its functioning, a system must face **constraints**—the limits (in terms of capacity, speed, or capabilities) to what it can do and how it can achieve its purpose within its environment. Some of these constraints are imposed inside the system (e.g., a limited number of staff available), and others are imposed by the environment (e.g., due dates or regulations). A system takes input from its environment in order to function. People, for example, take in food, oxygen, and water from the environment as input. You are constrained from breathing fresh air if you're in an elevator with someone who is smoking. Finally, a system returns output to its environment as a result of its functioning and thus achieves its purpose. The system is constrained if electrical power is cut.

Constraint
A limit to what a system can accomplish.

Important System Concepts

Systems analysts need to know several other important systems concepts:

- Decomposition
- Modularity
- Coupling
- Cohesion

Decomposition is the process of breaking down a system into its smaller components. These components may themselves be systems (subsystems) and can be broken down into their components as well. How does decomposition

Decomposition
The process of breaking the description of a system down into small components; also known as *functional decomposition*.

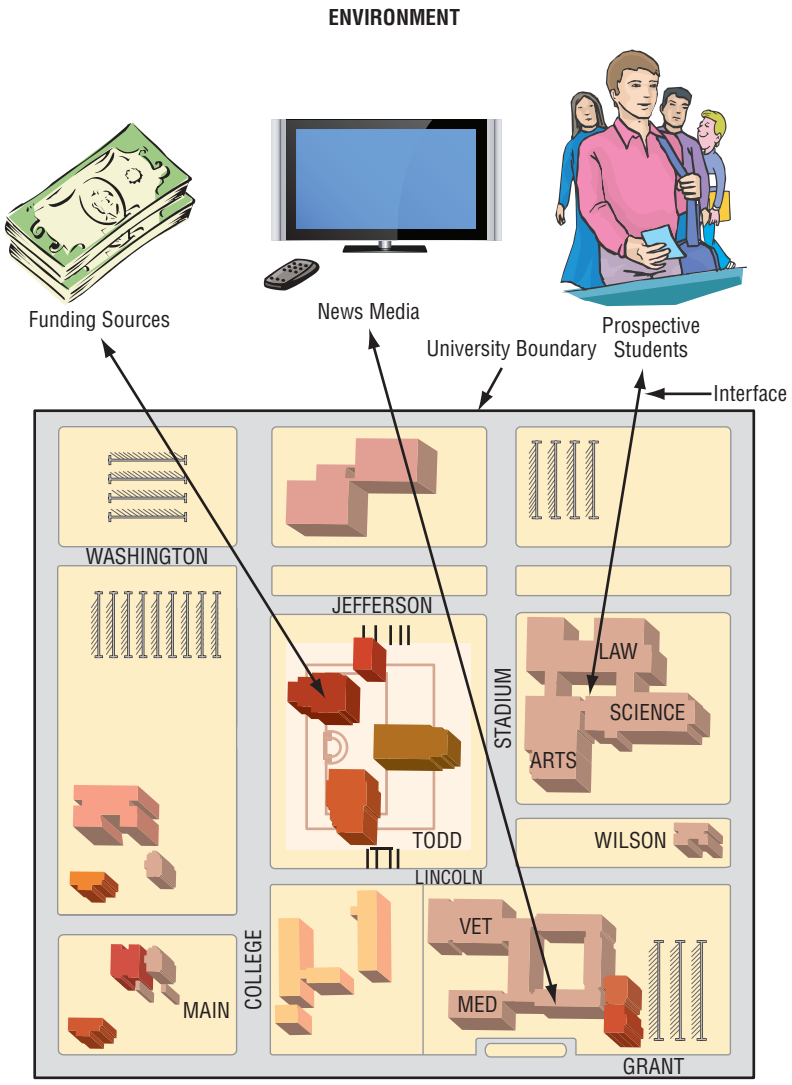


FIGURE 1-5
A university as a system.

aid understanding of a system? It results in smaller and less complex pieces that are easier to understand than larger, complicated pieces. Decomposing a system also allows us to focus on one particular part of a system, making it easier to think of how to modify that one part independently of the entire system. Decomposition is a technique that allows the systems analyst to:

- Break a system into small, manageable, and understandable subsystems
- Focus attention on one area (subsystem) at a time, without interference from other areas
- Concentrate on the part of the system pertinent to a particular group of users, without confusing users with unnecessary details
- Build different parts of the system at independent times and have the help of different analysts

Figure 1-6 shows the decomposition of a portable MP3 player. Decomposing the system into subsystems reveals the system's inner workings. You can decompose an MP3 player into at least three separate physical subsystems. (Note that decomposing the same MP3 player into *logical* subsystems would

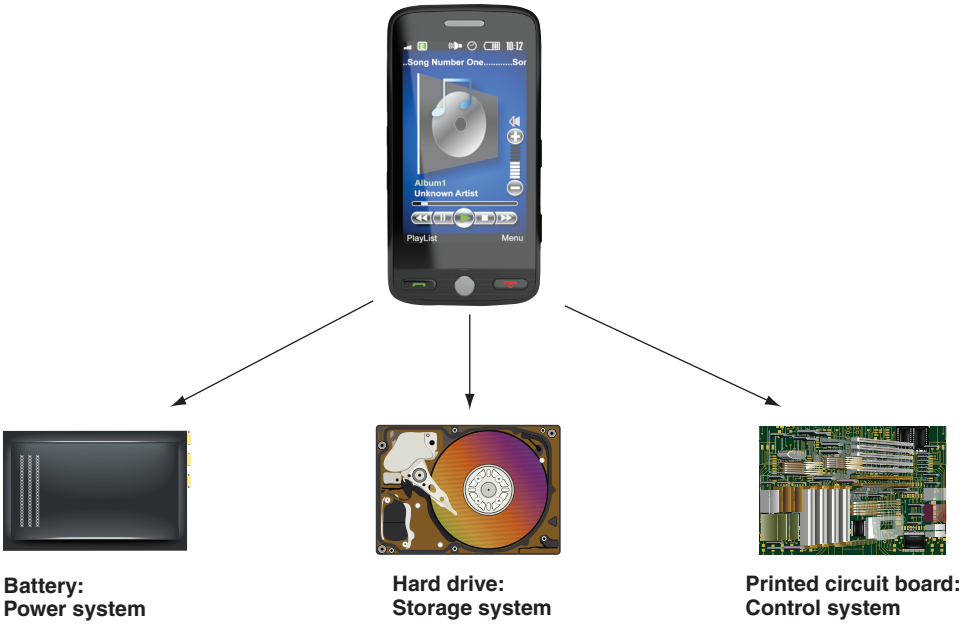


FIGURE 1-6
An MP3 player is a system with power supply, storage, and control subsystems.
Source: Shutterstock.

result in a different set of subsystems.) One subsystem, the battery, supplies the power for the entire system to operate. A second physical subsystem, the storage system, is made up of a hard drive that stores thousands of MP3 recordings. The third subsystem, the control subsystem, consists of a printed circuit board (PCB), with various chips attached, that controls all of the recording, playback, and access functions. Breaking the subsystems down into their components reveals even more about the inner workings of the system and greatly enhances our understanding of how the overall system works.

Modularity is a direct result of decomposition. It refers to dividing a system into chunks or modules of a relatively uniform size. Modules can represent a system simply, making it easier to understand and easier to redesign and rebuild. For example, each of the separate subsystem modules for the MP3 player in Figure 1-6 shows how decomposition makes it easier to understand the overall system.

Modularity
Dividing a system up into chunks or modules of a relatively uniform size.

Coupling means that subsystems are dependent on each other. Subsystems should be as independent as possible. If one subsystem fails and other subsystems are highly dependent on it, the others will either fail themselves or have problems functioning. Looking at Figure 1-6, we would say the components of a portable MP3 player are tightly coupled. The best example is the control system, made up of the printed circuit board and its chips. Every function the MP3 player can perform is enabled by the board and the chips. A failure in one part of the circuit board would typically lead to replacing the entire board rather than attempting to isolate the problem on the board and fix it. Even though repairing a circuit board in an MP3 player is certainly possible, it is typically not cost effective; the cost of the labor expended to diagnose and fix the problem may be worth more than the value of the circuit board itself. In a home stereo system, the components are loosely coupled because the subsystems, such as the speakers, the amplifier, the receiver, and the CD player, are all physically separate and function independently. If the amplifier in a home stereo system fails, only the amplifier needs to be repaired.

Coupling
The extent to which subsystems depend on each other.

Cohesion is the extent to which a subsystem performs a single function. In the MP3 player example, supplying power is a single function.

Cohesion
The extent to which a system or subsystem performs a single function.

This brief discussion of systems should better prepare you to think about computer-based information systems and how they are built. Many of the same principles that apply to systems in general apply to information systems as well. In the next section, we review how the information systems development process and the tools that have supported it have changed over the decades.

A Modern Approach to Systems Analysis and Design

Today, systems development focuses on systems integration. Systems integration allows hardware and software from different vendors to work together in an application. It also enables existing systems developed in procedural languages to work with new systems built with visual programming environments. Developers use visual programming environments, such as Visual Basic, to design the user interfaces for systems that run on client/server platforms. In a client/server environment, some of the software runs on the server, a powerful computer designed to allow many people access to software and data stored on it, and some of the software runs on client machines. Client machines are the PCs you use at your desk at work. The database usually resides on the server. These relationships are shown in Figure 1-7. The Internet is also organized in a client/server format. With the browser software on your home PC, you can get files and applications from many different computers throughout the world. Your home PC is the client, and all of the Internet computers are servers.

Alternatively, organizations may purchase an enterprise-wide system from companies such as SAP (Systems, Applications, and Products in Data Processing) or Oracle. Enterprise-wide systems are large, complex systems that consist of a series of independent system modules. Developers assemble systems by choosing and implementing specific modules. Enterprise-wide systems usually contain software to support many different tasks in an organization rather than only one or two functions. For example, an enterprise-wide system may handle all human resources management, payroll, benefits, and retirement functions within a single, integrated system. It is, in fact, increasingly rare for organizations to develop systems in-house anymore. Chapter 2 will introduce you to the various sources of information systems technology. First, however, you

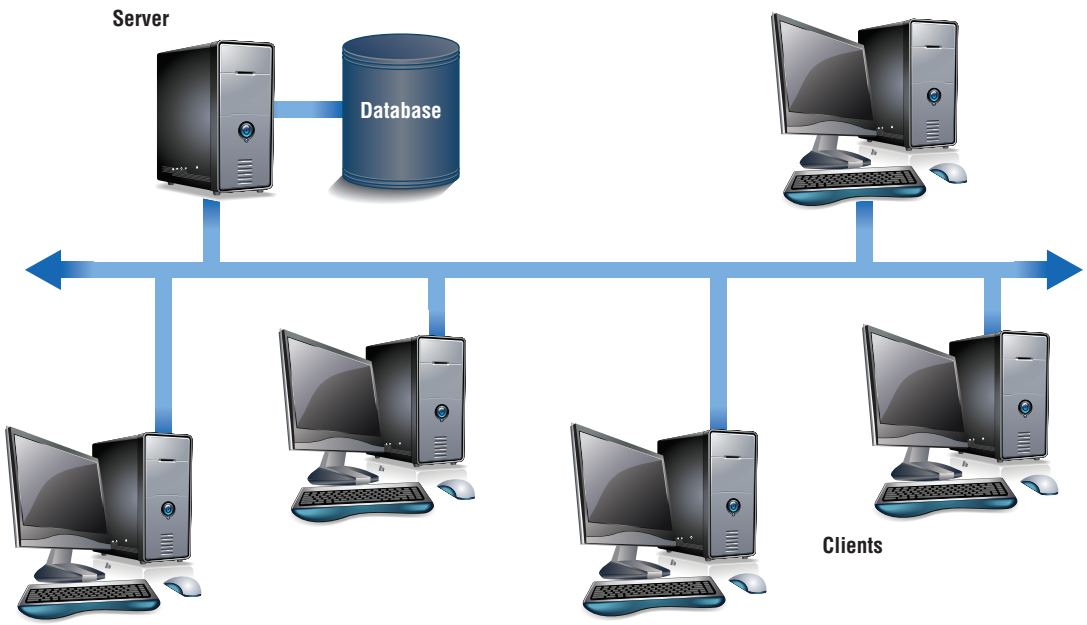


FIGURE 1-7
The client/server model.

must gain some insight into what your role will be in the systems development process.

Your Role in Systems Development

Systems analyst
The organizational role most responsible for the analysis and design of information systems.

Although many people in organizations are involved in systems analysis and design, the **systems analyst** has the primary responsibility. A career as a systems analyst will allow you to have a significant impact on how your organization operates. This fast-growing and rewarding position is found in both large and small companies. According to the U.S. Bureau of Labor Statistics, the professional IT workforce will grow by more than 22 percent between 2010 and 2020 (Thibodeau, 2012). The fastest growth will come for software developers (32 percent) and database administrators (31 percent). One particular aspect of the IT industry, cloud computing, is predicted to create almost 14 million technology-related jobs by 2015 (McDougall, 2012). Annual revenues from cloud computing will be over $1.1 trillion (USD) starting that year. With the challenges and opportunities of dealing with rapid advances in technology, it is difficult to imagine a more exciting career choice than information technology, and systems analysis and design is a big part of the IT landscape. The primary role of a systems analyst is to study the problems and needs of an organization in order to determine how people, methods, and information technology can best be combined to bring about improvements in the organization. A systems analyst helps system users and other business managers define their requirements for new or enhanced information services.

Systems analysts are key to the systems development process. To succeed as a systems analyst, you will need to develop four types of skills: analytical, technical, managerial, and interpersonal. Analytical skills enable you to understand the organization and its functions, to identify opportunities and problems, and to analyze and solve problems. One of the most important analytical skills you can develop is systems thinking, or the ability to see organizations and information systems as systems. Systems thinking provides a framework from which to see the important relationships among information systems, in the organizations where they exist, and in the environment where the organizations themselves exist. Technical skills help you understand the potential and the limitations of information technology. As an analyst, you must be able to envision an information system that will help users solve problems and that will guide the system's design and development. You must also be able to work with programming languages such as C++ and Java, various operating systems such as Windows and Linux, and computer hardware platforms such as IBM and Mac. Management skills help you manage projects, resources, risk, and change. Interpersonal skills help you work with end users as well as with other analysts and programmers. As a systems analyst, you will play a major role as a liaison among users, programmers, and other systems professionals. Effective written and oral communication, including competence in leading meetings, interviewing end users, and listening, are key skills that analysts must master. Effective analysts successfully combine these four types of skills, as Figure 1-8 (a typical advertisement for a systems analyst position) illustrates.

Let's consider two examples of the types of organizational problems you could face as a systems analyst. First, you work in the information systems department of a major magazine company. The company is having problems keeping an updated and accurate list of subscribers, and some customers are getting two magazines instead of one. The company will lose money and subscribers if these problems continue. To create a more efficient tracking system, the users of the current computer system as well as financial managers submit their problem to you and your colleagues in the information systems department. Second, you work in the information systems department at a university, where

FIGURE 1-8
A job advertisement for a systems analyst.

Simon & Taylor, Inc., a candle manufacturer, has an immediate opening for a systems analyst in its Vermont-based office.

The ideal candidate will have:

1. A bachelor's degree in management information systems or computer science.
2. Two years' experience with UNIX/LINUX.
3. Experience with C, Java, and/or other object-oriented programming languages, and with application development environments such as Visual Studio or IBM's Rational Unified Process.
4. LAN-related skills and experience.
5. Familiarity with distribution and manufacturing concepts (allocation, replenishment, shop floor control, and production scheduling).
6. Working knowledge of project management and all phases of the systems development life cycle.
7. Strong communication skills.

We offer a competitive salary, relocation assistance, and the challenges of working in a state-of-the-art IT environment.

E-mail your resume to HR@simontaylor.com.

Simon & Taylor, Inc., is an equal opportunity employer.

you are called upon to address an organizational problem such as the mailing of student grades to the wrong addresses.

When developing information systems to deal with problems such as these, an organization and its systems analysts have several options: They can go to an information technology services firm, such as Accenture or Capgemini, to have the system developed for them; they can buy the system off the shelf; they can implement an enterprise-wide system from a company such as SAP; they can obtain open-source software; or they can use in-house staff to develop the system. Alternatively, the organization can decide to outsource system development and operation. All of these options are discussed in detail in Chapter 2.

Developing Information Systems and the Systems Development Life Cycle

Systems development methodology
A standard process followed in an organization to conduct all the steps necessary to analyze, design, implement, and maintain information systems.

Systems development life cycle (SDLC)
The series of steps used to mark the phases of development for an information system.

Organizations use a standard set of steps, called a **systems development methodology**, to develop and support their information systems. Like many processes, the development of information systems often follows a life cycle. For example, a commercial product, such as a Nike sneaker or a Honda car, follows a life cycle: It is created, tested, and introduced to the market. Its sales increase, peak, and decline. Finally, the product is removed from the market and is replaced by something else. The **systems development life cycle (SDLC)** is a common methodology for systems development in many organizations. It marks the phases or steps of information systems development: Someone has an idea for an information system and what it should do. The organization that will use the system decides to devote the necessary resources to acquiring it. A careful study is done of how the organization currently handles the work the system will support. Professionals develop a strategy for designing the new system, which is then either built or purchased. Once complete, the system is installed in the organization, and after proper training, the users begin to incorporate the new system into their daily work. Every organization uses a slightly different life-cycle model to model these steps, with anywhere from three to

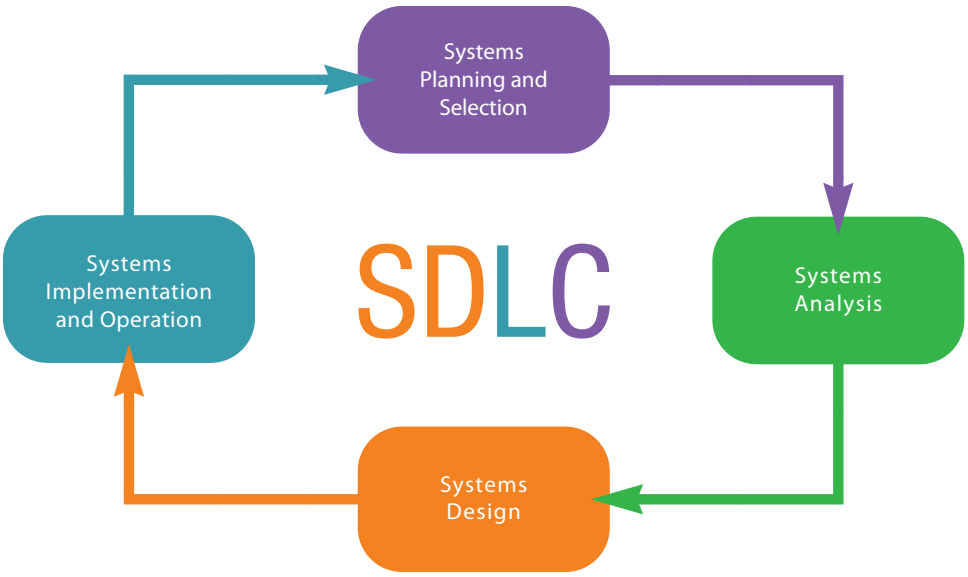


FIGURE 1-9
The systems development life cycle (SDLC).

almost twenty identifiable phases. In this book, we highlight four SDLC steps: (1) planning and selection, (2) analysis, (3) design, and (4) implementation and operation (see Figure 1-9).

Although any life cycle appears at first glance to be a sequentially ordered set of phases, it actually is not. The specific steps and their sequence are meant to be adapted as required for a project. For example, in any given SDLC phase, the project can return to an earlier phase, if necessary. Similarly, if a commercial product does not perform well just after its introduction, it may be temporarily removed from the market and improved before being reintroduced. In the systems development life cycle, it is also possible to complete some activities in one phase in parallel with some activities of another phase. Sometimes the life cycle is iterative; that is, phases are repeated as required until an acceptable system is found. Some systems analysts consider the life cycle to be a spiral, constantly cycling through the phases at different levels of detail, as illustrated in Figure 1-10. The circular nature of the life-cycle diagram in Figure 1-10

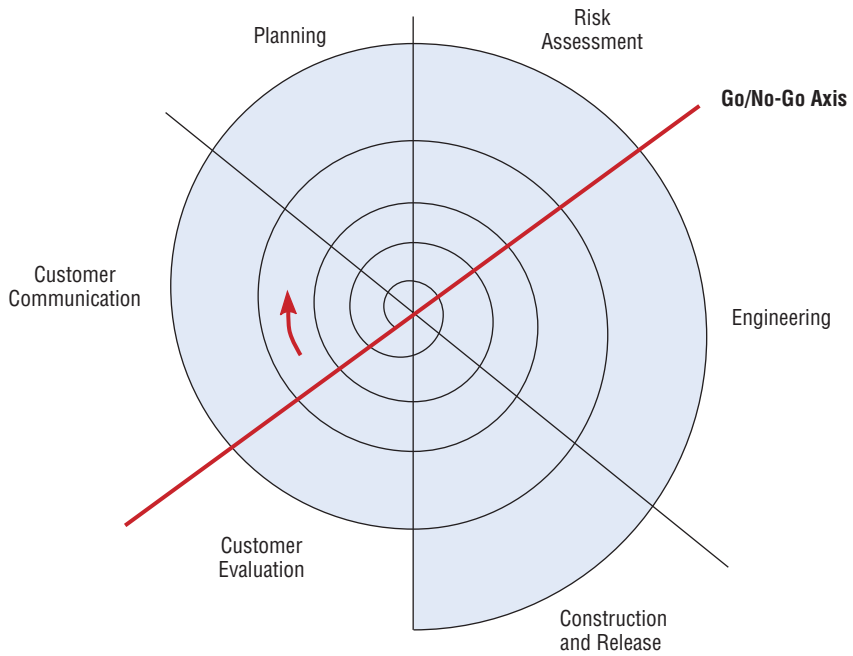


FIGURE 1-10
Evolutionary model SDLC.

illustrates how the end of the useful life of one system leads to the beginning of another project that will replace the existing system altogether. However conceived, the systems development life cycle used in an organization is an orderly set of activities conducted and planned for each development project. The skills required of a systems analyst apply to all life-cycle models.

Every medium-to-large corporation, such as Walmart, and every custom software producer, such as SAP, will have its own specific, detailed life-cycle or systems development methodology in place. Even if a particular methodology does not look like a cycle, many of the SDLC steps are performed, and SDLC techniques and tools are used. This book follows a generic SDLC model, as illustrated in Figure 1-9. We use this SDLC as an example of methodology and a way to think about systems analysis and design. You can apply this methodology to almost any life cycle. As we describe this SDLC throughout the book, it becomes clear that each phase has specific outcomes and deliverables that feed important information to other phases. At the end of each phase (and sometimes within phases for intermediate steps), a systems development project reaches a milestone. Then, as deliverables are produced, they are often reviewed by parties outside the project team, including managers and executives.

Phase 1: Systems Planning and Selection

Systems planning and selection
The first phase of the SDLC, in which an organization's total information system needs are analyzed and arranged, and in which a potential information systems project is identified and an argument for continuing or not continuing with the project is presented.

The first phase in the SDLC, **systems planning and selection**, has two primary activities. First, someone identifies the need for a new or enhanced system. Information needs of the organization are examined, and projects to meet these needs are identified. The organization's information system needs may result from:

- Requests to deal with problems in current procedures
- The desire to perform additional tasks
- The realization that information technology could be used to capitalize on an existing opportunity

The systems analyst prioritizes and translates the needs into a written plan for the information systems (IS) department, including a schedule for developing new major systems. Requests for new systems spring from users who need new or enhanced systems. During the systems planning and selection phase, an organization determines whether resources should be devoted to the development or enhancement of each information system under consideration. A *feasibility study* is conducted before the second phase of the SDLC to determine the economic and organizational impact of the system.

The second task in the systems planning and selection phase is to investigate the system and determine the proposed system's scope. The team of systems analysts then produces a specific plan for the proposed project for the team to follow. This baseline project plan customizes the standardized SDLC and specifies the time and resources needed for its execution. The formal definition of a project is based on the likelihood that the organization's IS department is able to develop a system that will solve the problem or exploit the opportunity and determine whether the costs of developing the system outweigh the possible benefits. The final presentation to the organization's management of the plan for proceeding with the subsequent project phases is usually made by the project leader and other team members.

Systems analysis
Phase of the SDLC in which the current system is studied and alternative replacement systems are proposed.

Phase 2: Systems Analysis

The second phase of the systems development life cycle is **systems analysis**. During this phase, the analyst thoroughly studies the organization's current

procedures and the information systems used to perform tasks such as general ledger, shipping, order entry, machine scheduling, and payroll. Analysis has several subphases. The first subphase involves determining the requirements of the system. In this subphase, you and other analysts work with users to determine what the users want from a proposed system. This subphase involves a careful study of any current systems, manual and computerized, that might be replaced or enhanced as part of this project. Next, you study the requirements and structure them according to their interrelationships, eliminating any redundancies. As part of structuring, you generate alternative initial designs to match the requirements. Then you compare these alternatives to determine which best meets the requirements within the cost, labor, and technical levels the organization is willing to commit to the development process. The output of the analysis phase is a description of the alternative solution recommended by the analysis team. Once the recommendation is accepted by the organization, you can make plans to acquire any hardware and system software necessary to build or operate the system as proposed.

Phase 3: Systems Design

The third phase of the SDLC is called **systems design**. During systems design, analysts convert the description of the recommended alternative solution into logical and then physical system specifications. You must design all aspects of the system from input and output screens to reports, databases, and computer processes.

Systems design
Phase of the SDLC in which the system chosen for development in systems analysis is first described independently of any computer platform (logical design), and is then transformed into technology-specific details (physical design) from which all programming and system construction can be accomplished.

Logical design is not tied to any specific hardware and systems software platform. Theoretically, the system you design could be implemented on any hardware and systems software. Logical design concentrates on the business aspects of the system—that is, how the system will impact the functional units within the organization. Figure 1-11 shows both the logical design for a product and its physical design, side by side, for comparison. You can see from the comparison that many specific decisions had to be made to move from the logical model to the physical product. The situation is similar in information systems design.

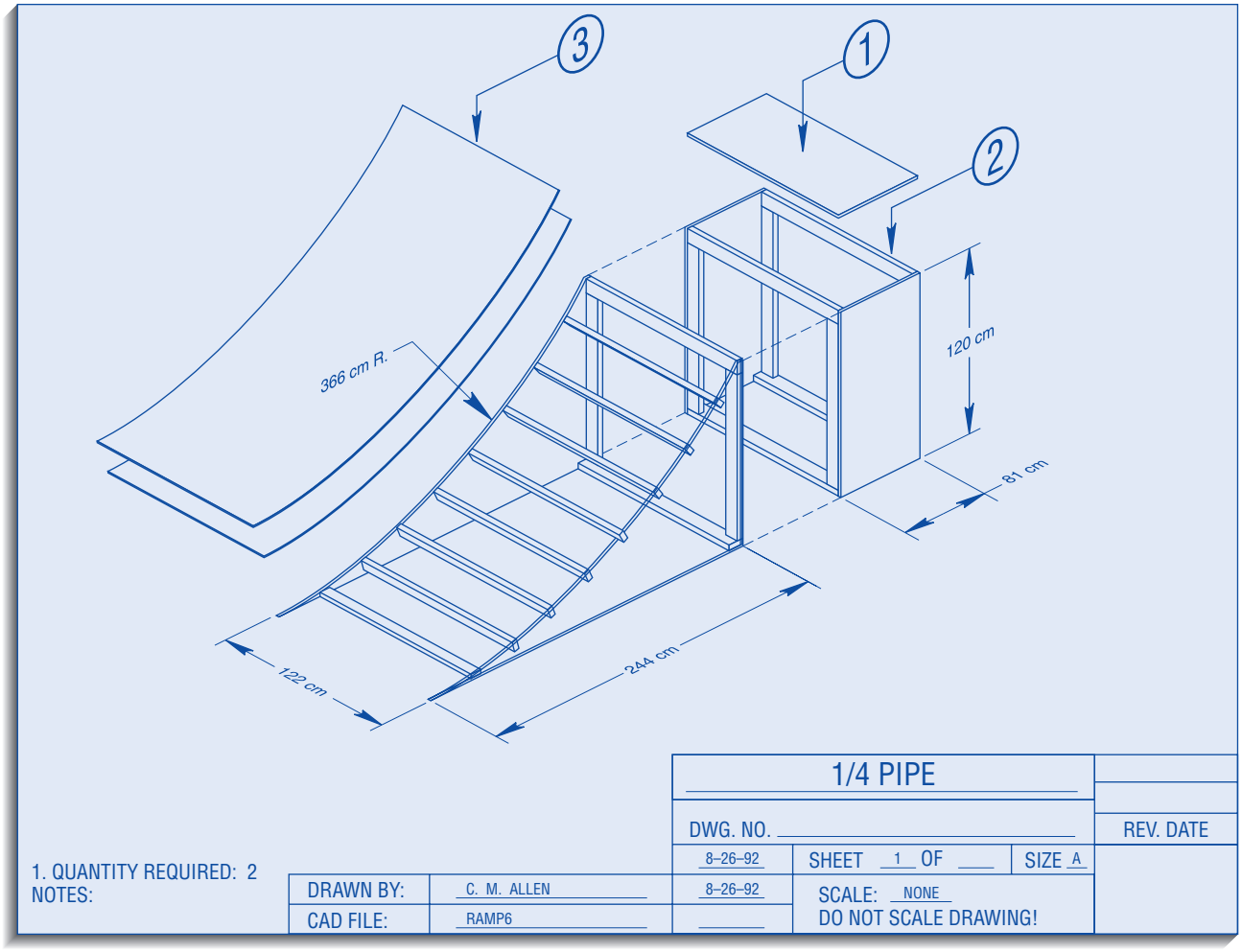
In physical design, you turn the logical design into physical, or technical, specifications. For example, you must convert diagrams that map the origin, flow, and processing of data in a system into a structured systems design that can then be broken down into smaller and smaller units for conversion to instructions written in a programming language. You design the various parts of the system to perform the physical operations necessary to facilitate data capture, processing, and information output. During physical design, the analyst team decides which programming languages the computer instructions will be written in, which database systems and file structures will be used for the data, and which hardware platform, operating system, and network environment the system will run under. These decisions finalize the hardware and software plans initiated at the end of the analysis phase. Now you can acquire any new technology not already present in the organization. The final product of the design phase is the physical system specifications, presented in a form, such as a diagram or written report, ready to be turned over to programmers and other system builders for construction.

Phase 4: Systems Implementation and Operation

Systems implementation and operation
Final phase of the SDLC, in which the information system is coded, tested, and installed in the organization, and in which the information system is systematically repaired and improved.

The final phase of the SDLC is a two-step process: **systems implementation and operation**. During systems implementation and operation, you turn system specifications into a working system that is tested and then put into use. Implementation includes coding, testing, and installation. During coding,

A



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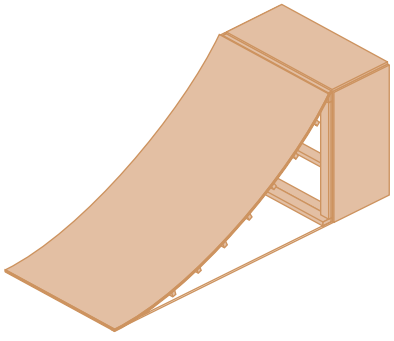

FIGURE 1-11
The difference between logical design and physical design: (A) A skateboard ramp blueprint (logical design), (B) a skateboard ramp (physical design).

Source: www.tumyeto.com/tydu/skatebrd/organizations/plans/14pipe.jpg; www.tumyeto.com/tydu/skatebrd/organizations/iuscblue.html (accessed September 16, 1999). Reprinted by permission of the International Association of Skateboard Companies.

programmers write the programs that make up the system. During testing, programmers and analysts test individual programs and the entire system in order to find and correct errors. During installation, the new system becomes a part of the daily activities of the organization. Application software is installed, or loaded, on existing or new hardware; then users are introduced to the new system and trained. Begin planning for both testing and installation as early as the project planning and selection phase, because they both require extensive analysis in order to develop exactly the right approach.

Systems implementation activities also include initial user support such as the finalization of documentation, training programs, and ongoing user assistance.

Note that documentation and training programs are finalized during implementation; documentation is produced throughout the life cycle, and training (and education) occurs from the inception of a project. Systems implementation can continue for as long as the system exists because ongoing user support is also part of implementation. Despite the best efforts of analysts, managers, and programmers, however, installation is not always a simple process. Many well-designed systems have failed because the installation process was faulty. Note that even a well-designed system can fail if implementation is not well managed. Because the management of systems implementation is usually done by the project team, we stress implementation issues throughout.

The second part of the fourth phase of the SDLC is operation. While a system is operating in an organization, users sometimes find problems with how it works and often think of improvements. During operation, programmers make the changes that users ask for and modify the system to reflect changing business conditions. These changes are necessary to keep the system running and useful. The amount of time and effort devoted to system enhancements during operation depends a great deal on the performance of the previous phases of the life cycle. Inevitably, the time comes when an information system is no longer performing as desired, when the costs of keeping a system running become prohibitive, or when an organization's needs have changed substantially. Such problems indicate that it is time to begin designing the system's replacement, thereby completing the loop and starting the life cycle over again.

The SDLC is a highly linked set of phases whose products feed the activities in subsequent phases. Table 1-1 summarizes the outputs or products of each phase based on the preceding descriptions.

Throughout the systems development life cycle, the systems development project itself needs to be carefully planned and managed. The larger the systems project, the greater the need for project management. Several project management techniques have been developed in the last quarter-century, and

TABLE 1-1: Products of the SDLC Phases

Phase	Products, Outputs, or Deliverables
Systems planning and selection	Priorities for systems and projects
	Architecture for data, networks, hardware, and IS management
	Detailed work plan for selected project
	Specification of system scope
	System justification or business case
Systems analysis	Description of current system
	General recommendation on how to fix, enhance, or replace current system
	Explanation of alternative systems and justification for chosen alternative
	Acquisition plan for new technology
Systems design	Detailed specifications of all system elements
Systems implementation and operation	Code
	Documentation
	Training procedures and support capabilities
	New versions or releases of software with associated updates to documentation, training, and support

many have been improved through automation. Chapter 3 contains a more detailed treatment of project planning and management techniques.

Alternative Approaches to Development

Prototyping, computer-aided software engineering (CASE) tools, joint application design (JAD), rapid application development (RAD), participatory design (PD), and the use of Agile Methodologies represent different approaches that streamline and improve the systems analysis and design process from different perspectives.

Prototyping

Prototyping
Building a scaled-down version of the desired information system.

Designing and building a scaled-down but working version of a desired system is known as **prototyping**. A prototype can be developed with a CASE tool, a software product that automates steps in the systems development life cycle. CASE tools make prototyping easier and more creative by supporting the design of screens and reports and other parts of a system interface. CASE tools also support many of the diagramming techniques you will learn, such as data-flow diagrams and entity-relationship diagrams.

Figure 1-12 illustrates prototyping. The analyst works with users to determine the initial or basic requirements for the system. The analyst then quickly builds a prototype. When the prototype is completed, the users work with it and tell the analyst what they like and do not like about it. The analyst uses this feedback to improve the prototype and takes the new version back to the users. This iterative process continues until the users are relatively satisfied with what they have seen. The key advantages of the prototyping technique are: (1) it involves the user in analysis and design, and (2) it captures requirements in concrete, rather than verbal or abstract, form. In addition to being used as a stand-alone, prototyping may also be used to augment the SDLC. For example, a prototype of the final system may be developed early in analysis to help the analysts identify what users want. Then the final system is developed based on the specifications of the prototype. We discuss prototyping in greater detail in Chapter 5 and use various prototyping tools in Chapter 9 to illustrate the design of system outputs.

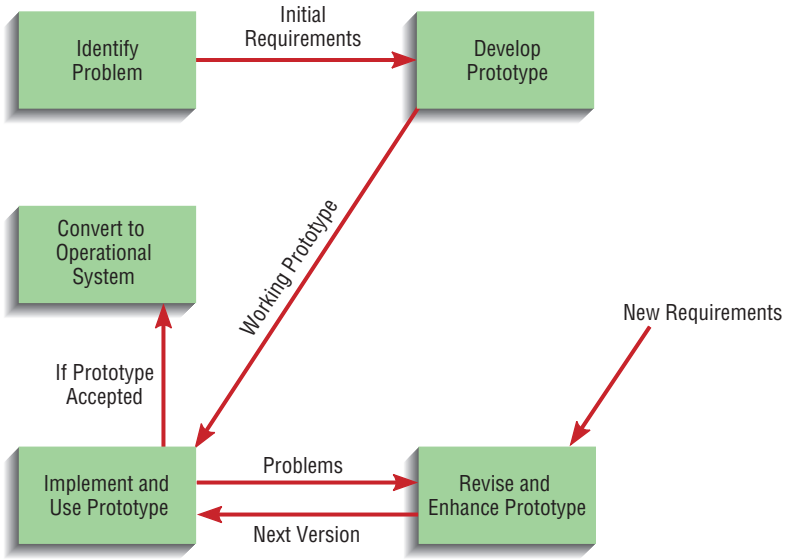

FIGURE 1-12
The prototyping method.
Source: Adapted from J. D. Naumann and A. M. Jenkins, "Prototyping: The New Paradigm for Systems Development," *MIS Quarterly* 6, no. 3 (1982): 29–44.

Computer-Aided Software Engineering (CASE) Tools

Computer-aided software engineering (CASE) refers to automated software tools used by systems analysts to develop information systems. These tools can be used to automate or support activities throughout the systems development process with the objective of increasing productivity and improving the overall quality of systems. CASE helps provide an engineering-type discipline to software development and to the automation of the entire software life-cycle process, sometimes with a single family of integrated software tools. In general, CASE assists systems builders in managing the complexities of information system projects and helps ensure that high-quality systems are constructed on time and within budget.

Computer-aided software engineering (CASE)
Software tools that provide automated support for some portion of the systems development process.

Vendors of CASE products have "opened up" their systems through the use of standard databases and data-conversion utilities to more easily share information across products and tools. An integrated and standard database called a **repository** is the common method for providing product and tool integration and has been a key factor in enabling CASE to manage larger, more complex projects easier and to seamlessly integrate data across various tools and products. The general types of CASE tools include:

Repository
A centralized database that contains all diagrams, forms and report definitions, data structures, data definitions, process flows and logic, and definitions of other organizational and system components; it provides a set of mechanisms and structures to achieve seamless data-to-tool and data-to-data integration.

- Diagramming tools that enable system process, data, and control structures to be represented graphically.
- Computer display and report generators that help prototype how systems "look and feel" to users. Display (or form) and report generators also make it easier for the systems analyst to identify data requirements and relationships.
- Analysis tools that automatically check for incomplete, inconsistent, or incorrect specifications in diagrams, forms, and reports.
- A central repository that enables the integrated storage of specifications, diagrams, reports, and project management information.
- Documentation generators that help produce both technical and user documentation in standard formats.
- Code generators that enable the automatic generation of program and database definition code directly from the design documents, diagrams, forms, and reports.

Joint Application Design

In the late 1970s, systems development personnel at IBM developed a new process for collecting information system requirements and reviewing system designs. The process is called **joint application design (JAD)**. The idea behind JAD is to structure the requirements determination phase of analysis and the reviews that occur as part of the design. Users, managers, and systems developers are brought together for a series of intensive structured meetings run by a JAD session leader. By gathering the people directly affected by an IS in one room at the same time to work together to agree on system requirements and design details, time and organizational resources are better managed. Group members are more likely to develop a shared understanding of what the IS is supposed to do. JAD has become common in certain industries, such as insurance, and in specific companies, such as CIGNA. We discuss JAD in more detail in Chapter 5.

Joint application design (JAD)
A structured process in which users, managers, and analysts work together for several days in a series of intensive meetings to specify or review system requirements.

Rapid Application Development

Prototyping, CASE, and JAD are key tools that support **rapid application development (RAD)**. The fundamental principle of any RAD methodology is

Rapid application development (RAD)
Systems development methodology created to radically decrease the time needed to design and implement information systems.